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Providing telecommunication to the tea plantations in Bangladesh

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Providing Telecommunication to the Tea Plantations in Bangladesh

By

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Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Information Technology

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B. Thomas Golisano College
of
Computing and Information Sciences

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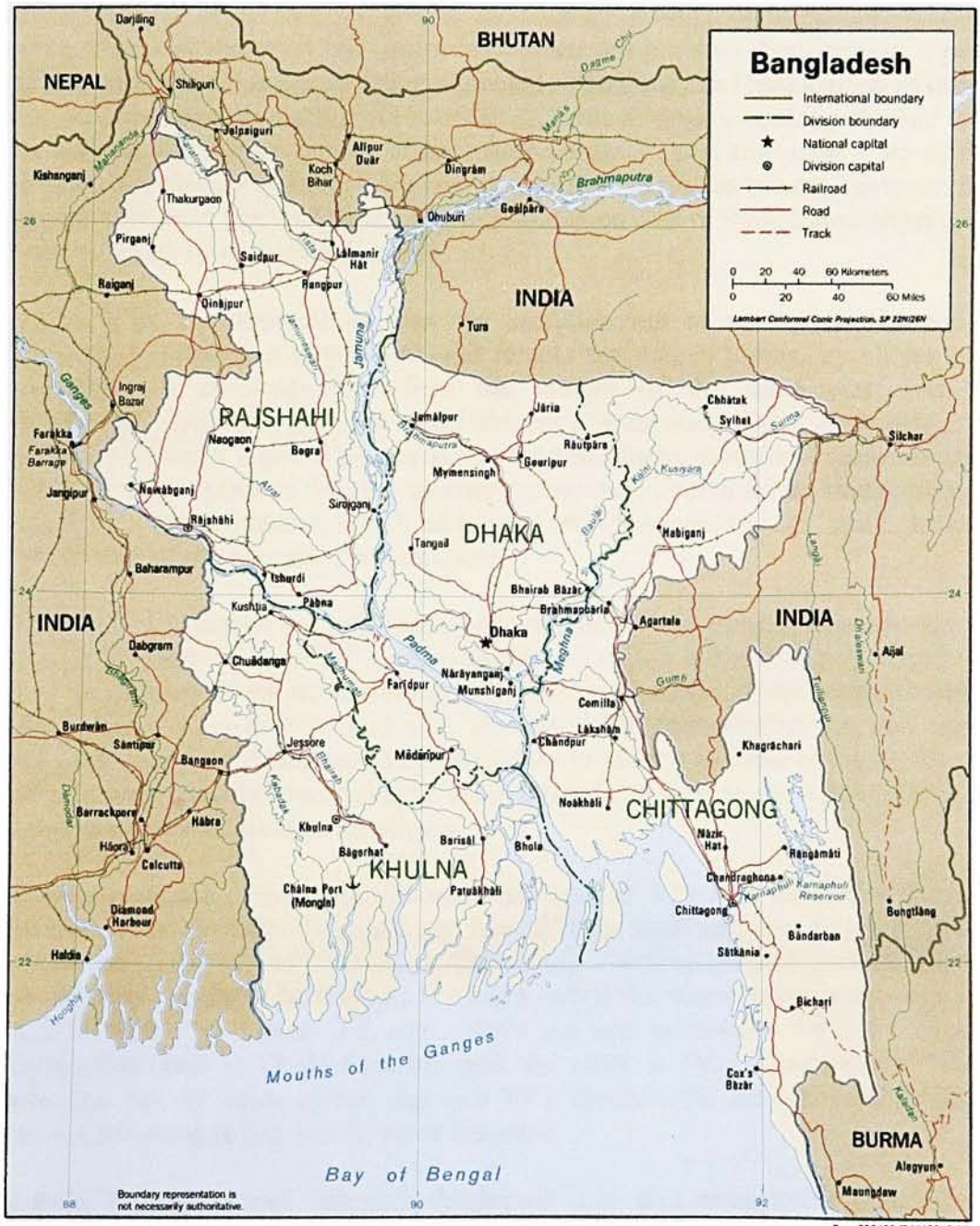
Table of Contents

Abstract

Analyzing all the existing telecommunication technologies in Bangladesh, discussing their merits and demerits, and choosing the most viable option in order to provide a network system to the tea planters for facilitating updating of necessary information of the tea estates to the head offices and vice versa.



Introduction

Tea is a major cash crop in Bangladesh. Most of the tea estates in Bangladesh lie in the North-East of the country in the Sylhet area and a few in the South-East in the Chittagong Hill Tracts. Individuals and companies own these tea estates with their headquarters mostly in Dhaka, while others are in the port city of Chittagong. Thus, administrative offices of these tea estates are situated in these two large cities and are run by these tea estate owners/companies. The problem is that, owners have to employ managers to stay in the tea estate for supervision and to give the detailed information to the headquarters. However, telecommunication and data transmission is a problem. Furthermore, a person is regularly required to commute between the tea estates and the Headquarters in order to transmit information and arrange for transfer of funds through a banking channel to run the tea estates. An employee writes these transactions in pen and paper / stores these transactions in a computer in the administrative office. In the tea estates, however, these records are written in pen and paper. The transportation cost of these transactions is high and must be borne by owners/companies.

The purpose of my thesis is to plan the establishment of a network between the headquarters in those two large cities and remote tea estates jointly, by all tea estate owners/companies in order to reduce the burden of the setup cost from one owner/company. That is, to plan the establishment of a network so that an employee in a tea estate can remotely login to a computer at the headquarter in order to remotely update the necessary information in the Headquarter's computer. Therefore, the transactions and information can be automated, which eliminates the transportation cost and reduces the time of delivery of the necessary information.

The confidential nature of the information of a tea estate will be considered so that it is not viewed by other estates. The implementation of such a network which supports the speed of the delivery of the necessary information (i.e., bandwidth), the confidentiality of each tea estate (i.e., including firewalls), as well as the cost-effectiveness can only be decided after analyzing/discussing about the different aspects of some of the existing and newest telecommunication technologies in Bangladesh as well as stating the merits and the demerits of each of these technologies.

Bangladesh has four satellite earth stations. One standard 'A' type is situated at the south-eastern part of the country (Betbunia) and one 'B' type earth station is situated 33 miles away from the capital city of Dhaka (i.e., Talibabad). The third one, a digital standard 'A' station has been set up at Mohakhali in Dhaka, while the fourth earth station has been installed at Sylhet by British Telecom. There are two microwave links for overseas communication, one is Dhaka-Calcutta and the other is Dhaka-Kathmandu. Dhaka-Calcutta link has 59 voice circuit and one VFT channel. On the other hand, Dhaka-Kathmandu Microwave link has 12 voice channels.

Bangladesh Telephone and Telegraph Board (BTTB) is a government establishment under the Ministry of Post and Telecommunication (MOPT). The Board is headed by the Chairman with 4 full-time members and 3 part-time members under him. At this moment,

BTTB is providing the basic telecommunication services throughout the country and also providing carriers to communicate with the outside world.

BTTB has installed a Packet Switched Data Network at Dhaka and 5 other cities namely Chittagong, Rajshahi, Bogra, Khulna, and Sylhet. This network caters services for three types of subscribers. These are X.25 leased lines, X.28 leased lines, X.28 dial-up subscribers, and X.75 inter-routing lines. Inter-city connectivity has been provided through Microwave (existing analog and digital) and international gateway connectivity has been obtained through Mohakhali Satellite Earth Station taking one 64 Kbps circuit with VSNL (Videsh Sanchar Nigam Limited), New Delhi.

For many years, BTTB enjoyed monopoly over this telecommunication sector. But, the poor quality of services provided by BTTB (telephone density of 0.26 lines per 1000 people, 10 years of waiting time for a connection, installation charge of $450 USD for a new line, successful completion of only 2 of 10 calls, and an average of 50 complaints per 100 lines per year) has led the way to privatizating telecommunication as well as to introduce cellular technologies.

GrameenPhone, the leading private telecommunications company in the country, leases and operates a 1,800 k.m. long optical fiber cable from Bangladesh Railroad and uses GSM900 to provide cellular services in both urban and rural areas (GrameenPhone uses Railway's optical fiber as the main highway and connects Base Stations at 35 kilometer for GSM transmission — the Base Stations are located at Railway Stations). Grameen-Phone is a joint collaboration of Grameen Bank (which provides loans to poor villagers, specially women in order to start their own businesses), Gonofone (a New-York based company), Telenor AS (the primary telephone company in Norway), and Marubeni Corporation of Japan. GrameenPhone employs some Grameen Bank members to provide telephone services to villagers so that they can make telephone calls and/or receive outgoing calls from the homes of these Village Phone operators who are Grameen Bank members. In this way, each of the Village Phone operators is making $2 per day on the average, or $700 per year (twice the country's annual per-capita income), after covering all her/his costs.

But, the drawback of GSM is that it is not a viable option for Internet and e-mails. There are two more private companies named Bangladesh Rural Telephone Authority (BRTA) and Sheba Telecom operating on the northern and the southern parts, respectively. Both BRTA and Sheba have received licenses to operate for 25 years and are utilizing Wireless Local Loop (WLL) technology. WLL is more cost-effective than GSM technology for rural areas. Furthermore, WLL and other options provide much better bandwidth and cost of service. The drawback of WLL is that users experience problems when they try to connect to the phone line of other operators. Fortunately, GrameenPhone has introduced WAP (Wireless Application Protocol) browser from August 1, 2001 which allows the user to browse the Internet in text format, send or receive e-mail, buy or sell stocks, etc., through their GSM phones. The only drawback with GSM is that it can provide a maximum of 9.6 Kbps. There are two other companies providing GSM : (i) Sheba Telecom and (ii) AKTel.

There is a private company named Pacific Bangladesh Telecom Limited / Citycell, which offers CDMA through their cell phones Motorola 182c and Cyberbell 100. CDMA covers Dhaka district, Chittagong district, Comilla district, and Sylhet district.

Recently, BTTB has started providing Dial-Up and Leased Line Internet services at Dhaka and four other major cities namely Chittagong, Bogra, Khulna, and Sylhet. The Internet access is established via Mohakhali Satellite Earth Station using a backbone capacity of 512 Kbps with Teleglobe, Canada. Process is under way to take another 2 Mbps backbone with C & W, UK. The target was to increase the Internet backbone speed to 8 Mbps by June, 2001. But, as soon as the establishment of the Dhaka-Chittagong Optical Fiber Link is completed, Chittagong, too, will be connected, using Digital Data Network.

Very recently, BTTB has installed DSL nodes at 5 exchanges in Dhaka and 4 other places namely Chittagong, Sylhet, Khulna, and Bogra. Through this network, BTTB is providing high speed point-to-point data lines (64 Kbps to 2048 Kbps) using voice grade copper cables. Already some of the banks and corporate offices have started utilizing these lines.

It is being heard that there will be no Analog Exchanges in place after 2001 in the district city level. All transmission links interconnecting the district headquarters will become digital by the end of 2001. Most of the major districts will be interconnected through Digital Microwave Transmission Line. This will increase the quality of service of the links and higher bandwidth of the links will boost up the transmission of Data as well as voice. BTTB also has a plan to use Frame Relay with ATM network.

Major backbone transmission links in Bangladesh are presently using star formation with Dhaka as the center of the network. Some of the proposed transmission routes will introduce mesh formation in some areas of backbone transmission network, which will increase the reliability of communication. Some of the old Plesynchronous Digital Hierarchy (PDH) links will be converted to Synchronous Digital Hierarchy (SDH) links.

Programs were under implementation to increase the Internet Backbone capacity to 8 Mbps by June, 2001. A Memorandum of Understanding has already been signed with Singapore Telecommunication to interconnect Bangladesh with the outside world through Optical Fiber Link. The estimated project time is 1 year 9 months from the commissioning of the project. A Project Concept Paper (PCP) has already been submitted by the Ministry of Post and Telecommunication to expand Internet Services and High-Speed Digital Subscriber Line (DSL) Services to all the 64 districts of Bangladesh. An ATM Network between the Divisional Headquartes has also been proposed in this PCP.

Reference :

Mr. Abdur Raquib Saber (saber@grameenphone.com)

Geography of Bangladesh and its tea plantation portions

Bangladesh is a small, low-lying riverine country in South Asia with an area of 143,998 sq. k.m. (55,598 sq. miles) and a population of 129 million. Its location is amidst the Himalayan foothills and the Indian Ocean. Dhaka is the largest city and the capital of Bangladesh.[1]

India borders on the north, east, and west, while Myanmar (Burma) is on the south-west and the Bay of Bengal flows on the south with a marshy coastline of 600 kilometers.[2]

Bangladesh lies within the broad, green delta formed by the Ganges, Brahmaputra, and Meghna rivers and its tributaries. Since the land is flat and low-lying, annual flood waters deposit fertile, alluvial soil.[3]

The hilly terrain, which makes up one-tenth of the country, is in the Chittagong Hill Tracts situated in the narrow strip of land forming the extreme south-eastern part. The country's highest peak — Mowdok Mual (1,003 meters / 3,292 feet) lies on the border with Myanmar. Small hills are scattered along the north-eastern region of Sylhet.[2]

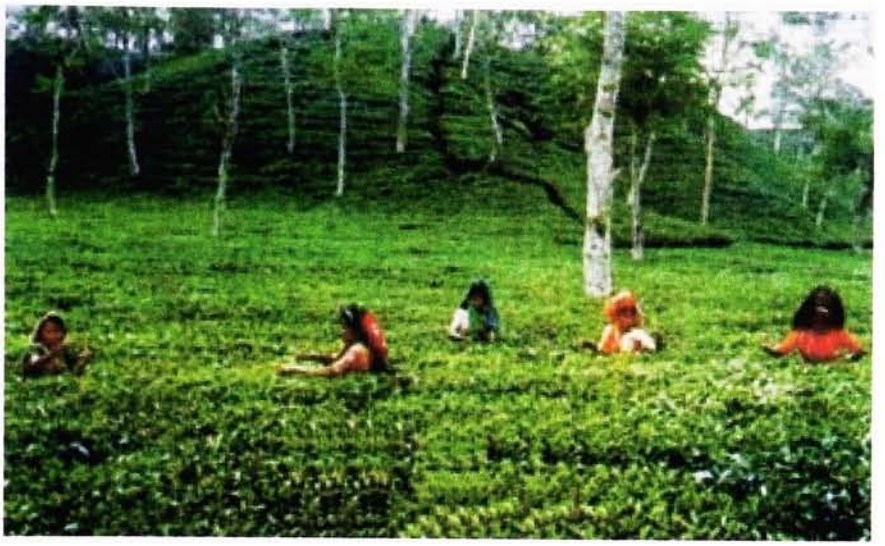
Bangladesh has its share of annual cyclones and floods. Although it is one of the world's most populated countries, the rural areas are spacious. Bangladesh is a land with a rich history and a variety of attractions for country of such a small size. It has archaeological sites dating back over 2,000 years; the world's longest beach is in Cox's Bazaar (Chittagong) and the world's largest littoral mangrove forest — Sundarbans (Khulna) in the south is presently the home of the Royal Bengal Tiger, besides other wild animals.[3]

The country is mainly agricultural, due to its fertile, alluvial soil. Bamboo and palm forests intermingle with monsoonal forests; while in the southern region, mangrove and hardwood forests form the lush vegetation of the country. Since the Tropic of Cancer

horizontally cuts through the middle of the country, Bangladesh has a tropical monsoonal climate with three seasons — the hot summer season when there are heavy thunderstorms between March and June. The monsoons last from June to September. 80% of the annual precipitation (1.27 meters to 1.52 meters / 50 inches to 60 inches) occurs while heavy, frequent downpours shroud the country. During the monsoons, it is cooler than the hot summer, but humidity is present. The winters are cool and dry and last from October to February.[4]

The picturesque Surma and Halda valleys are the southernmost slopes of the famous tea growing hills, which roll down from Assam (India). Once these foothills abounded with buffalos, elephants, and leopards. This was the home of the ferocious, majestic, Royal Bengal Tiger around a century ago, before man migrated down from the north, clearing the forests, setting up homes, and converting the fertile valley slopes into tea plantations.[5]

The golden tips of tea were ripe for plucking around the mid 19th century. The first, experimental tea plantations were carried out in the slopes of the Chittagong club in 1840. Bangladesh tea industry dates back to 1857, when the first commercial tea garden was established in Malnicherra in Sylhet by the British. Soon Bangladesh tea established a place in the London Tea Auction, and among tea tasters and consumers. Tea production in those early days were in its primitive phases. Tea harvests were carried to ocean bound vessels in the Bay of Bengal by small country-boats navigating an intricate network of rivers. On embarking upon the first decade of the 21st century, there is more to the tea-growing industry than a heritage Bangladesh can be proud of.[5]



The tea belt of Surma and Halda valley nestles between the Khasia and Jaintia hills on the north and the Tripura hills on the south. The monotonous flatlands of the country are broken in Sylhet by a multitude of terraced tea gardens, rolling countryside and the exotic flora and fauna. Here, the thick tropical forests still abound with many species of wildlife, scented orange groves and luxuriant pineapple plantations. A beautiful pair of winding rivers named Surma and Kushiara fed by innumerable hillstreams from the north and south flows through the Sylhet valley. The valley has many big natural depressions called "haors". During summer, these are vast stretches of green grassland; but during the monsoons, they turn into large lakes. These lakes provide sanctuary to millions of migratory birds flying across the Himalayas to avoid the severe Siberia winter.[6]

Srimangal, about 80 kilometers south of Sylhet city is known as the tea capital of Bangladesh and the mode of transportation is by road and rail. This is the actual tea center where the Tea Research Institute is situated. Tea gardens spread around for miles like lush green carpets over the plain lands and the sloping hills. Sylhet has 134 tea gardens and possesses three of the largest tea gardens in the world — both in area and production.[6]

The approximate total area of the tea belt in Sylhet division is 97,731.35 hectares. The approximate distance of the nearest tea garden from Sylhet city (Dadanagar Tea Estate) is

8 kilometers and the approximate distance of the farthest tea garden from Sylhet city (Rema Tea Estate) is 110 kilometers.[7]

Chittagong, the second largest city in the country, was termed as "a sleeping beauty emerging from the mist and water" in the 7th century and "Ports Grande" in the 16th century. This is the largest port city which has developed amidst beautiful natural surroundings studded with green hills, coconut palms, mosques, minarets, shrines, hindu temples, and buddhist pagodas against a background of silvery-blue waters of the Bay of Bengal. There are a few tea gardens around Chittagong and Chittagong Hill Tracts of Rangamati.[8]

The approximate total area of tea belt in the Chittagong division is 13,593.94 hectares. There are a total of 24 tea gardens in the Chittagong division. The approximate distance of the nearest tea garden from Chittagong city (Potya Tea Estate) is 10 kilometers and the approximate distance of the farthest tea garden from Chittagong city (Rangamati Tea Estate) is 60 kilometers.[7]

The processed tea arrives from tea gardens in bulk to Chittagong city, which are graded and auctioned by brokers. Then, they are sent to the bonded warehouses for shipment abroad.

[1] http://travel.yahoo.com/t/asia/bangladesh/lp_facts.html
[2] http://www.geocities.com/hali2001/safgamesdata/bangladesh.html
[3] http://travel.yahoo.com/t/asia/bangladesh/lp_general.html
[4] http://www.atlapedia.com/online/countries/banglad.htm
[5] http://www.bdteaboard.com/first.html
[6] http://www.lunarpages.com/sylhet/sylhet.htm
[7] Rema and Sabazpur Tea Company ltd.
55, Motijheel Commercial Area, Dhaka-1000, Bangladesh.
rema@bangla.net
[8] http://www.epbbd.com/country1.htm

Operations in Tea Plantations

Tea is an agro-based, labor intensive, and export oriented sector. It plays an important role in the country's national economy through export earnings, trade balance, and employment generation.[1]

The word "tea" is derived from "t'e" of the Chinese dialect. Tea drinking originated in China. Use of tea as a beverage commenced towards the end of the 6th century. The popularity of tea spread to different parts of the world by the 17th century.

Setting up of the tea industry in undivided India

In 1834, Lord William Bentick, then the Governor General of India, appointed a tea committee to advise on the possibility of commercial cultivation of tea in India. The first private-owned tea company, "The Assam Company" was formed in 1839 and emerged as the first successful tea company in the world.

Different phases of work done in a tea plantation

Cultivation : Tea (Camellia Sinensis), grows into a small tree of 9 meters in natural conditions. Under cultivation for commercial purposes, tea plants are trimmed as low spreading bushes, subjected to various treatments, including pruning and plucking to ensure the maximum number of tender plucking shoots.

Tea plants flower between July and October and the seeds which are 1 c.m. in diameter, are collected from October to January. After the shell protecting the kernel cracks, the seeds are removed and planted in nursery beds where they grow for 9-12 months. They are then planted in plantation areas. A tea bush can yield leaves up to 100 years, but the yield gradually tapers down after 50 years.

The modern method of cultivation is to take cuttings from good high yielding mother plants. This method is known as clonal planting. Tea leaves are harvested at a convenient height from the bushes kept to a flat top surface or table. Shoots grow through the surface and two or three leaves and a bud are harvested above the table. The foliage below the table is the maintainance foliage and is not plucked.

Mother bush and nucleus clone plot : The plants reared from the cuttings of one mother bush form a clone. A separate plot is maintained for each individual clone. The plot from where cuttings are taken from mother clone plants is called the nucleus clone plant.

Vegetative Propagation : Shoots pruned from mother bushes for preparation of cuttings are transported to the nursery site quickly. Exposure to the sun and wind causing wilting

of the shoots are avoided. All cutting works are done in the shade. Good cuttings come from semi-hard middle portion of the shoot. The best time for propagation is from May to October. Cuttings can be raised straightaway in polythene sleeves or in primary nursery beds. If planted in primary beds, the cuttings after rooting are transferred into polythene bags. When cuttings grow to a reasonable height, the overhead shade is gradually removed to harden the plants to withstand field conditions. After 12-15 months, plants are transplanted in the field when they are 18 inches in height and the stem is pencil thick.

Climatic factors : Climatic factors such as rainfall, temperature, humidity, and duration of light determine the success of tea crop production of a region. Rainfall and temperature play the most important role in the development and growth of tea plants and ultimately in yield per unit area. The water requirement of the tea plant is high and therefore a well distributed rainfall throughout the year is conducive to the growth tea plants. Reasonable humidity maintained during the cropping season is ideal.

Soil characteristics : Tea is a deep rooted plant and for satisfactory growth requires a loose ariable soil. Although water requirement of tea plant is high, water logging causes damage. Tea grows very well in soil rich in organic matter because it contains nitrogen and other essential plant nutrients. For successful tea culture, soil acidity is an important factor. The soil should be neither alkaline nor very acidic. The ideal PH value for tea is between 4.5 and 5.8.

Land preparation and planting : The land selected for tea planting is cleared at the beginning of the dry reason and leveled properly making it ready for the layout of the roads, drains, and planting. Before laying out the drains, due consideration is given to the topography, soil type, rainfall, etc. of the area. Then either high yielding seedlings or clones are planted. A reasonably cool, humid, and moist soil favors transplanting.

Pruning : Freely growing tea plants produce flowers and fruits in due course but very few shoots for the manufacture of tea. The tea plants are therefore pruned to (a) produce a low spreading frame, (b) facilitate harvesting, (c) develop a sturdy framework that can sustain luxurious vegetative growth for future years to harvest maximum crop. The bushes are pruned at intervals to renovate the branch system and keep the bush in the vegetative phase. In the following years, the bushes are either skiffed or leveled off at a higher height.

Plucking : The tender portions of shoots consisting of two or three leaves and a bud are tipped off in plucking. The young shoots are used in the manufacture of tea. Plucking is carried out at intervals of 7/8 days which is called a plucking round. A tea plant is usually tipped after 12 months of planting, but gives full yield in 5 years time after a plant is converted into a bush after a 2-frame formation prune. Plucking starts usually from March and ends in December. Plucking is not normally done during the cold weather of January and February when there is no moisture in the soil; otherwise plucking continues for more or less 10 months.

Shade and shade trees : From the early days of the tea industry, it was observed that a canopy of trees was beneficial for the growth of tea bushes, thus planting shade trees among tea bushes has been practiced for a long time. Shade trees provide a cover for the tea bushes allowing sufficient light to filter through the foliage of the shade trees. The most important functions of shade trees are :

(a) Supplying a large quantity of organic matter which helps in maintaining soil structure and fertility.

(b) Reducing leaf temperature and protecting the tea bushes from sun scorching, wind, and hail damage.

(c) Reducing the incidence of pest and disease.

Nutrient requirement and manuring : With the passage of time, soil fertility gradually decreases. Planters use organic manure like green manure and cattle manure. Inorganic fertilizers are also used. Tea bushes require 3 major nutrients :

(a) Nitrogen requirement is very high as this enhances leaf growth.

(b) Phosphorous is required for root development.

(c) Potassium is needed for carbohydrate synthesis and frame development.

Water management and drainage : Tea plants absorb nutrients from the soil. In the dry soil, nutrients applied as fertilizers as well as those present in the soil remain unavailable to the tea plant. Water is essential for plant growth, but excess of it in the soil interferes with the absorption of nutrients by plant roots. Manuring becomes ineffective if plants do not get the right amount of water. Rainfall in the tea areas vary widely and its distribution is uneven. Hence, water management in tea involves dealing with situations arising out of too little, too much, and uneven distribution of rain.

Drainage is essential for removing excess and stagnant water from the tea area. While designing the layout of drains, care is taken so that no water remains stagnant during heavy rains and also that the area does not dry up excessively during dry periods. Thus, moisture content level is maintained throughout the year. Drainage improves the physical condition of the soil thereby maintaining the desired temperature. In well drained areas, plant roots travel deeper helping up the plants to absorb adequate plant nutrients and withstand drought.

Irrigation and water conservation : Irrigation is necessary in tea areas exposed to long dry spells. A suitable source of water at a convenient place near the irrigation site is a prerequisite for successful irrigation of tea areas.

In areas of low and marginal rainfall, conservation of water in tea areas is more important than the supply of water through irrigation. It is very important to cover the bare soils in tea areas by "mulching" to conserve moisture.

Weed and pest control : Tea bushes are hosts to a wide variety of pests which in sufficient numbers can seriously affect the yielding capacity of the tea estate. These pests

include weeds, bacteria, fungi, insects, eel worms, and mites. Weed/pest control is done in nurseries and on young and mature tea bushes. Sturdy plants, which yield well, are better able to withstand and recover quickly from pest attacks.

In many cases, correcting poor field practices like improving drainage, proper manure levels, reducing weed competition, will suffice.

Pests will always be present. But, awareness of the management of climatic conditions which allow populations to multiply, is important. The key to successful control is careful observation and routine monitoring of different sections of the estate. Control is done depending on the type of weed/pests and the part of the plant affected (leaf, bark, etc.) or age of the plant. Sometimes, hand picking is done when the attack is slight. At other times, affected branches are scraped or clean-cut, painted with coal tar, bitumin, etc.. Chemical control is done after careful evaluation of the alternatives.

Processing of tea : The freshly plucked tender shoots consist of either two leaves or three leaves with a bud, which is the basic material for tea manufacture. These plucked shoots contain 77% moisture and 23% solid matter.

Presently, Bangladesh manufactures only the following two types of tea : (a) CTC — 99% and (b) Green tea — 1%. Gradually, the orthodox method of processing tea has been phased out. Using CTC machines eliminates the orthodox rolling out procedure.

Withering : Withering reduces the moisture content of the leaf, concentrating the juices and bringing the leaf to a flaccid condition in which the leaf can withstand the subsequent proocess of manufacturing. Withering is carried out under controlled conditions in troughs, where trough fans flow dry conditioned air through the green leaves and the desired percentage of physical withering can be achieved under any climatic condition. Proper withering (60% to 70% wither) is a prerequisite for quality tea.

CTC manufacture : The CTC machine is used for Cutting, Tearing, and Curling of the withered leaves for the CTC manufacture of tea. The CTC is used in conjunction with either rolling or rotorvane systems where the leaf has been conditioned for CTC processing. In this machine, 70% withered leaf is cut, torn, and curled in the small gap between the serrated surfaces of the rollers.

Fermentation : This is done on the floor of the factory on epoxy painted areas. It is also done in Continuous Fermenting Machine. Here, oxidation of the tanin in tea leaf is caused by enzymic action. During fermentation, important properties of tea like color, strength, and aroma are developed.

Drying : This is done by firing in a blast of hot air in order to arrest the fermentation, achieve the desirable properties and remove moisture from oxidized leaf (2%-3% at dryer

mouth level) to obtain a finished product — made tea, which can be handled, transported, and marketed.

Sorting and Grading : The dried tea is sorted on the basis of physical separation of different sizes of particles of dried tea and given grade names. There are 10 primary grades of CTC tea. "Brokens" are bigger grades of made tea. "Fannings" are smaller grades and "dusts" are powdery made teas.[2]

Category	Grades
BROKENS	FP (Flowery Pekoe) FBOP(Flowery Broken Orange Pekoe) BOP (Broken Orange Pekoe) GBOP(Golden Broken Orange Pekoe)
FANNINGS	OF (Orange Fanning) FOF (Flowery Orange Fannings)
DUST	PD (Pekoe Dust) RD (Red Dust) D (Dust) CD (Churamani Dust)

Packing : After grading, the processed tea is packed in airtight gunny bags or tea chests and sent to the warehouses in Chittagong.

Maintenance of National & International Standard Specification of Tea : After arrival of the tea in bulk in the Warehouse from the garden, the authorized brokers draw samples from both leaf tea and dust tea from each lot of chests for tasting and examination in the tea tasting laboratory to conform with international standard specification ISO-3720 and Bangladesh standard specification of BDSS-808 and make valuations of the teas on the basis of quality, demand, supply and the previous weekly auction price.

Export of tea : Tea is exported in wooden chests, aluminium lined multiple paper sacks, and aluminium lined gunny bags of international standard. The capacity of tea chests and paper sacks vary from 50 kg to 60 kg, while the capacity of gunny bags is 33 kg to 35 kg.

Packet tea : Box packets made of carton papers contain both tea and tea bags. The latter is of 2 types — single and double chambered, both of which are produced in Bangladesh of international standard and are popular abroad.

Agencies Assisting Production and Marketing of Tea : Bangladesh Tea Board (BTB) is the government department responsible for overall control for development of tea

industry. BTB. through its field wings located in the tea growing areas of Srimongal and Bangladesh Tea Research Institute (BTRI) and the other is Project Development Unit (PDU), provides technical, advisory and management services to tea industry. Other institutions which are of direct relevance to the tea industry are Bangladeshiyo Cha Sangsad (BCS). Tea Traders Association of Bangladesh (TTAB), which are associations representing tea planters and tea traders respectively. Bangladesh Krishi Bank (BKB), which is the government funded bank acts as the conduit for project funds to reach tea estates for development works.

Marketing System : Marketing system of Bangladesh tea is defined as the process of sale of manufactured tea in bulk or packed from tea estates to the buyers at Chittagong Auction or at estates from where teas are sold with the permission of Bangladesh Tea Board either directly to overseas buyers or internal traders. Tea Auction is held every Tuesday at Chittagong. a major port city with sufficient warehouses and port facilities and well connected by road railways and air link. About 55% of the total production is exported to different countries.

1. ***Direct negotiation sale*** : Tea can be exported to foreign buyers through direct negotiation between the buyers and traders.
2. ***Ex-Garden sale*** : Tea is sold directly by the individual producers to the internal buyers (wholesellers & retailers) take place.

Broadly speaking, the marketing of tea in Bangladesh can be divided into 2 main segments : Internal Market and External Market.

Internal Market : Internal market deals with wholesale and retail business of tea for internal consumption of the country. In this case both wholesale and retail trade license must be obtained from Bangladesh Tea Board along with Bidder ship license to participate in the tea auction. The auction is arranged by the Tea Traders Association of Bangladesh (TTAB) under the guidance of Bangladesh Tea Board. All these licenses are renewable yearly. At present, there are about 500 registered retailers, 200 wholesellers and 230 bidders who are active in the trade.

External Market : Bangladesh exports 27 million kg of tea to as many as 44 countries of the world viz : Afghanistan, Australia, Bahrain, Holland, Iran, India, Iraq, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgystan, Malaysia, New Zealand, Nepal, Oman, Pakistan, Poland, Qatar, Rumania, Russia, Saudi Arabia, Sudan, Switzerland, Spain, Singapore, Taiwan, Turkey, U.A.E., U.K., Ukraine, Uzbakistan, Yemen, and others.[1]

[1] http://www.guransetea.com/event/paper2.html

[2] Rema and Sabazpur Tea Company Limited,
55, Motijheel Commercial Area, Dhaka-1000, Bangladesh.
rema@bangla.net

DATABASE DESIGN

A particular tea plantation keeps track of nurseries, plantation areas, factory machines, employees (their names, addresses, birthdate, position, etc.), as well as works performed by these employees — planting, plucking, controlling weeds and/or pests, and working in factories in the tea garden in order to manufacture made tea. Dependents of employees are also taken into account.

DESCRIPTION OF EMPLOYEES

There are three kinds of staff employed in a tea garden. They are : (1) Laborers, (2) Supervisors, and (3) Contractors.

1. **Laborers** : Laborers work in two different areas : (i) agro-area (nursery and/or plantation) and (ii) factory.

(i) There are three kinds of work performed by laborers in an agro-area. They are :

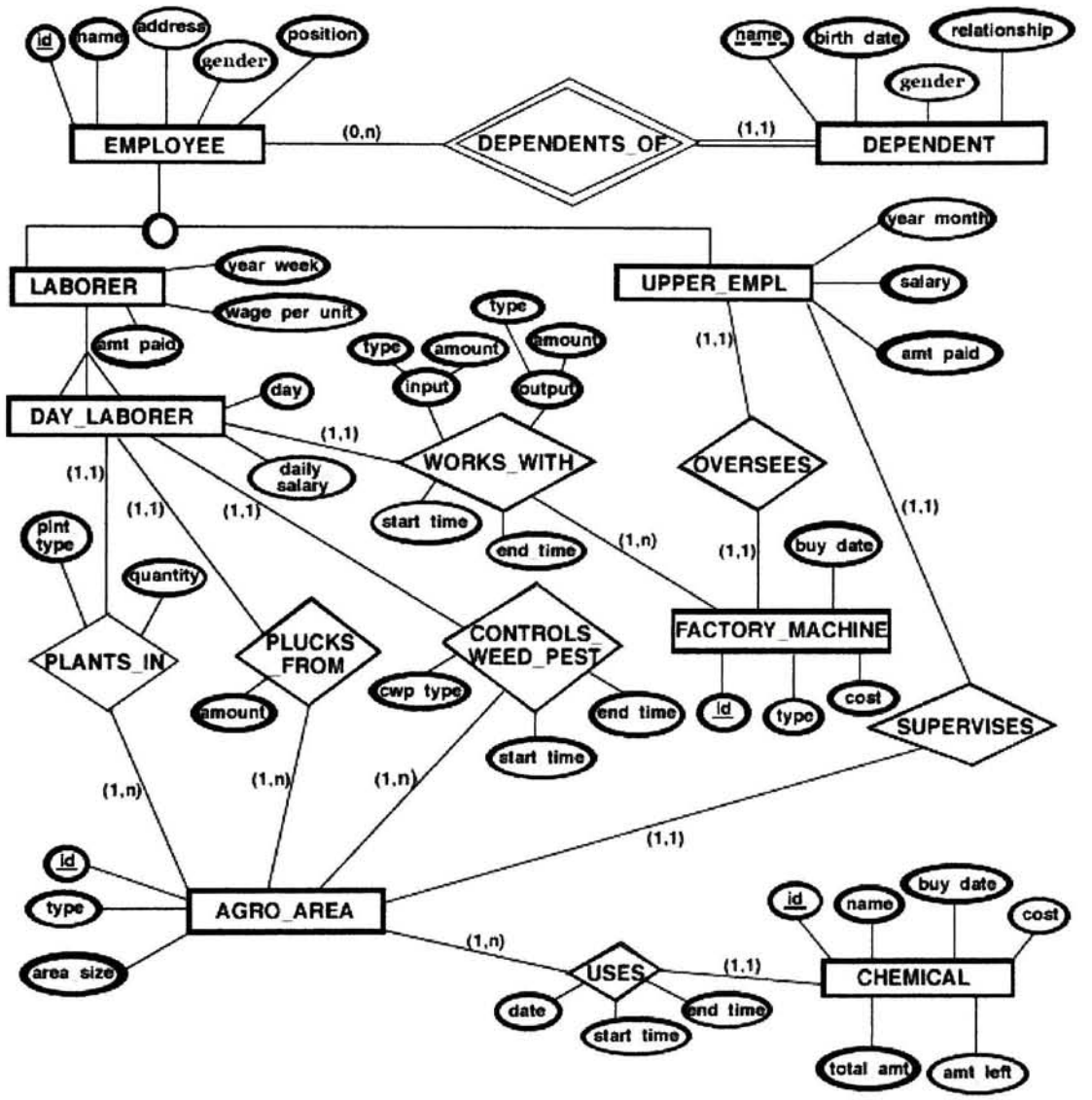
- ***Planting*** — A laborer is paid by the number of saplings planted in a nursery or replanting mature cuttings from the nursery in a plantation area or the number of hours worked on a particular day.
- ***Plucking*** — A laborer plucks tea leaves from the plantation. Here, he/she is paid by the amount (grams/kgs) of tea leaves plucked from the plantation on a particular day, which are added and paid at the end of the week.
- ***Controlling weeds/pests*** — A laborer controls weeds/pests by hand-picking and destroying, scraping, cutting, painting with tar, or spraying chemicals in order to arrest further damage. In this case, the date and time of conducting the above tasks are noted and the employee is paid by the number of hours worked.

(ii) An employee working in the factory gets a fixed daily wage, which is added each day and paid at the end of the week.

2. **Supervisors** : Supervisors supervise laborers working in a particular agro-area or in a particular section of the factory. They (supervisors) get a fixed monthly salary.

3. **Contractors** : Contractors employ some laborers for a certain period who are not permanent residents in the garden. They (contractors) get a fixed monthly salary.

For the factory machines, the type of a particular machine, the type and amount of input given in that machine, and the type and amount of output produced from that machine on a particular day is also noted.



Entity-Relationship Diagram

DESCRIPTION OF THE ENTITY-RELATIONSHIP (ER) DIAGRAM

In the ER diagram, we see that there are some geometrical forms, i.e., rectangles, ovals, diamonds, and a double-diamond — encompassing different kinds of entities and relationships associated with them. Rectangles represent different entities, diamonds represent relationships associated with two entities, the double diamond represents an identifying relationship, ovals connected with each rectangle represent attributes of that particular entity, and ovals connected with each diamond represent attributes of that particular relationship. There are some ovals which have multiple ovals as their branches / tributaries — representing the root oval as composite attributes, i.e., attributes having

smaller subparts, "which represent more basic attributes with independent meaning". Entities and relationships are described below.

ENTITIES :

1. The entity EMPLOYEE has five attributes : id, name, address, gender, and position.
2. The entity UPPER_EMPL derives the attribute "id" from EMPLOYEE (since UPPER_EMPL is one type of EMPLOYEE) and possesses attributes year_month, salary, and amt_paid (amount paid) of its own.
3. The entity LABORER derives the attribute "id" from EMPLOYEE (since LABORER is another type of EMPLOYEE) and possesses attributes year_week, wage_per_unit, and amt_paid of its own.
4. The entity DAY_LABORER derives atrributes id and year_week from LABORER (since DAY_LABORER is only one type of LABORER) and possesses attributes day and daily_salary of its own (since it keeps track of days when the laborer has worked and the daily_salary of each day).
5. The entity DEPENDENT has four attributes : name, birth_date, gender, and "relationship" with the employee.
6. The entity AGRO_AREA has three attributes : id, type, and area_size.
7. The entity FACTORY_MACHINE has four attributes : id, type, buy_date (date when it is bought), and cost.
8. The entity CHEMICAL has six attributes : id, name, buy_date (date when it is bought), cost, total_amt (total amount), and amt_left (amount left).

RELATIONSHIPS :

1. DEPENDENTS_OF is the relationship between entities EMPLOYEE and DEPENDENT. An EMPLOYEE can have no dependents or more than one dependents, but a DEPENDENT must be a dependent of only one EMPLOYEE.
2. OVERSEES is the relationship between entities UPPER_EMPL and FACTORY_MACHINE. It is a 1:1 relationship, since an upper-level employee must oversee a particular factory machine and the factory machine must be overseen by a particular upper-level employee.
3. SUPERVISES is the relationship between entities UPPER_EMPL and AGRO_AREA. It is a 1:1 relationship, since an upper-level employee must supervise a particular agro-area and an agro-area must be supervised by a particular upper-level employee.
4. PLANTS_IN is the relationship between DAY_LABORER and AGRO_AREA, which has attributes plnt_type (plant type) and quantity of its own. A day laborer must plant plants in a particular agro-area and he/she can plant in only one agro-area in a particular day. But, in an agro-area, there must be at least one day laborer planting plants and there can be more than one day laborers planting in a particular agro-area in a particular day.

5. PLUCKS_FROM is the relationship between DAY_LABORER and AGRO_AREA, which has the attribute amount of its own. A day laborer must pluck tea leaves from a particular agro-area and he/she can pluck leaves from only one agro-area in a particular day. But, from an agro-area, there must be at least one day laborer plucking leaves and there can be more than one day laborers plucking leaves from a particular agro-area in a particular day.

6. CONTROLS_WEED_PEST is the relationship between DAY_LABORER and AGRO_AREA, which has attributes cwp_type (type of controlling weeds and/or pests), start_time and end_time of its own. A day laborer must control weeds and/or pests in a particular agro-area and he/she can control weeds and pests in only one agro-area in a particular day during a particular time. But, in an agro-area, there must be at least one day laborer controlling weeds and/or pests and there can be more than one day laborers controlling weeds and/or pests in a particular agro-area in that day and at that time.

7. WORKS_WITH is the relationship between DAY_LABORER and FACTORY_MACHINE, which has attributes start_time, end_time, input, and output of its own. Attributes input and output are composite attributes, both of which have smaller attributes type and amount. A day laborer must work with a particular factory machine and he/she can work with only one factory machine in a particular day and during a particular time. But, there must be at least one day laborer working with that machine and there can be more than one day laborers working with that machine in that day and during that time.

8. USES is the relationship between AGRO_AREA and CHEMICAL, which has attributes date, start_time, and end_time of its own. There must be at least one type of chemical used in an agro-area and there can be more than one type of chemicals used in an agro-area. But, a particular chemical must be used in a particular agro-area.

REFERENCE : Fundamentals of Database Systems — Ramez El Masri, Shamkant B. Navathe

RELATIONAL SCHEMA

EMPLOYEE

EMP_ID	NAME	ADDRESS	GENDER	POSITION

p.k. = EMP_ID

DEPENDENT

f.k. p.k.

EMP_ID	**NAME**	BIRTH_DATE	GENDER	RELATIONSHIP

p.k. = (EMP_ID, NAME)

UPPER_EMPL

f.k.

UE_ID	YEAR_MONTH	SALARY	AMT_PAID

p.k. = (UE_ID, YEAR_MONTH)

LABORER

f.k.

L_ID	YEAR_WEEK	WAGE_PER_UNIT	AMT_PAID

p.k. = (L_ID, YEAR_WEEK)

DAY_LABORER

|----------f.k.----------|

L_ID	YEAR_WEEK	DAY	DAILY_SALARY

p.k. = (L_ID, YEAR_WEEK, DAY)

AGRO_AREA

p.k. f.k.

AA_ID	AA_TYPE	NAME	AREA_SIZE	UE_ID

p.k. = AA_ID

PLANTS_IN

|----------f.k.----------| f.k.

L_ID	YEAR_WEEK	DAY	AA_ID	PLNT_TYPE	QUANTITY

p.k. = (L_ID, YEAR_WEEK, DAY, AA_ID)

PLUCKS_FROM

|----------f.k.----------| f.k.

L_ID	YEAR_WEEK	DAY	AA_ID	AMOUNT

p.k. = (L_ID, YEAR_WEEK, DAY, AA_ID)

CONTROLS_WEED_PEST

|----------f.k.----------| f.k.

L_ID	YEAR_WEEK	DAY	AA_ID	START_TIME	END_TIME	CWP_TYPE

p.k. = (L_ID, YEAR_WEEK, DAY, AA_ID)

FACTORY_MACHINE

p.k. f.k.

FM_ID	FM_TYPE	BUY_DATE	COST	UE_ID

p.k. = FM_ID

WORKS_WITH

|----------f.k.----------| f.k.

L_ID	YEAR_WEEK	DAY	FM_ID	START_TIME	END_TIME	IN_TYPE	IN_AMOUNT	OUT_TYPE	OUT_AMOUNT

p.k. = (L_ID, YEAR_WEEK, DAY, FM_ID)

CHEMICAL

p.k.

CHEM_ID	NAME	BUY_DATE	COST	TOTAL_AMT	AMT_LEFT

p.k. = CHEM_ID

USES

f.k. f.k.

AA_ID	CHEM_ID	DATE	START_TIME	END_TIME

p.k. = (AA_ID, CHEM_ID)

REFERENCE : Fundamentals of Database Systems — Ramez El-Masri, Shamkant B. Navathe

DESCRIPTION OF RELATIONAL SCHEMA

1. The schema EMPLOYEE is created from the entity EMPLOYEE, taking all the attributes of it (i.e., ID, NAME, ADDRESS, GENDER, and POSITION). Here, ID is renamed as EMP_ID and this the primary key.
2. The schema DEPENDENT is created from the entity DEPENDENT, taking all the attributes of it (i.e., NAME, BIRTH_DATE, GENDER, and RELATIONSHIP) as well as the attribute EMP_ID from EMPLOYEE as the foreign key. Here, (EMP_ID, NAME) is the primary key.
3. The schema UPPER_EMPL is created from the entity UPPER_EMPL, taking all the attributes of it (i.e., YEAR_MONTH, SALARY, and AMT_PAID) as well as inheriting the attribute ID from the entity EMPLOYEE. Here, ID is renamed as UE_ID and (UE_ID, YEAR_MONTH) is the primary key.
4. The schema LABORER is created from the entity LABORER, taking all the attributes of it (i.e., YEAR_WEEK, WAGE_PER_UNIT, and AMT_PAID) as well as inheriting the attribute ID from the entity EMPLOYEE. Here, ID is renamed as L_ID and (L_ID, YEAR_WEEK) is the primary key.
5. The schema DAY_LABORER is created from the entity DAY_LABORER, taking all the attributes of it (i.e., DAY and DAILY_SALARY) as well as inheriting the attribute L_ID from the entity LABORER. Here, (L_ID, YEAR_WEEK, DAY) is the primary key.
6. The schema AGRO_AREA is created from the entity AGRO_AREA, taking all the attibutes of it (i.e., ID, TYPE, NAME, AREA_SIZE) and the attribute UE_ID from the entity UPPER_EMPL as the foreign key. Here, attributes ID and TYPE of the entity AGRO_AREA are renamed as AA_ID and AA_TYPE, respectively and AA_ID is the primary key.
7. The schema PLANTS_IN is created from the relationship PLANTS_IN, taking all the attributes of it (i.e., PLNT_TYPE and QUANTITY), the primary key (L_ID,

YEAR_WEEK, DAY) of the entity DAY_LABORER as its foreign key, and the primary key AA_ID of the entity AGRO_AREA as its foreign key. Here, (L_ID, YEAR_WEEK, DAY, AA_ID) is the primary key.

8. The schema PLUCKS_FROM is created from the relationship PLUCKS_FROM, taking the one and only attribute AMOUNT of it, the primary key (L_ID, YEAR_WEEK, DAY) of the entity DAY_LABORER as its foreign key, and the primary key AA_ID of the entity AGRO_AREA as its foreign key. Here, (L_ID, YEAR_WEEK, DAY, AA_ID) is the primary key.

9. The schema CONTROLS_WEED_PEST is created from the relationship CONTROLS_WEED_PEST, taking all the attributes of it (i.e., START_TIME, END_TIME, and CWP_TYPE), the primary key (L_ID, YEAR_WEEK, DAY) of the entity DAY_LABORER as its foreign key, and the primary key AA_ID of the entity AGRO_AREA as its foreign key. Here, (L_ID, YEAR_WEEK, DAY, AA_ID) is the primary key.

10. The schema FACTORY_MACHINE is created from the entity FACTORY_ MACHINE, taking all the attributes of it (i.e., ID, TYPE, BUY_DATE, and COST) and the primary key UE_ID from the entity UPPER_EMPL as its foreign key. Here, attributes ID and TYPE of the entity FACTORY_MACHINE are renamed as FM_ID and FM_TYPE, respectively and FM_ID is the primary key.

11. The schema WORKS_WITH is created from the relationship WORKS_WITH, taking attributes START_TIME and END_TIME, attributes TYPE and AMOUNT from the composite attribute INPUT, attributes TYPE and AMOUNT from the composite attribute OUTPUT, the primary key (L_ID, YEAR_WEEK, DAY) from the entity DAY_LABORER as its foreign key, and the primary key FM_ID from the entity FACTORY_MACHINE as its another foreign key. Here, attributes TYPE and AMOUNT of the composite attribute INPUT are renamed as IN_TYPE and IN_AMOUNT, respectively. Also, attributes TYPE and AMOUNT of the composite attribute OUTPUT are renamed as OUT_TYPE and OUT_AMOUNT, respectively. The primary key of the schema WORKS_WITH is (L_ID, YEAR_WEEK, DAY, FM_ID).

12. The schema CHEMICAL is created from the entity CHEMICAL, taking all the attributes of it (i.e., ID, NAME, BUY_DATE, COST, TOTAL_AMT, and AMT_LEFT). Here, ID is renamed as CHEM_ID and it is the primary key.

13. The schema USES is created from the relationship USES, taking all the attributes of it (i.e., DATE, START_TIME, and END_TIME), the primary key AA_ID from the entity AGRO_AREA as its foreign key, and the primary key CHEM_ID from the entity CHEMICAL as its another foreign key. Here, (AA_ID, CHEM_ID) is the primary key.

All the schemas are already in third normal form.

The next chapter shows sql tables created from schemas described above and the chapter right after the chapter of sql tables depicts some sample sql queries as well as creating some sample views (virtual tables).

REFERENCE : Fundamentals of Database Systems — Ramez El-Masri, Shamkant B. Navathe

SQL TABLES

```
CREATE TABLE EMPLOYEE
      (EMP_ID          CHAR(5)          NOT NULL,
       NAME            VARCHAR(32)      NOT NULL,
       ADDRESS         VARCHAR(30)      NOT NULL,
       GENDER          CHAR,
       POSITION        VARCHAR(20)      NOT NULL,
       PRIMARY KEY (EMP_ID));

CREATE TABLE DEPENDENT
      (EMP_ID          CHAR(5)          NOT NULL,
       NAME            VARCHAR(32)      NOT NULL,
       GENDER          CHAR,
       BIRTH_DATE      DATE             NOT NULL,
       RELATIONSHIP    VARCHAR(16),
       PRIMARY KEY (EMP_ID, NAME),
       FOREIGN KEY (EMP_ID) REFERENCES EMPLOYEE(EMP_ID));

CREATE TABLE UPPER_EMPL
      (UE_ID           CHAR(5)          NOT NULL,
       YEAR_MONTH      CHAR(6)          NOT NULL,
       SALARY          DECIMAL(5,2)     NOT NULL,
       AMT_PAID        DECIMAL(5,2),
       PRIMARY KEY (UE_ID, YEAR_MONTH),
       FOREIGN KEY (UE_ID) REFERENCES EMPLOYEE(EMP_ID));

CREATE TABLE LABORER
      (L_ID                CHAR(5)          NOT NULL,
       YEAR_WEEK           CHAR(6)          NOT NULL,
       WAGE_PER_UNIT       DECIMAL(5,2)     NOT NULL,
       AMT_PAID            DECIMAL(5,2),
       PRIMARY KEY (L_ID, YEAR_WEEK),
       FOREIGN KEY (L_ID) REFERENCES EMPLOYEE(EMP_ID));

CREATE TABLE DAY_LABORER
      (L_ID                CHAR(5)          NOT NULL,
       YEAR_WEEK           CHAR(6)          NOT NULL,
       DAY                 CHAR(3)          NOT NULL,
       DAILY_SALARY        DECIMAL(5,2)     NOT NULL,
       PRIMARY KEY (L_ID, YEAR_WEEK, DAY),
       FOREIGN KEY (L_ID, YEAR_WEEK) REFERENCES
                                  LABORER(L_ID, YEAR_WEEK));

CREATE TABLE AGRO_AREA
```

```
(AA_ID          CHAR(5)         NOT NULL,
 AA_TYPE        VARCHAR(15)     NOT NULL,
 NAME           VARCHAR(30),
 AREA_SIZE      DECIMAL(6,2),
 UE_ID          CHAR(5)         NOT NULL,
 PRIMARY KEY (AA_ID),
 FOREIGN KEY (UE_ID) REFERENCES UPPER_EMPL(UE_ID));

CREATE TABLE PLANTS_IN
 (L_ID          CHAR(5)         NOT NULL,
 YEAR_WEEK      CHAR(6)         NOT NULL,
 DAY            CHAR(3)         NOT NULL,
 AA_ID          CHAR(5)         NOT NULL,
 PLNT_TYPE      VARCHAR(10)     NOT NULL,
 QUANTITY       INT             NOT NULL,
 PRIMARY KEY (L_ID, YEAR_WEEK, DAY, AA_ID),
 FOREIGN KEY (L_ID, YEAR_WEEK, DAY) REFERENCES
                DAY_LABORER(L_ID, YEAR_WEEK, DAY),
 FOREIGN KEY (AA_ID) REFERENCES AGRO_AREA(AA_ID));

CREATE TABLE PLUCKS_FROM
 (L_ID          CHAR(5)         NOT NULL,
 YEAR_WEEK      CHAR(6)         NOT NULL,
 DAY            CHAR(3)         NOT NULL,
 AA_ID          CHAR(5)         NOT NULL,
 AMOUNT         DECIMAL(4,2)    NOT NULL,
 PRIMARY KEY (L_ID, YEAR_WEEK, DAY, AA_ID),
 FOREIGN KEY (L_ID, YEAR_WEEK, DAY) REFERENCES
                DAY_LABORER(L_ID, YEAR_WEEK, DAY),
 FOREIGN KEY (AA_ID) REFERENCES AGRO_AREA(AA_ID));

CREATE TABLE CONTROLS_WEED_PEST
 (L_ID          CHAR(5)         NOT NULL,
 YEAR_WEEK      CHAR(6)         NOT NULL,
 DAY            CHAR(3)         NOT NULL,
 AA_ID          CHAR(5)         NOT NULL,
 START_TIME     DECIMAL(2,2)    NOT NULL,
 END_TIME       DECIMAL(2,2)    NOT NULL,
 CWP_TYPE       VARCHAR(10)     NOT NULL,
 PRIMARY KEY (L_ID, YEAR_WEEK, DAY, AA_ID),
 FOREIGN KEY (L_ID, YEAR_WEEK, DAY) REFERENCES
                DAY_LABORER(L_ID, YEAR_WEEK, DAY),
 FOREIGN KEY (AA_ID) REFERENCES AGRO_AREA(AA_ID));

CREATE TABLE FACTORY_MACHINE
```

```
(FM_ID          CHAR(5)          NOT NULL,
 FM_TYPE        VARCHAR(15)      NOT NULL,
 BUY_DATE       DATE             NOT NULL,
 COST           DECIMAL(3,2)     NOT NULL,
 UE_ID          CHAR(5)          NOT NULL,
 PRIMARY KEY (FM_ID),
 FOREIGN KEY (UE_ID) REFERENCES UPPER_EMPL(UE_ID));

CREATE TABLE WORKS_WITH
 (L_ID                CHAR(5)          NOT NULL,
 YEAR_WEEK            CHAR(6)          NOT NULL,
 DAY                  CHAR(3)          NOT NULL,
 FM_ID                CHAR(5)          NOT NULL,
 START_TIME           DECIMAL(2,2)     NOT NULL,
 END_TIME             DECIMAL(2,2)     NOT NULL,
 IN_TYPE              VARCHAR(20)      NOT NULL,
 IN_AMOUNT            DECIMAL(4,2)     NOT NULL,
 OUT_TYPE             VARCHAR(20)      NOT NULL,
 OUT_AMOUNT           DECIMAL(4,2)     NOT NULL,
 PRIMARY KEY (L_ID, YEAR_WEEK, DAY, FM_ID),
 FOREIGN KEY (L_ID, YEAR_WEEK, DAY) REFERENCES
                DAY_LABORER(L_ID, YEAR_WEEK, DAY),
 FOREIGN KEY (FM_ID) REFERENCES FACTORY_MACHINE(FM_ID));

CREATE TABLE CHEMICAL
 (CHEM_ID        CHAR(5),
  NAME           CHAR(20)         NOT NULL,
  BUY_DATE       DATE             NOT NULL,
  COST           DECIMAL(3,2)     NOT NULL,
  TOTAL_AMT      DECIMAL(3,2)     NOT NULL,
  AMT_LEFT       DECIMAL(3,2)     NOT NULL,
  PRIMARY KEY(CHEM_ID));

CREATE TABLE USES
 (AA_ID          CHAR(5)          NOT NULL,
 CHEM_ID         CHAR(5)          NOT NULL,
 DATE            DATE             NOT NULL,
 START_TIME      DECIMAL(2,2)     NOT NULL,
 END_TIME        DECIMAL(2,2)     NOT NULL,
 PRIMARY KEY (AA_ID, CHEM_ID),
 FOREIGN KEY (AA_ID) REFERENCES AGRO_AREA(AA_ID),
 FOREIGN KEY (CHEM_ID) REFERENCES CHEMICAL(CHEM_ID));
```

REFERENCE : Fundamentals of Database Systems — Ramez El-Masri, Shamkant B. Navathe

SQL QUERIES

Q1: Show the number and type of plants planted in the year 2001, and calculate the total number of plants planted in the same year.

```
SELECT      PLNT_TYPE, SUM(QUANTITY)
FROM        PLANTS_IN
WHERE       YEAR_WEEK LIKE '2001__'
GROUP BY    AA_ID, PLNT_TYPE
ORDER BY    AA_ID, QUANTITY;
```

Q2: Create a view for the infilling in order to keep track of the number of plants planted in places where plant casualty has occurred.

```
CREATE VIEW INFILL (L_ID, YEAR_WEEK, DAY, AA_ID, IN_TYPE,
                    QUANTITY)
AS SELECT  L_ID, YEAR_WEEK, DAY, AA_ID, PLNT_TYPE, QUANTITY
FROM       AGRO_AREA JOIN PLANTS_IN ON AA_ID;
```

Q3: Insert values 'la123', '200142', 'mon', 'pla03', 'mature', and 40000 into the view INFILL.

```
INSERT INTO   INFILL (L_ID, YEAR_WEEK, DAY, AA_ID, IN_TYPE,
              QUANTITY)
VALUES        ('la123', '200142', 'mon', 'pla03', 'mature', 40000);
```

Q4: Show and calculate the number and type of plants planted in the area where plant casualty has taken place in the year 2001.

```
SELECT      IN_TYPE, SUM(QUANTITY)
FROM        INFILL
WHERE       YEAR_WEEK LIKE '2001__'
GROUP BY    AA_ID, IN_TYPE
ORDER BY    AA_ID, QUANTITY;
```

Q5: Create a table for storing the total number of plants planted in each year.

```
CREATE TABLE TOTAL_PLANT
      (YEAR          CHAR(4)     NOT NULL,
       TOTAL_QTY     INT,
       PRIMARY KEY (YEAR));
```

Q6: Insert the total number of plants planted in the year 2001 into the table TOTAL_PLANT.

```
INSERT INTO     TOTAL_PLANT (YEAR)
VALUES          '2001';

UPDATE      TOTAL_PLANT AS TP
SET         TP.TOTAL_QTY = QTY
WHERE       TP.YEAR = '2001' AND QTY IN
            (SELECT     SUM(PI.QUANTITY)
             FROM       PLANTS_IN AS PI
             WHERE      PI.YEAR_WEEK LIKE '2001__');
```

Q7: Show and calculate the total amount of tea leaves plucked from different agro-areas in the year 2001.

```
SELECT          AA_ID, SUM(AMOUNT)
FROM            PLUCKS_FROM
WHERE           YEAR_WEEK LIKE '2001__'
GROUP BY        AA_ID;
```

Q8: Show and calculate the total number of infilling done in the year 2001.

```
SELECT          AA_ID, SUM(QUANTITY)
FROM            INFILL
WHERE           YEAR_WEEK LIKE '2001__'
GROUP BY        AA_ID;
```

Q9: Create a table TOTAL_PLUCK for storing the total amount of tea leaves plucked each year.

```
CREATE TABLE TOTAL_PLUCK
      (YEAR             CHAR(4)          NOT NULL,
       TOTAL_AMT        DECIMAL(4,2),
       PRIMARY KEY (YEAR));
```

Q10: Insert the total amount of tea leaves plucked in the year 2001 into the table TOTAL_PLUCK.

```
INSERT INTO     TOTAL_PLUCK (YEAR)
VALUES          '2001';

UPDATE      TOTAL_PLUCK AS TP
SET         TP.TOTAL_AMT = AMT
WHERE       TP.YEAR = '2001' AND AMT IN
            (SELECT     SUM(PF.AMOUNT)
             FROM       PLUCKS_FROM AS PF
             WHERE      PF.YEAR_WEEK LIKE '2001__');
```

Q11: Select the highest crop year from the table TOTAL_PLUCK.

```
SELECT    TP1.YEAR,TP1.TOTAL_AMT
FROM      TOTAL_PLUCK AS TP1
WHERE     TP1.TOTAL_AMT IN
          (SELECT    MAX(TP2.TOTAL_AMT)
           FROM      TOTAL_PLUCK AS TP2
           WHERE     TP1.TOTAL_AMT >= MAX(TP2.TOTAL_AMT));
```

Q12: Show and calculate the total amount of made tea produced in the year 2001.

```
SELECT    SUM(OUT_AMOUNT)
FROM      WORKS_WITH
WHERE     YEAR_WEEK LIKE '2001_ _' AND OUT_TYPE = 'made tea';
```

Q13: Create the table TOTAL_MFG in order to store the total amount of made tea produced in each year.

```
CREATE TABLE TOTAL_MFG
      (YEAR              CHAR(4)          NOT NULL,
       TOTAL_MT          DECIMAL(4,2),
       PRIMARY KEY (YEAR));
```

Q14: Insert the total amount of made tea produced in the year 2001 into the table TOTAL_MFG.

```
INSERT INTO    TOTAL_MFG (YEAR)
VALUES         '2001';

UPDATE    TOTAL_MFG AS TM
SET       TM.TOTAL_MT = MT
WHERE     TM.YEAR = '2001' AND MT IN
          (SELECT    SUM(WW.OUT_AMOUNT)
           FROM      WORKS_WITH AS WW
           WHERE     WW.YEAR_WEEK LIKE '2001_ _');
```

Q15: Determine the year of maximum manufacture of made tea from the table TOTAL_MFG.

```
SELECT    TM1.YEAR, TM1.TOTAL_MT
FROM      TOTAL_MFG AS TM1
WHERE     TM1.TOTAL_MT IN
          (SELECT    MAX(TM2.TOTAL_MT)
           FROM      TOTAL_MFG AS TM2
```

```
WHERE     TM1.TOTAL_MT >= MAX(TM2.TOTAL_MT));
```

Q16: Select the names of employees who have at least one dependent.

```
SELECT    E.EMP_ID, E.NAME
FROM      EMPLOYEE AS E
WHERE     E.EMP_ID IN (SELECT    D.EMP_ID
                       FROM      DEPENDENT AS D
                       WHERE     D.EMP_ID = E.EMP_ID
                       HAVING    COUNT(*) >= 1);
```

Q17: Create tables for (i) deceased employees, (ii) deceased upper employees, and (iii) deceased laborers.

```
CREATE TABLE   DECEASED_EMPL
      (EMP_ID          CHAR(5)          NOT NULL,
       NAME            VARCHAR(32)      NOT NULL,
       ADDRESS         VARCHAR(30)      NOT NULL,
       GENDER          CHAR,
       POSITION        VARCHAR(20)      NOT NULL,
       DEATH_DATE      DATE,
       PRIMARY KEY (EMP_ID));

CREATE TABLE   DECEASED_UE
      (UE_ID           CHAR(5)          NOT NULL,
       YEAR_MONTH      CHAR(6)          NOT NULL,
       ALLOWANCE       DECIMAL(5,2),
       AMT_PAID        DECIMAL(5,2),
       PRIMARY KEY (UE_ID),
       FOREIGN KEY (UE_ID) REFERENCES DECEASED_EMPL(EMP_ID));

CREATE TABLE   DECEASED_L
      (L_ID            CHAR(5)          NOT NULL,
       YEAR_WEEK       CHAR(6)          NOT NULL,
       NO_OF_DEP       INT              NOT NULL,
       ALLOWANCE       DECIMAL(5,2),
       AMT_PAID        DECIMAL(5,2),
       PRIMARY KEY (L_ID),
       FOREIGN KEY (L_ID) REFERENCES DECEASED_EMPL(EMP_ID));
```

Q18: Update the information of the manager named 'Arif Quadri' who passed away on December 16, 2000.

```
INSERT INTO    DECEASED_EMPL (EMP_ID, NAME, ADDRESS, GENDER,
               POSITION)
```

```
SELECT      E.EMP_ID, E.NAME, E.ADDRESS, E.GENDER, E.POSITION
FROM        EMPLOYEE AS E
WHERE       E.NAME = 'Arif Quadri' AND E.GENDER = 'M' AND
            E.POSITION = 'Manager';

UPDATE      DECEASED_EMPL
SET         DEATH_DATE = '2000-12-16'
WHERE       NAME = 'Arif Quadri' AND GENDER = 'M' AND POSITION =
            'Manager';

INSERT INTO DECEASED_UE (UE_ID, ALLOWANCE)
SELECT      EMP_ID, SALARY
FROM        DECEASED_EMPL JOIN UPPER_EMPL ON
            EMP_ID = UE_ID
WHERE       NAME = 'Arif Quadri' AND GENDER = 'M' AND POSITION =
            'Manager';

DELETE FROM UPPER_EMPL
WHERE       UE_ID IN (SELECT    EMP_ID
                      FROM      EMPLOYEE
                      WHERE     NAME = 'Arif Quadri' AND
                                GENDER = 'M' AND POSITION =
                                'Manager');

UPDATE      DECEASED_UE
SET         YEAR_MONTH = '200201', AMT_PAID = 0.0
WHERE       UE_ID IN    (SELECT     EMP_ID
                         FROM       EMPLOYEE
                         WHERE      NAME = 'Arif Quadri' AND GENDER =
                                    'M' AND POSITION = 'Manager');

DELETE FROM EMPLOYEE
WHERE       NAME = 'Arif Quadri' AND GENDER = 'M' AND POSITION =
'Manager';
```

Q19: Update the information of the laborer named 'Amrit Pal' who passed away on February 21, 1999.

```
INSERT INTO DECEASED_EMPL (EMP_ID, NAME, ADDRESS, GENDER,
            POSITION)
SELECT      E.EMP_ID, E.NAME, E.ADDRESS, E.GENDER, E.POSITION
FROM        EMPLOYEE AS E
WHERE       E.NAME = 'Amrit Pal' AND E.GENDER = 'M' AND
            E.POSITION = 'laborer';

UPDATE      DECEASED_EMPL
```

```
SET             DEATH_DATE = '1999-02-21'
WHERE           NAME = 'Amrit Pal' AND GENDER = 'M' AND POSITION =
                'laborer';

INSERT INTO     DECEASED_L (L_ID, NO_OF_DEP, ALLOWANCE)
SELECT          EMP_ID, COUNT(*), 50.00*COUNT(*)
FROM            DECEASED_EMPL JOIN DEPENDENT ON ID = EMP_ID
WHERE           NAME = 'Amrit Pal' AND GENDER = 'M' AND POSITION =
                'laborer';

DELETE FROM     LABORER
WHERE           L_ID IN (SELECT  L_ID
                         FROM    EMPLOYEE
                         WHERE   NAME = 'Amrit Pal' AND GENDER = 'M'
                                 AND POSITION = 'laborer');

UPDATE      DECEASED_L
SET         YEAR_WEEK = '200201', AMT_PAID = 0.00
WHERE       L_ID IN (SELECT  EMP_ID
                     FROM    EMPLOYEE
                     WHERE   NAME = 'Amrit Pal' AND GENDER = 'M' AND
                             POSITION = 'laborer');

DELETE FROM     EMPLOYEE
WHERE       NAME = 'Amrit Pal' AND GENDER = 'M' AND POSITION =
'laborer';
```

Q20: Show and calculate the total expenditure of January, 2002 (including salaries of presently employed upper employees and allowances for the families of dead upper employees).

```
CREATE VIEW     UPPER_SAL (UE_ID, SALARY, AMT_PAID, AMT_DUE)
AS SELECT       UE.UE_ID, UE.SALARY, UE.AMT_PAID, (UE.SALARY
                - UE.AMT_PAID)
FROM            UPPER_EMPL AS UE
WHERE           UE.AMT_PAID < UE.SALARY AND UE.YEAR_MONTH
                = '200201';

INSERT INTO     UPPER_SAL (UE_ID, SALARY, AMT_PAID, AMT_DUE)
SELECT          UE.UE_ID, UE.SALARY, UE.AMT_PAID, (UE.SALARY
                - UE.AMT_PAID)
FROM            UPPER_EMPL AS UE
WHERE           UE.AMT_PAID < UE.SALARY AND UE.YEAR_MONTH
                = '200201';
```

```
CREATE VIEW     UPPER_ALL (UE_ID, ALLOWANCE, AMT_PAID,
                AMT_DUE)
AS SELECT       DUE.UE_ID, DUE.ALLOWANCE, DUE.AMT_PAID,
                (DUE.ALLOWANCE – DUE.AMT_PAID)
FROM            DECEASED_UE AS DUE
WHERE           DUE.AMT_PAID < DUE.ALLOWANCE AND
                DUE.YEAR_MONTH = '200201';

INSERT INTO     UPPER_ALL (UE_ID, ALLOWANCE, AMT_PAID,
                AMT_DUE)
SELECT          DUE.UE_ID, DUE.ALLOWANCE, DUE.AMT_PAID,
                (DUE.ALLOWANCE – DUE.AMT_PAID)
FROM            DECEASED_UE AS DUE
WHERE           DUE.AMT_PAID < DUE.ALLOWANCE AND
                DUE.YEAR_MONTH = '200201';

SELECT    SUM(US.AMT_DUE)+SUM(UA.AMT_DUE)
FROM      UPPER_SAL AS US, UPPER_ALL AS UA;
```

After the Payment :

```
UPDATE    UPPER_SAL
SET       AMT_PAID = AMT_PAID + AMT_DUE, AMT_DUE = 0.0;

UPDATE    UPPER_EMPL AS UE
SET       UE.UE_ID = ID, UE.AMT_PAID = UE.AMT_PAID + AP
WHERE     UE.YEAR_MONTH = '200201' AND (ID, AP) IN
          (SELECT    US.UE_ID, US.AMT_PAID
           FROM      UPPER_SAL AS US);

UPDATE    UPPER_ALL
SET       AMT_PAID = AMT_PAID + AMT_DUE, AMT_DUE = 0.0;

UPDATE    DECEASED_UE AS DUE
SET       DUE.UE_ID = ID, DUE.AMT_PAID = DUE.AMT_PAID + AP
WHERE     DUE.YEAR_MONTH = '200201' AND (ID, AP) IN
          (SELECT    UA.UE_ID, UA.AMT_PAID
           FROM      UPPER_ALL AS UA);

DROP VIEW       UPPER_SAL;
DROP VIEW       UPPER_ALL;
```

Q21: Show and calculate the total expenditure of the fourth week of 2002 (including salaries of presently employed laborers, allowances for the families of deceased laborers, and costs of chemicals to be bought).

```
CREATE TABLE L_SAL
        (L_ID           CHAR(5)         NOT NULL,
         TOTAL_AMT      DECIMAL(5,2),
         AMT_PAID       DECIMAL(5,2),
         AMT_DUE        DECIMAL(5,2),
         PRIMARY KEY (L_ID),
         FOREIGN KEY (L_ID) REFERENCES DAY_LABORER(L_ID));

INSERT INTO     L_SAL (L_ID, AMT_PAID)
SELECT          L_ID, AMT_PAID
FROM            LABORER
WHERE           YEAR_WEEK = '200204';

UPDATE      L_SAL
SET         TOTAL_AMT = 0.0, AMT_DUE = 0.0;

UPDATE      L_SAL
SET         TOTAL_AMT = TOTAL_AMT + EXTRA
WHERE       EXTRA IN
            (SELECT     SUM (DAILY_SALARY
                        + (WAGE_PER_UNIT * QUANTITY))
             FROM       LABORER JOIN DAY_LABORER ON
                        (L_ID, YEAR_WEEK)
             WHERE      YEAR_WEEK = '200204' AND QUANTITY IN
                        (SELECT     QUANTITY
                         FROM       DAY_LABORER JOIN PLANTS_IN ON
                                    (L_ID, YEAR_WEEK)
                         WHERE      YEAR_WEEK = '200204'
                         GROUP BY   (L_ID, YEAR_WEEK))
             GROUP BY   (L_ID, YEAR_WEEK))
GROUP BY    L_ID;

UPDATE      L_SAL
SET         TOTAL_AMT = TOTAL_AMT + EXTRA
WHERE       EXTRA IN
            (SELECT     SUM (DAILY_SALARY
                        + (WAGE_PER_UNIT * AMOUNT))
             FROM       LABORER JOIN DAY_LABORER ON
                        (L_ID, YEAR_WEEK)
             WHERE      YEAR_WEEK = '200204' AND AMOUNT IN
                        (SELECT     AMOUNT
                         FROM       DAY_LABORER  JOIN  PLUCKS_FROM
                                    ON (L_ID, YEAR_WEEK)
                         WHERE      YEAR_WEEK = '200204'
```

```
                    GROUP BY (L_ID, YEAR_WEEK))
          GROUP BY (L_ID, YEAR_WEEK))
GROUP BY  L_ID;

UPDATE    L_SAL
SET       TOTAL_AMT = TOTAL_AMT + EXTRA
WHERE     EXTRA IN
          (SELECT   SUM (DAILY_SALARY
                    + ((END_TIME – START_TIME) * WAGE_PER_UNIT))
           FROM     CONTROLS_WEED_PEST JOIN DAY_LABORER ON
                    (L_ID, YEAR_WEEK, DAY)
           WHERE    YEAR_WEEK = '200204' AND WAGE_PER_UNIT IN
                    (SELECT     WAGE_PER_UNIT
                     FROM       LABORER JOIN DAY_LABORER ON
                                (L_ID, YEAR_WEEK)
                     WHERE      YEAR_WEEK = '200204')
           GROUP BY (L_ID, YEAR_WEEK, DAY))
GROUP BY  L_ID;

UPDATE    L_SAL
SET       TOTAL_AMT = TOTAL_AMT + EXTRA
WHERE     EXTRA IN
          (SELECT   SUM (DAILY_SALARY
                    + ((END_TIME – START_TIME) * WAGE_PER_UNIT))
           FROM     WORKS_WITH JOIN DAY_LABORER ON
                    (L_ID, YEAR_WEEK, DAY)
           WHERE    YEAR_WEEK = '200204' AND WAGE_PER_UNIT IN
                    (SELECT     WAGE_PER_UNIT
                     FROM       LABORER JOIN DAY_LABORER ON
                                (L_ID, YEAR_WEEK)
                     WHERE      YEAR_WEEK = '200204')
           GROUP BY (L_ID, YEAR_WEEK, DAY))
GROUP BY  L_ID;

UPDATE    L_SAL
SET       AMT_DUE = AMT_DUE + (TOTAL_AMT – AMT_PAID)
WHERE     AMT_PAID < TOTAL_AMT;

CREATE VIEW   L_ALLOW (L_ID, ALLOWANCE, AMT_PAID, AMT_DUE)
AS SELECT     DL.L_ID, DL.ALLOWANCE, DL.AMT_PAID,
              (DL.ALLOWANCE – DL.AMT_PAID)
FROM          DECEASED_L AS DL
WHERE         DL.AMT_PAID < DL.ALLOWANCE AND DL.YEAR_WEEK
              = '200204';
```

```
INSERT INTO     L_ALLOW (L_ID, ALLOWANCE, AMT_PAID, AMT_DUE)
SELECT          DL.L_ID, DL.ALLOWANCE, DL.AMT_PAID,
                (DL.ALLOWANCE – DL.AMT_PAID)
FROM            DECEASED_L AS DL
WHERE           DL.AMT_PAID < DL.ALLOWANCE AND DL.YEAR_WEEK
                = '200204';

CREATE VIEW     CHEM (NAME, COST, TOTAL_AMT)
AS SELECT       C.NAME, C.COST, C.TOTAL_AMT
FROM            CHEMICAL AS C
WHERE           C.AMT_LEFT/C.TOTAL_AMT <= 0.05;

INSERT INTO     CHEM (NAME, COST, TOTAL_AMT)
SELECT          C.NAME, C.COST, C.TOTAL_AMT
FROM            CHEMICAL AS C
WHERE           C.AMT_LEFT/C.TOTAL_AMT <= 0.05;

SELECT          SUM(LS.AMT_DUE) + SUM(LA.AMT_DUE) + SUM(C.COST)
FROM            L_SAL AS LS, L_ALLOW AS LA, CHEM AS C;
```

After the Payment :

```
UPDATE      L_SAL
SET         AMT_PAID = AMT_PAID + AMT_DUE, AMT_DUE = 0.0;

UPDATE      LABORER AS L
SET         ID = L.L_ID, L.AMT_PAID = L.AMT_PAID + AP
WHERE       YEAR_WEEK = '200204' AND (ID, AP) IN
            (SELECT     LS.L_ID, LS.AMT_PAID
             FROM       L_SAL AS LS);

UPDATE      L_ALLOW
SET         AMT_PAID = AMT_PAID + AMT_DUE, AMT_DUE = 0.0;

UPDATE      DECEASED_L AS DL
SET         ID = DL.L_ID, DL.AMT_PAID = DL.AMT_PAID + AP
WHERE       DL.YEAR_WEEK = '200204' AND (ID, AP) IN
            (SELECT     LA.L_ID, LA.AMT_PAID
             FROM       L_ALLOW AS LA);

INSERT INTO     CHEMICAL (NAME, COST, TOTAL_AMT, AMT_LEFT)
SELECT          CHEM.NAME, CHEM.COST, CHEM.TOTAL_AMT,
                CHEM.TOTAL_AMT
FROM            CHEM;
```

```
UPDATE      CHEMICAL
SET         BUY_DATE = DATE()
WHERE       AMT_LEFT = TOTAL_AMT;

DROP TABLE      L_SAL;
DROP VIEW       L_ALLOW;
DROP VIEW       CHEM;
```

REFERENCE : Fundamentals of Database Systems — Ramez El-Masri, Shamkant B. Navathe

CALCULATION OF THE TOTAL AMOUNT OF DATA TO BE TRANSFERRED

Suppose, the size of a character is 1 byte, the size of an integer is 4 bytes, the size of a decimal is 8 bytes, and the size of a date is 10 bytes.

Therefore, the size of the table EMPLOYEE is [(5*1)+(32*1)+(30*1)+(1*1)+(20*1)] bytes = (5+32+30+1+20) bytes = 88 bytes.

The size of the table UPPER_EMPL is [(5*1)+(6*1)+8+8] bytes = (5+6+8+8) bytes = 27 bytes.

The size of the table LABORER is [(5*1)+(6*1)+8+8] bytes = (5+6+8+8) bytes = 27 bytes.

The size of the table DAY_LABORER is [(5*1)+(6*1)+(3*1)+8] bytes = (5+6+3+8) bytes = 22 bytes.

The size of the table DEPENDENT is [(5*1)+(32*1)+(1*1)+10+(16*1)] bytes = (5+32+1+10+16) bytes = 64 bytes.

The size of the table AGRO_AREA is [(5*1)+(15*1)+(30*1)+8+(5*1)] bytes = (5 + 15 + 30 + 8 + 5) bytes = 63 bytes.

The size of the table PLANTS_IN is [(5*1)+(6*1)+(3*1)+(5*1)+(10*1)+4] bytes = (5 + 6 + 3 + 5 + 10 + 4) bytes = 33 bytes.

The size of the table PLUCKS_FROM is [(5*1)+(6*1)+(3*1)+(5*1)+8] bytes = (5 + 6 + 3 + 5 + 8) bytes = 27 bytes.

The size of the table CONTROLS_WEED_PEST is [(5*1) + (6*1) + (3*1) + (5*1) + 8 + 8 + (10*1)] bytes = (5+6+3+5+8+8+10) bytes = 45 bytes.

The size of the table FACTORY_MACHINE is [(5*1) + (15*1) + 10 + 8 + (5*1)] bytes = (5+15+10+8+5) bytes = 43 bytes.

The size of the table WORKS_WITH is [(5*1) + (6*1) + (3*1) + (5*1) + 8 + 8 + (20*1) + 8 + (20*1) + 8] bytes = (5 + 6 + 3 + 5 + 8 + 8 + 20 + 8 + 20 + 8) bytes = 91 bytes.

The size of the table CHEMICAL is [(5*1) + (20*1) + 10 + 8 + 8 + 8] bytes = (5 + 20 + 10 + 8 + 8 + 8) bytes = 59 bytes.

The size of the table USES is [(5*1) + (5*1) + 10 + 8 + 8] bytes = (5 + 5 + 10 + 8 + 8) bytes = 36 bytes.

The size of the view INFILL created in query#2 is [(5*1)+(6*1)+(3*1)+(5*1)+(10*1)+4] bytes = (5+6+3+5+10+4) bytes = 33 bytes.

The size of the table TOTAL_PLANT created in query#5 is [(4*1) + 4] bytes = (4 + 4) bytes = 8 bytes.

The size of the table TOTAL_PLUCK created in query#9 is [(4*1) + 8] bytes = (4 + 8) bytes = 12 bytes.

The size of the table TOTAL_MFG created in query#13 is [(4*1) + 8] bytes = (4 + 8) bytes = 12 bytes.

The size of the table DECEASED_EMPL created in query#17 is [(5*1) + (32*1) + (30*1) + (1*1) + (20*1) + 10] bytes = (5 + 32 + 30 + 1 + 20 + 10) bytes = 98 bytes.

The size of the table DECEASED_UE created in query#17 is [(5*1)+(6*1)+8+8] bytes = (5 + 6 + 8 + 8) bytes = 27 bytes.

The size of the table DECEASED_L created in query#17 is [(5*1)+(6*1)+4+8+8] bytes = (5 + 6 + 4 + 8 + 8) bytes = 31 bytes.

The size of the view UPPER_SAL created in query#20 is [(5*1) + 8 + 8 + 8] bytes = (5 + 8 + 8 + 8) bytes = 29 bytes.

The size of the view UPPER_ALL created in query#20 is [(5*1) + 8 + 8 + 8] bytes = (5 + 8 + 8 + 8) bytes = 29 bytes.

The size of the table L_SAL created in query#21 is [(5*1) + 8 + 8 + 8] bytes = (5 + 8 + 8 + 8) bytes = 29 bytes.

The size of the view L_ALLOW created in query#21 is [(5*1) + 8 + 8 + 8] bytes = (5 + 8 + 8 + 8) bytes = 29 bytes.

The size of the view CHEM created in query#21 is [(20*1) + 8 + 8] bytes = (20 + 8 + 8) bytes = 36 bytes.

Suppose, there are 670 employees **:** 30 upper-level employees and 640 laborers. Amongst these 640 laborers, 140 laborers are engaged for planting, 380 laborers are engaged for plucking, 50 laborers are engaged for controlling weeds and pests, and 70 laborers work in the factory. Also assume that there is a total of 1000 dependents, a total of 5 agro-areas, a total of 30 factory machines, and a total of 20 chemicals. In special cases, it is

also assumed that there is a total of 5 deceased employees : 1 deceased upper-level employee and 4 deceased laborers.

Therefore, the amount of space to be always occupied
= (the total number of employees * the size of the table EMPLOYEE)

+ (the total number of upper-level employees * the size of the table UPPER_EMPL)

+ (the total number of laborers * the size of the table LABORER)

+ (the total number of day laborers * the size of the table DAY_LABORER)

+ (the total number of agro-areas * the size of the table AGRO_AREA)

+ (the total number of factory machines * the size of the table FACTORY_MACHINE)

+ (the total number of chemicals * the size of the table CHEMICAL)

= [(670*88)+(30*27)+(640*27)+(640*22)+(1000*64)+(5*63)+(30*43)+(20*59)] bytes

= (58960 + 810 + 17280 + 14080 + 64000 + 315 + 1290 + 1180) bytes = 157915 bytes

= 157.915 kilobytes.

If 5 deceased employees, 1 deceased upper-level employee, and 4 deceased laborers are included, then the extra amount of space needed = [(5*98) + (1*27) + (4*31)] bytes = (490 + 27 + 124) bytes = 641 bytes = 0.641 kilobyte.

Therefore, in special cases, the total amount of space needed = (157.915 + 0.641) KB = 158.556 KB.

The total amount of data to be transferred daily
= (the total number of laborers engaged for planting * the size of the table PLANTS_IN)

+ (the total number of laborers engaged for plucking * the size of the PLUCKS_FROM)

+ (the total number of laborers controlling weeds and pests (before lunch) * the size of the table CONTROLS_WEED_PEST) + (the total number of laborers controlling weeds and pests (after lunch) * the size of the table CONTROLS_WEED_PEST) + (the total

number of factory workers (working before lunch) * the size of WORKS_WITH) + (the total number of factory workers (working after lunch) * the size of WORKS_WITH)

= [(140*33) + (380*27) + (50*45) + (50*45) + (70*91) + (70*91)] bytes

= (4620 + 10260 + 2250 + 2250 + 6370 + 6370) bytes = 32120 bytes = (32120*8) bits

= 256960 bits = 256.96 kilobits = 32.12 KB.

At the end of the week, the total amount of data needed to be transferred
= the total amount of data to be transferred daily

+ (the total number of laborers * the size of the table L_SAL)

+ (the total number of deceased laborers * the size of the view L_ALLOW)

+ (the total number of chemicals to be bought (say, 5) * the size of the view CHEM)

+ (the total number of chemicals bought * the size of the table CHEMICAL)

= 32120 bytes + [(640*29) + (4*29) + (5*36) + (5*59)] bytes

= 32120 bytes + (18560 + 116 + 180 + 295) bytes = 32120 bytes + 19151 bytes

= (32120+19151) bytes = 51271 bytes = (51271*8) bytes

= 410168 bits = 410.168 kilobits = 51.271 KB.

At the end of the month, the total amount of data needed to be transferred

= the total amount of data to be transferred daily

+ (the total number of upper-level employees * the size of the view UPPER_SAL)

+ (the total number of deceased upper-level employees * size of the view UPPER_ALL)

= 32120 bytes + [(30*29) + (1*29)] bytes = 32120 bytes + (870+29) bytes

= 32120 bytes + 899 bytes = (32120+899) bytes = 33019 bytes

= (33019*8) bits = 264152 bits = 264.152 kilobits = 33.019 KB.

At the end of the year, the total amount of data needed to be transferred

= the total amount of data to be transferred monthly

+ the size of the table TOTAL_PLANT + the size of the table TOTAL_PLUCK

+ the size of the table TOTAL_MFG = 33019 bytes + 8 bytes + 12 bytes + 12 bytes

= (33019 + 8 + 12 + 12) bytes = 33051 bytes = (33051*8) bits

= 264408 bits = 264.408 kilobits = 33.051 KB.

The total amount of space needed to store the transaction of a year
= (the number of days in a year * the total amount of data to be transferred daily)

+ **[** the number of weeks in a year * **{** (the total number of laborers * the size of L_SAL)

+ (the total number of deceased laborers * the size of the view L_ALLOW)

+ (the total number of chemicals to be bought * the size of the view CHEM)

+ (the total number of chemicals bought * the size of the table CHEMICAL) **}]**

+ **[** the total number of months in a year *

{ (the total number of upper-level employees * the size of the view UPPER_SAL)

+ (the total number of deceased upper-level employees * the size of UPPER_ALL) **}]**

+ the size of the table TOTAL_PLANT + the size of the table TOTAL_PLUCK

+ the size of the table TOTAL_MFG

= (365*32120) bytes + [52 * {(640*29) + (4*29) + (5*36) + (5*59)}] bytes

+ [12 * {(30*29) + (1*29)}] bytes + 8 bytes + 12 bytes + 12 bytes = 11723800 bytes +

[52*(18560+116+180+295)] bytes + [12*(870+29)] bytes + 8 bytes + 12 bytes + 12 bytes

= 11723800 bytes + (52*19151) bytes + (12*899) bytes + (8 + 12 + 12) bytes

= 11723800 bytes + 995852 bytes + 10788 bytes + 32 bytes

= (11723800 + 995852 + 10788 + 32) bytes = 12,730,472 bytes

= 12.730472 MB ≈ 12.73 MB.

Description of some Sample Input Screens done in Visual Basic

1. When the user wants to view or edit information of the tea garden (by typing the URL or trying to access database files from the computers at the head office or at the tea garden), he/she will be confronted with the LOGIN SCREEN where the user ID and the password has to be typed (in order to check the validity of the user). If a valid user types his or her ID and password and then click the SUBMIT button, then the MENU ACTION SCREEN will occur. The CLEAR button clears texts written in these two input boxes (if any). If the EXIT button is clicked, then the program will be terminated.

2. In the MENU ACTION SCREEN, there are many choices for viewing or editing database files. When the user chooses ADD from the drop-down menu next to the text EMPLOYEE and presses the GO button at the immediate right side of this drop-down menu, the input screen for entering the information about employees will pop up. Similarly, choosing ADD from the drop-down menu of UPPER EMPLOYEE and pressing go will make the input screen for entering the information about upper-level employees to pop up, choosing ADD from the drop-down menu of LABORER and pressing go will make the input screen for entering the information about laborers to pop up, etc.. I have created input screens only for entering information about (i) employees, (ii) upper-level employees, (iii) laborers, (iv) day laborers, (v) agro-area(s), (vi) factory machine(s), (vii) daily planting, (viii) daily plucking, and (ix) daily control of weeds and pests, which will be described shortly. The button labelled "YEARLY PLUCKING OF TEA LEAVES!!!" is intended to be clicked for popping up a screen where the user can type an year and view the total amount of tea leaves plucked in that particular year. Similarly, the button labelled "YEARLY PRODUCTION OF MADE TEA!!!" is intended to be clicked for popping up a screen where the user can type an year and view the total amount of made tea produced in that particular year. The button labelled "UPDATE DATA" is intended for clicking in order to make a connection with the computer at the other end and update data in that computer or in the computer which is used by that user at that moment. If the user clicks "LOGOUT!!!", then the LOGIN SCREEN will appear. If the user clicks "EXIT!!!", then the program will be terminated.

3. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT EMPLOYEES", the user has to type name, address, and ID of a new employee, choose gender and position from the corresponding drop-down menus, and click the "SUBMIT" button. By clicking the "CLEAR" button, texts from three input boxes will be cleared, if any.

4. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT UPPER-LEVEL EMPLOYEES", the user has to type name and address and choose gender and position from the corresponding drop-down menus of the an existing upper-level employee in order to make that employee's ID to pop up. Then the user has to choose an year, a month, employee's salary for that month and amount paid from the corresponding drop-down menus and click the "SUBMIT" button in order to update data for the existing upper-level employees each month.

5. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT LABORERS", the user has to type name and address and choose gender from the drop-down menu of an existing laborer in order to make that laborer's ID to pop up. Then the user has to choose an year, a week, and laborer's wage per unit for that week from the corresponding drop-down menus and click the "SUBMIT" button in order to update data for the existing laborer each week.

6. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT DAY LABORERS", the user has to type name and address and choose gender from the drop-down menu of an existing day laborer in order to make that day laborer's ID to pop up. Then the user has to choose an year, a week, a day, the daily salary for that week, and amount paid from the corresponding drop-down menus and click the "SUBMIT" button in order to update data for the existing day laborer each day.

7. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT AGRO-AREAS", the user has to type name, size, and ID of a particular agro area and choose the type of that agro-area from the corresponding drop-down menu. Then, the user has to type supervisor's name and address and choose supervisor's gender in order to make the supervisor's ID to pop up. Finally, the user has to click the "SUBMIT" button in order to enter the information about a particular agro-area.

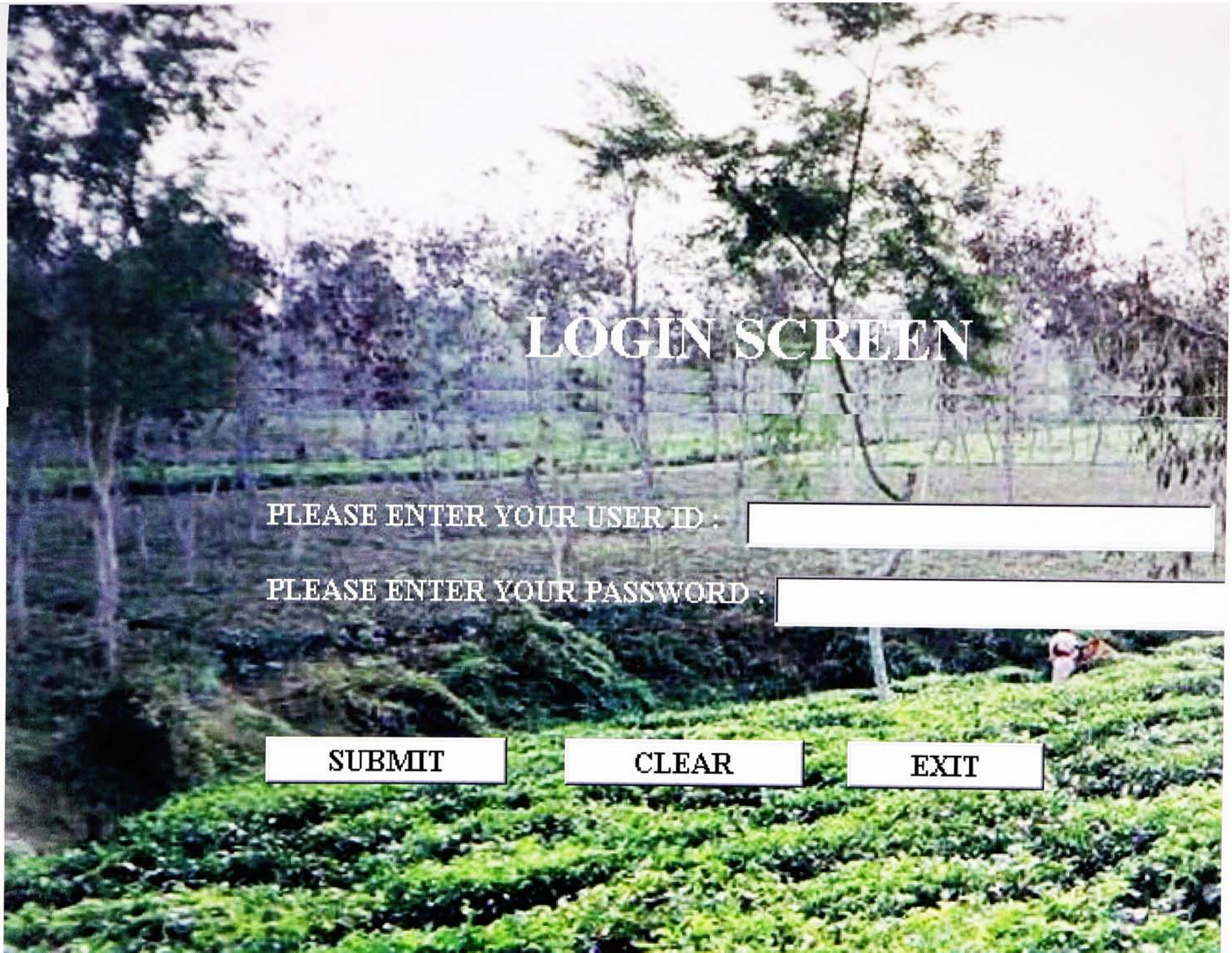
8. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT FACTORY MACHINES", the user has to type name, cost, and ID of a particular factory machine and choose day, month, and year from the corresponding drop-down menus (these drop-down menus are used for choosing the date when the machine was bought). Then, the user has to type supervisor's name and address and choose supervisor's gender in order to make the supervisor's ID to pop up. Finally, the user has to click the "SUBMIT" button in order to enter the information about a particular factory machine.

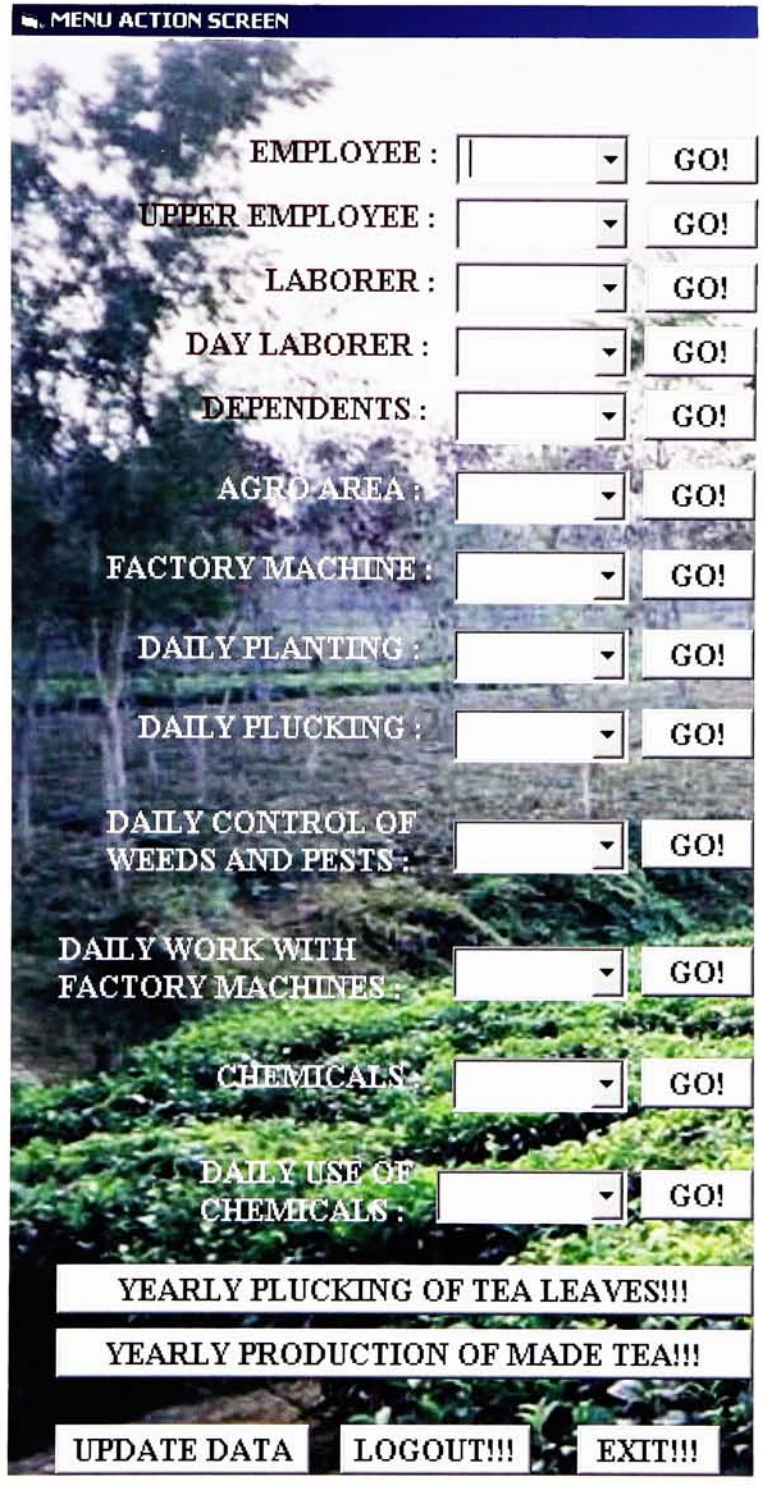
9. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT DAILY PLANTING", the user has to type a laborer's name and address and choose his/her gender from the corresponding drop-down menu in order to make his/her ID to pop up. Then, the user has to type the name of an agro-area and choose its type in order to make its ID to pop up. Finally, the user has to choose year, week, day, and plant type from the corresponding drop-down menus, type quantity (the number of plants planted), and then click the "SUBMIT" button in order to update the information about daily planting.

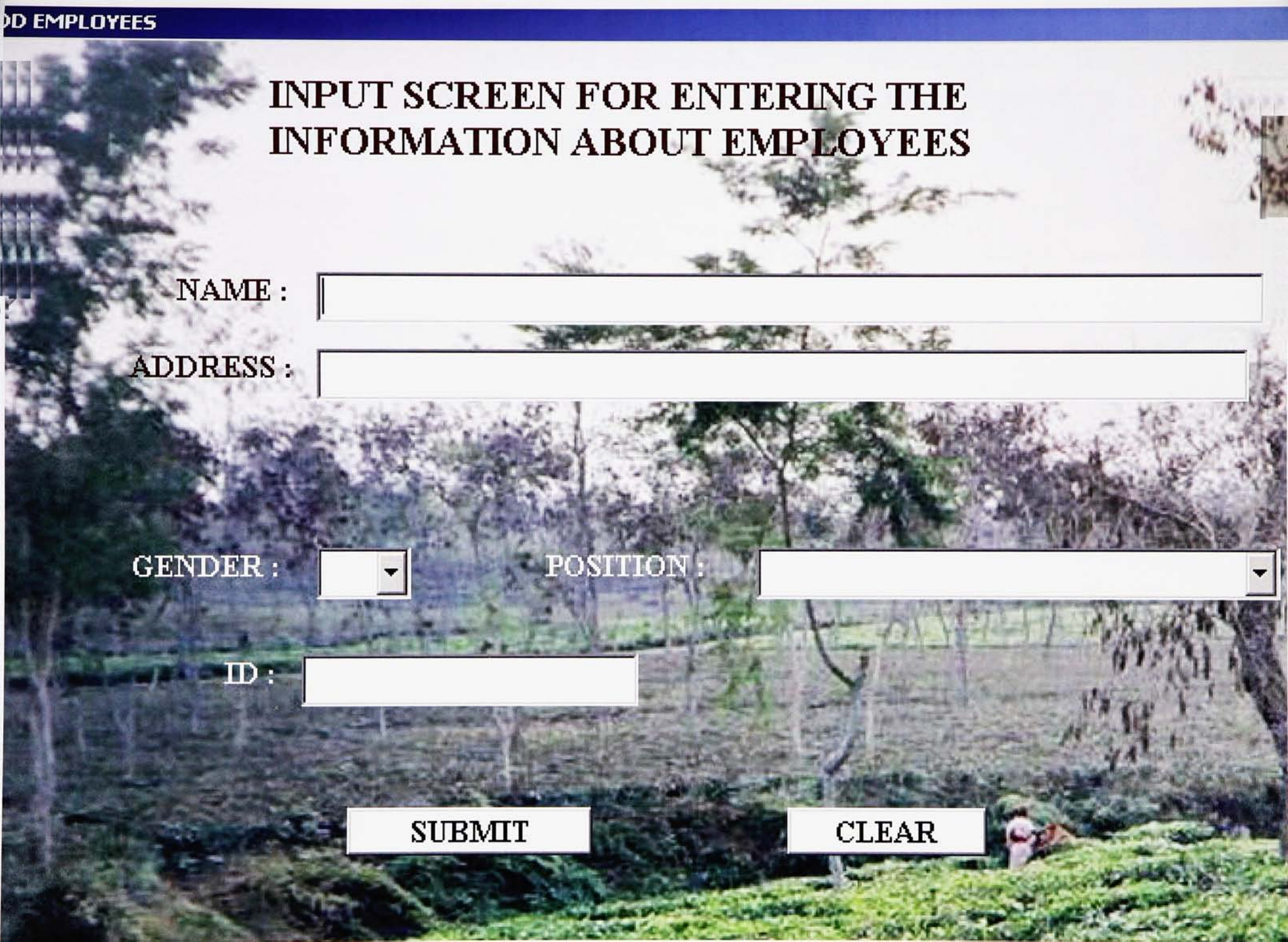
10. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT DAILY PLUCKING", the user has to type a laborer's name and address and choose his/her gender from the corresponding drop-down menu in order

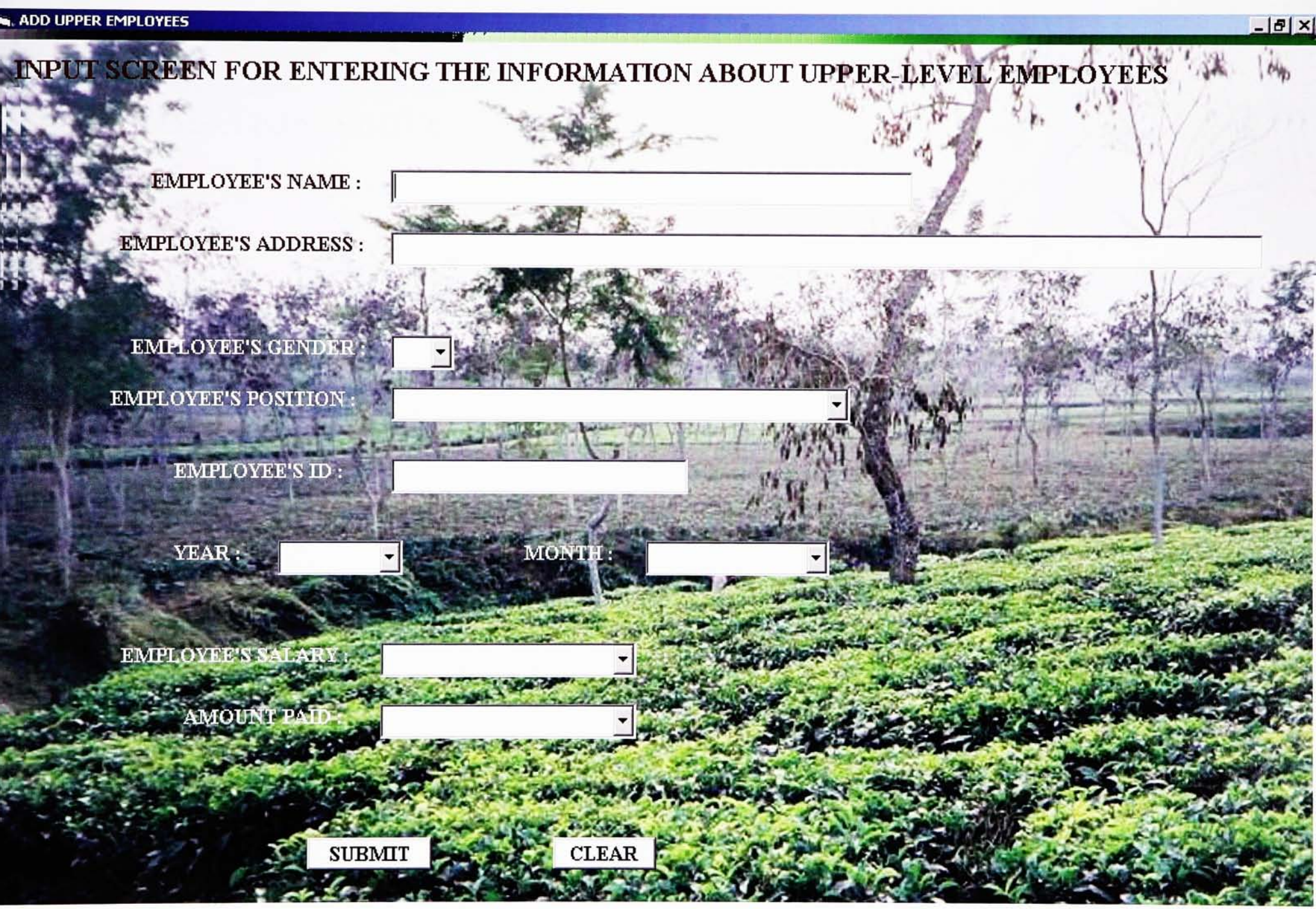
to make his/her ID to pop up. Then, the user has to type the name of an agro-area and choose its type in order to make its ID to pop up. Finally, the user has to choose year, week, and day from the corresponding drop-down menus, type the amount of tea leaves plucked by that laborer, and then click the "SUBMIT" button in order to update the information about daily plucking.

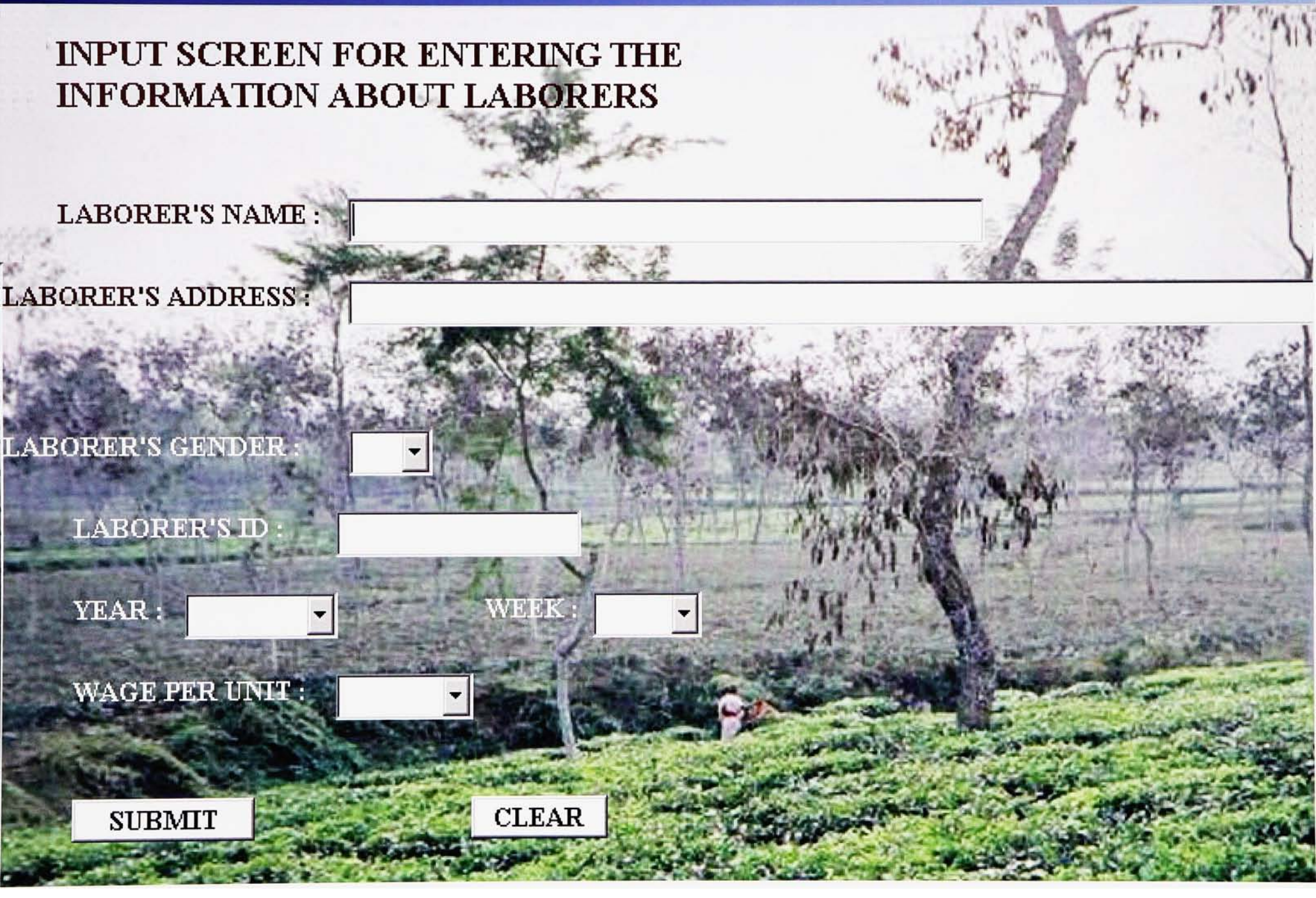
11. In the screen labelled "INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT THE DAILY CONTROL OF WEEDS AND PESTS", the user has to type a laborer's name and address and choose his/her gender from the corresponding drop-down menu in order to make his/her ID to pop up. Then, the user has to type the name of an agro-area and choose its type in order to make its ID to pop up. Finally, the user has to choose year, week, and day from the corresponding drop-down menus, choose hours, minutes, and seconds for both start time and time and then click the "SUBMIT" button in order to update the information about the daily control of weeds and pests.

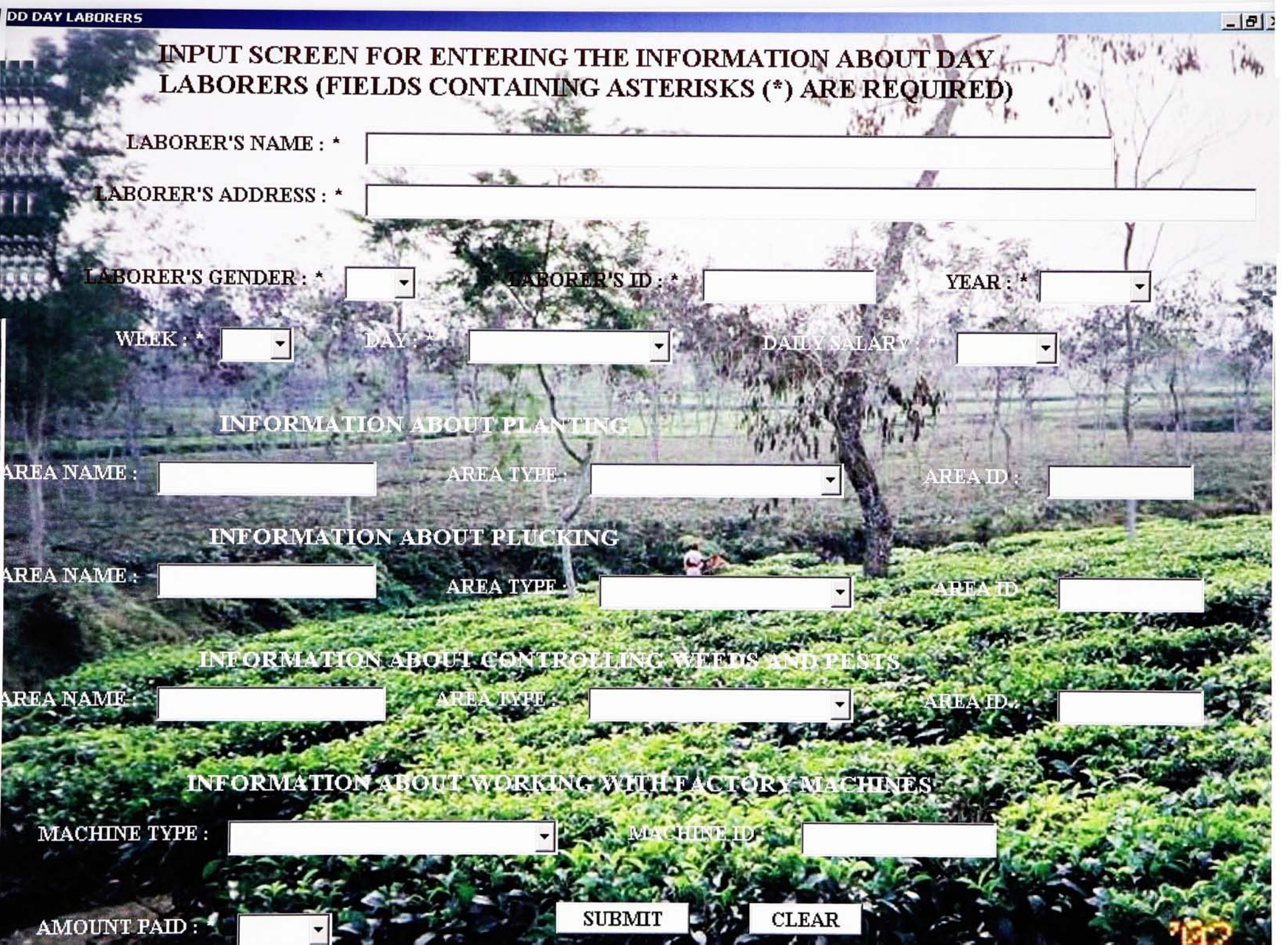

LOGIN SCREEN
PLEASE ENTER YOUR USER ID :
PLEASE ENTER YOUR PASSWORD :
SUBMIT
CLEAR
EXIT

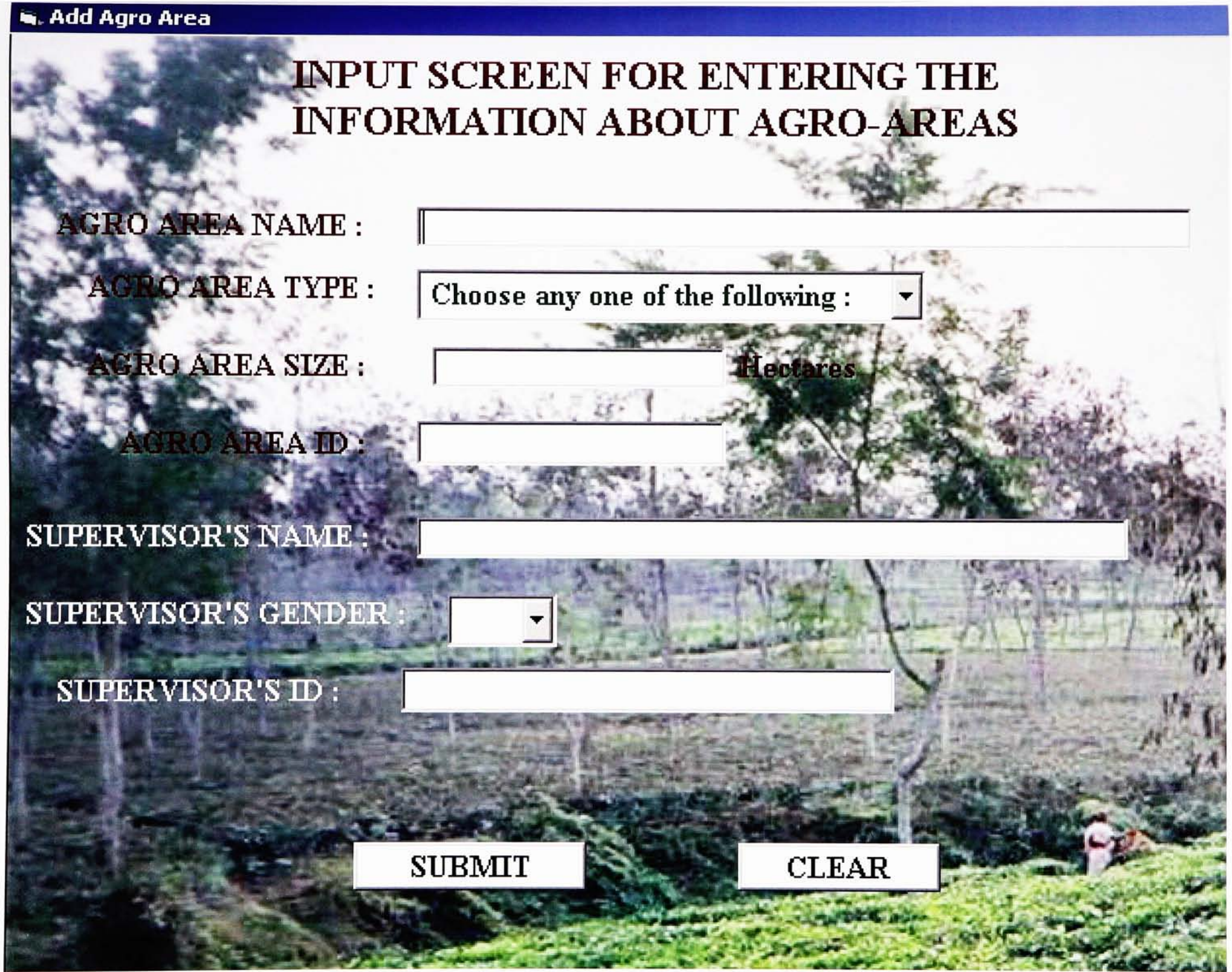

MENU ACTION SCREEN
EMPLOYEE :
GO!
UPPER EMPLOYEE :
GO!
LABORER :
GO!
DAY LABORER :
GO!
DEPENDENTS :
GO!
AGRO AREA :
GO!
FACTORY MACHINE :
GO!
DAILY PLANTING :
GO!
DAILY PLUCKING :
GO!
DAILY CONTROL OF WEEDS AND PESTS :
GO!
DAILY WORK WITH FACTORY MACHINES :
GO!
CHEMICALS :
GO!
DAILY USE OF CHEMICALS :
GO!
YEARLY PLUCKING OF TEA LEAVES!!!
YEARLY PRODUCTION OF MADE TEA!!!
UPDATE DATA
LOGOUT!!!
EXIT!!!

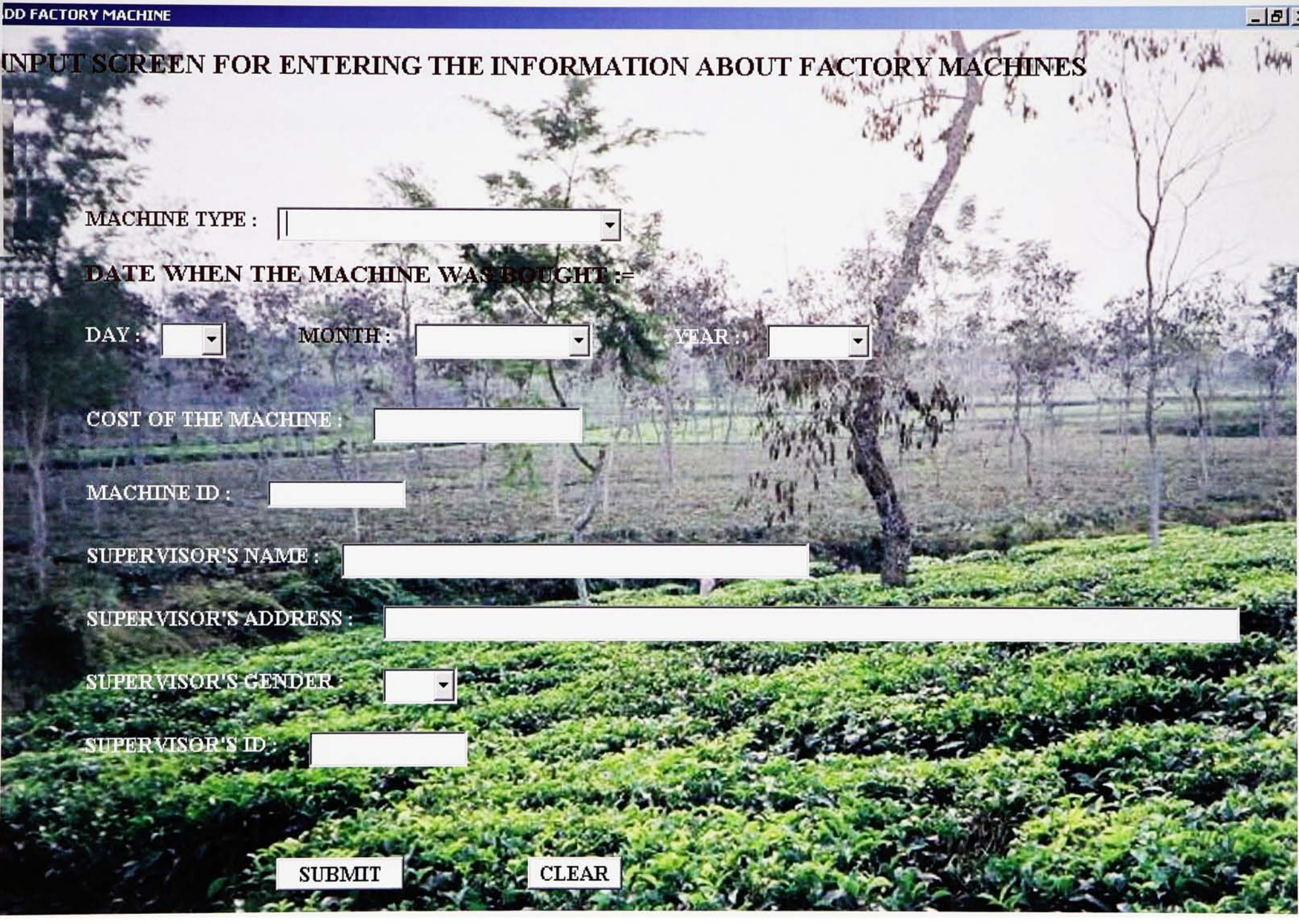

DD EMPLOYEES
INPUT SCREEN FOR ENTERING THE
INFORMATION ABOUT EMPLOYEES
NAME :
ADDRESS :
GENDER :
POSITION :
ID :
SUBMIT
CLEAR

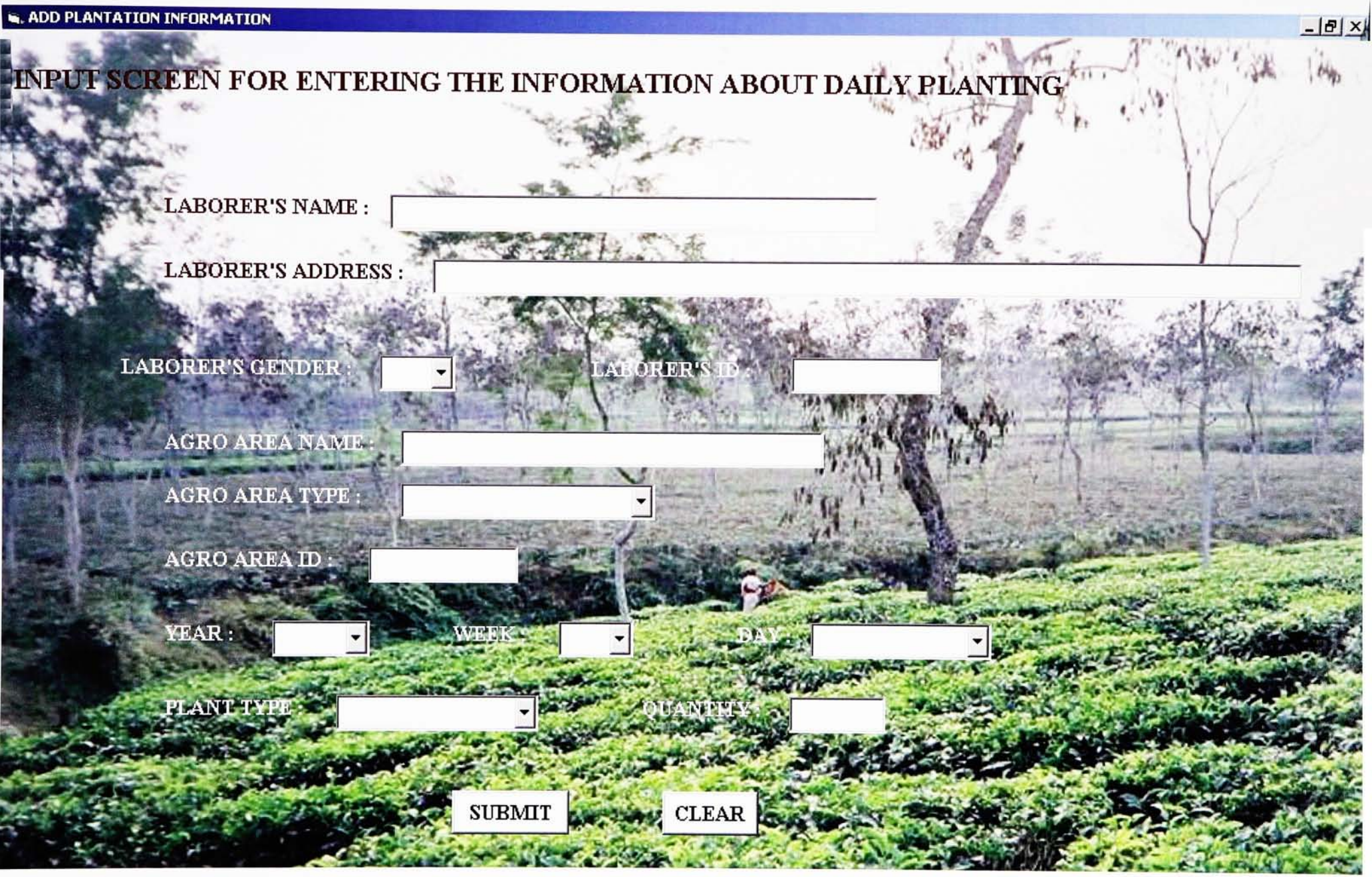

ADD UPPER EMPLOYEES
INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT UPPER-LEVEL EMPLOYEES
EMPLOYEE'S NAME :
EMPLOYEE'S ADDRESS :
EMPLOYEE'S GENDER :
EMPLOYEE'S POSITION :
EMPLOYEE'S ID :
YEAR :
MONTH :
EMPLOYEE'S SALARY :
AMOUNT PAID :
SUBMIT
CLEAR

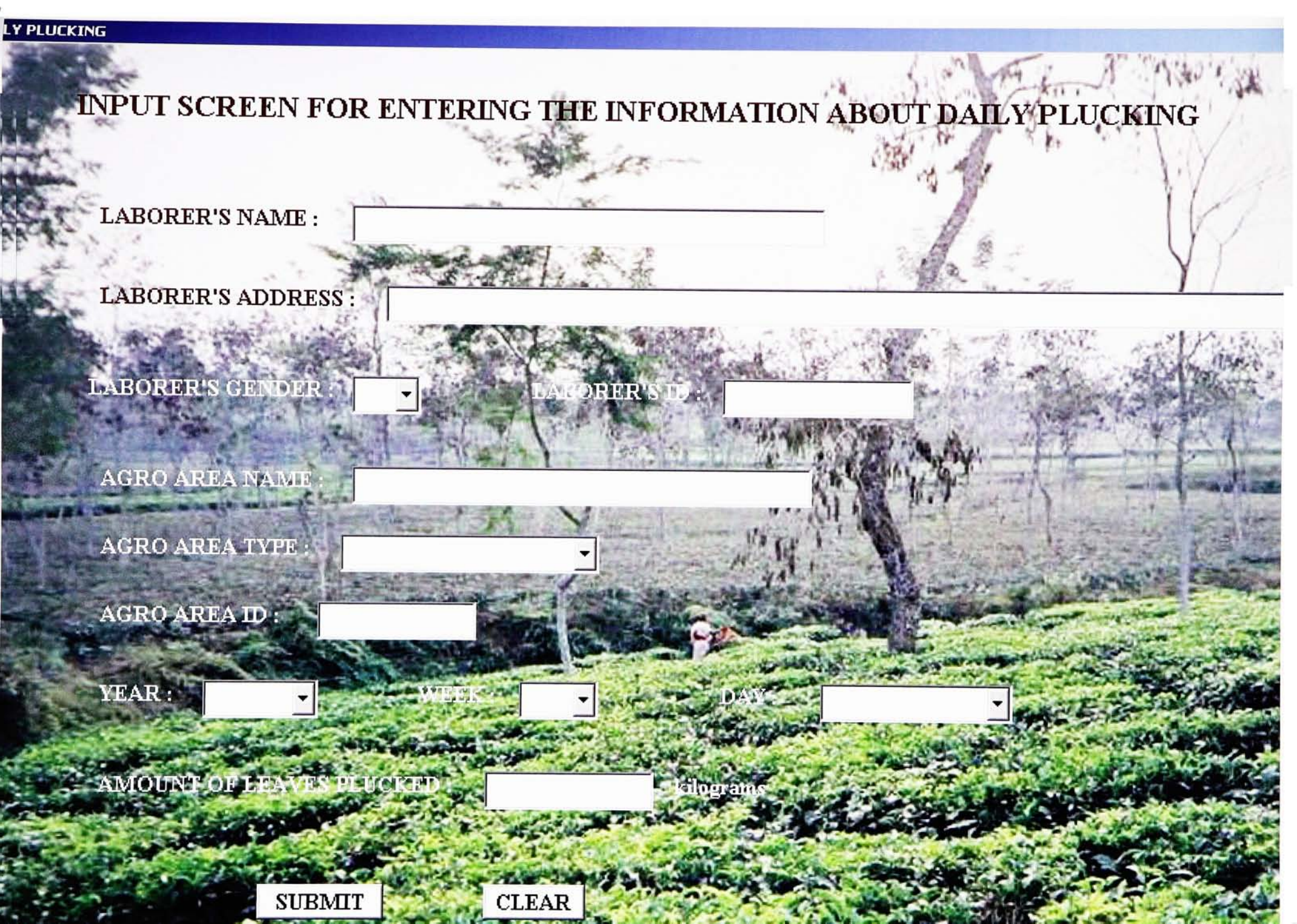

INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT LABORERS
LABORER'S NAME :
LABORER'S ADDRESS :
LABORER'S GENDER :
LABORER'S ID :
YEAR :
WEEK :
WAGE PER UNIT :
SUBMIT
CLEAR

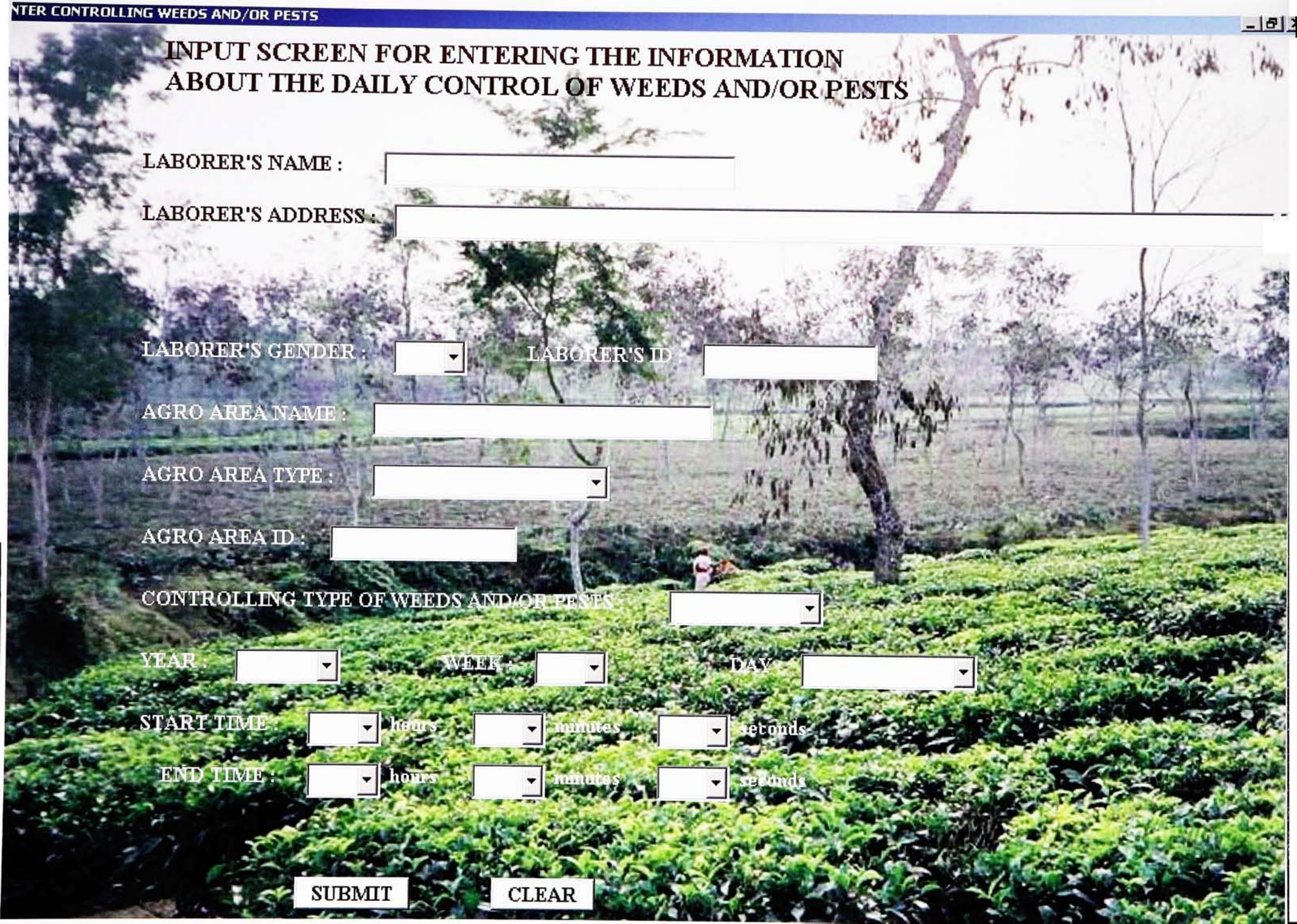

DD DAY LABORERS
INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT DAY LABORERS (FIELDS CONTAINING ASTERISKS (*) ARE REQUIRED)
LABORER'S NAME : *
LABORER'S ADDRESS : *
LABORER'S GENDER : *
LABORER'S ID : *
YEAR : *
WEEK : *
DAY : *
DAILY SALARY : *
INFORMATION ABOUT PLANTING
AREA NAME :
AREA TYPE :
AREA ID :
INFORMATION ABOUT PLUCKING
AREA NAME :
AREA TYPE :
AREA ID :
INFORMATION ABOUT CONTROLLING WEEDS AND PESTS
AREA NAME :
AREA TYPE :
AREA ID :
INFORMATION ABOUT WORKING WITH FACTORY MACHINES
MACHINE TYPE :
MACHINE ID :
AMOUNT PAID : *
SUBMIT
CLEAR


Add Agro Area
INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT AGRO-AREAS
AGRO AREA NAME :
AGRO AREA TYPE :
Choose any one of the following :
AGRO AREA SIZE :
Hectares
AGRO AREA ID :
SUPERVISOR'S NAME :
SUPERVISOR'S GENDER :
SUPERVISOR'S ID :
SUBMIT
CLEAR


DD FACTORY MACHINE
INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT FACTORY MACHINES
MACHINE TYPE :
DATE WHEN THE MACHINE WAS BOUGHT :=
DAY :
MONTH :
YEAR :
COST OF THE MACHINE :
MACHINE ID :
SUPERVISOR'S NAME :
SUPERVISOR'S ADDRESS :
SUPERVISOR'S GENDER :
SUPERVISOR'S ID :
SUBMIT
CLEAR

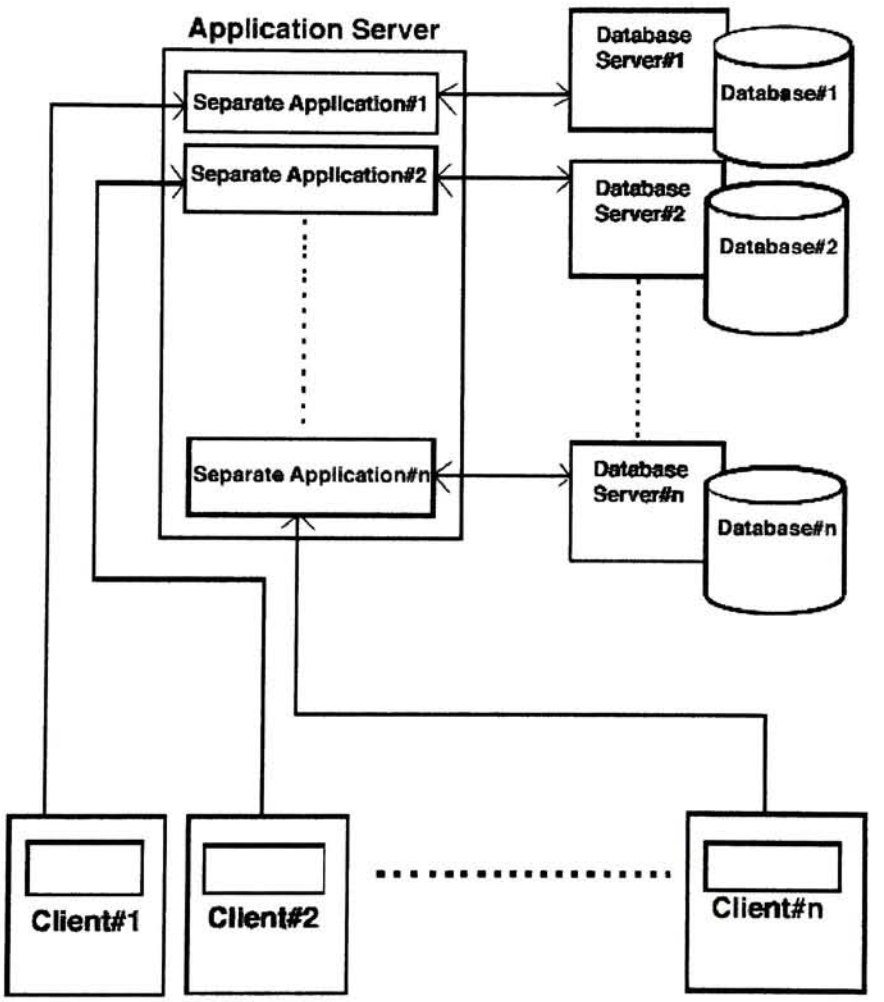

ADD PLANTATION INFORMATION
INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT DAILY PLANTING
LABORER'S NAME :
LABORER'S ADDRESS :
LABORER'S GENDER :
LABORER'S ID :
AGRO AREA NAME :
AGRO AREA TYPE :
AGRO AREA ID :
YEAR :
WEEK :
DAY :
PLANT TYPE :
QUANTITY :
SUBMIT
CLEAR


LY PLUCKING
INPUT SCREEN FOR ENTERING THE INFORMATION ABOUT DAILY PLUCKING
LABORER'S NAME :
LABORER'S ADDRESS :
LABORER'S GENDER :
LABORER'S ID :
AGRO AREA NAME :
AGRO AREA TYPE :
AGRO AREA ID :
YEAR :
WEEK :
DAY :
AMOUNT OF LEAVES PLUCKED :
kilograms
SUBMIT
CLEAR


NTER CONTROLLING WEEDS AND/OR PESTS
INPUT SCREEN FOR ENTERING THE INFORMATION
ABOUT THE DAILY CONTROL OF WEEDS AND/OR PESTS
LABORER'S NAME :
LABORER'S ADDRESS :
LABORER'S GENDER :
LABORER'S ID :
AGRO AREA NAME :
AGRO AREA TYPE :
AGRO AREA ID :
CONTROLLING TYPE OF WEEDS AND/OR PESTS :
YEAR :
WEEK :
DAY :
START TIME :
hours
minutes
seconds
END TIME :
hours
minutes
seconds
SUBMIT
CLEAR

Choosing the Number of Computers at Each End

It is obvious that there will be only one computer, i.e., one client in each tea garden. It is also clear that if a person or a company owns only one garden, he/she/it will buy only one computer, i.e., one server for the head office. But, the user has to decide whether he/she wants to buy the number of computers for the head office if he/she owns more than one garden. From a layman's point of view, one may think that a company needs as many server as the number of tea gardens it owns; i.e., if the company owns two gardens, then there should be two servers at the head office, one for each tea garden. Figure#1 shows this scenario.

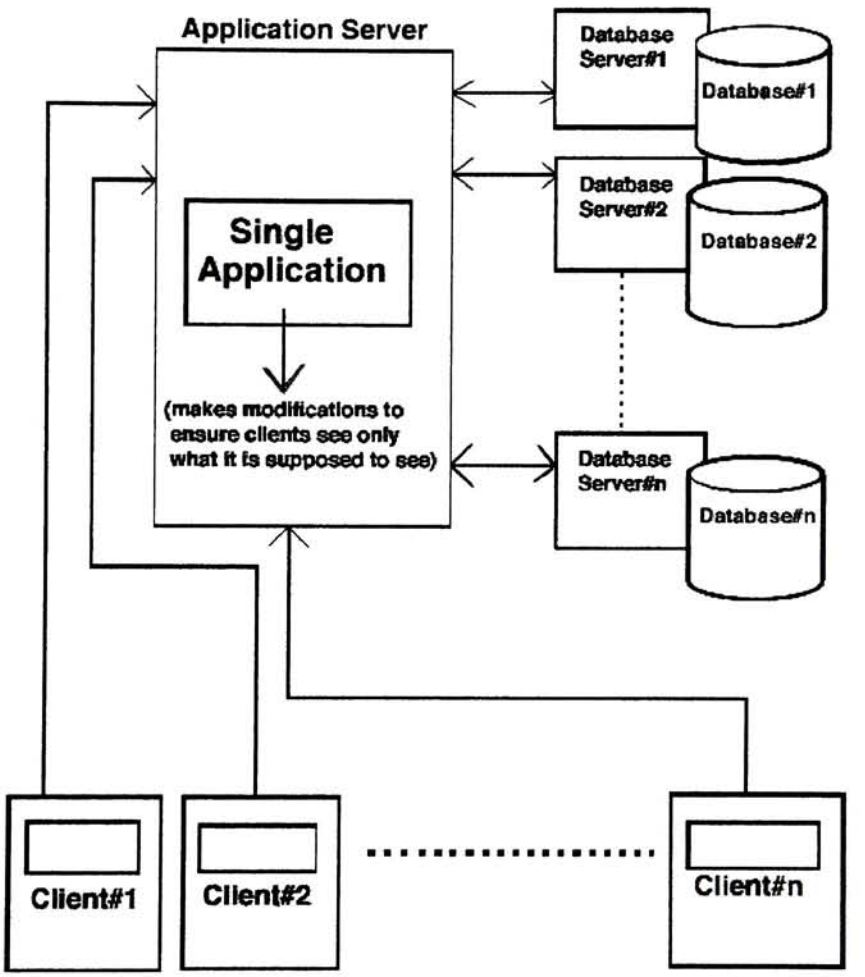


Figure#1 : Separate Database Servers and Applications for each tea garden

In Figure#1, it is shown that, there are more than one database servers — each dedicated to store data for only one tea garden. It is also shown that there is an application server where more than one applications are running — each one dedicated for only one tea garden. The strength of this design is that it provides 100 percent security of data. But

there are two weaknesses : (i) There are more than one same kind of applications running, where it would have been wise to run only one application and a network program for all tea gardens, and (ii) Each server is storing 12.73 MB of data for the whole year, where a Pentium III computer can have a free space of 121.63 MB of free space.

Figure#2 is shown as follows — which is a slight modification from Figure#1.

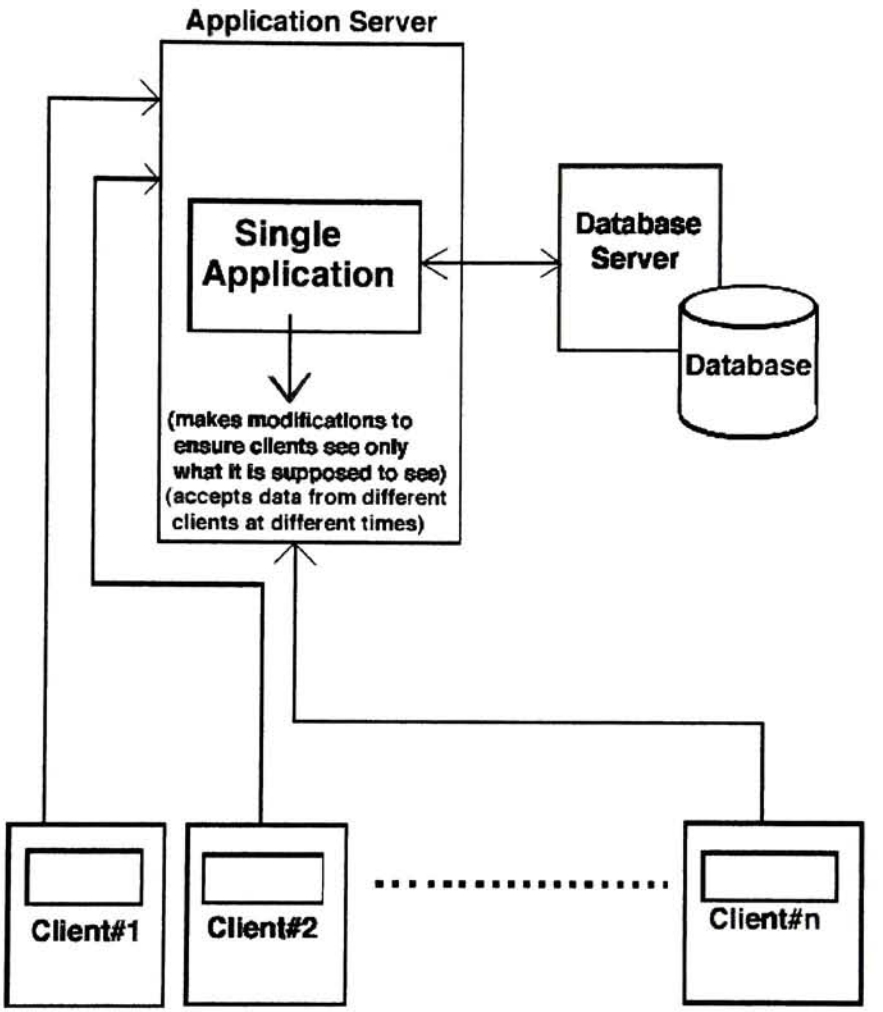


Figure#2 : Separate Database Servers for each tea garden and only one Application

In Figure#2, it is shown that the spplication in the application server forwards data to the server where it (the data) is destined to. But still there are so many spaces being wasted in each database servers. Also, in the application server, only an application program and a network program is stored and so many spaces is wasted.

There are two ways to utilize the extra space and save money from buying more than one database servers. They are stated as follows :

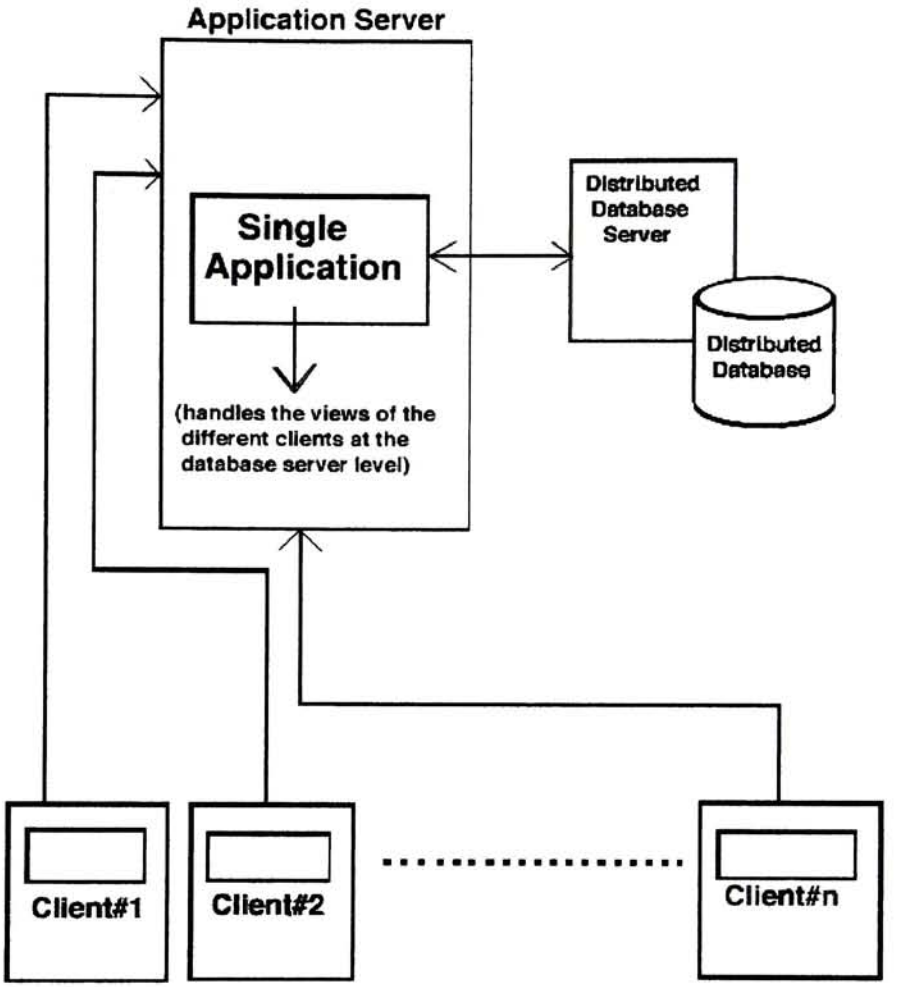
- Store databases of all tea gardens in one database server by receiving data from each client at different times, as shown in Figure#3.



Figure#3 : Only one Database Server and Application Server for all tea gardens

In Figure#3, it is shown that only one database server is used to store data of all tea gardens and the application server receives data from different clients at different times. But, it is not providing the full level of security. Also, the data entry clerk using one client may not finish his/her work before the time the server receives data from that particular client.

- Option#4 is to store data of all tea gardens in one compter, where there is an application program and a distributed database system, e.g., Access, Oracle, DB2, etc.. This scenario is shown in Figure#4 in the next page.



Figure#4 : Only one Distributed Database Server for all tea gardens

The scenario depicted in Figure#4 may seem well-designed and economical, but if prices of typical Oracle and SQL Servers are considered, then this design will not seem interesting anymore. Prices of Oracle and SQL servers are listed as follows :

Oracle9*i* Enterprise Edition and SQL Server 2000 Enterprise Edition

Number of CPUs	Oracle9*i* Enterprise Edition	SQL Server 2000 Enterprise Edition
1	$40,000.00	$19,999.00
2	$80,000.00	$39,998.00
4	$160,000.00	$79,996.00
8	$320,000.00	$159,992.00

16	$640,000.00	$319,984.00
32	$1,280,000.00	$639,968.00

Without OLAP or Data Mining

Number of CPUs	Oracle9*i* Enterprise Edition	SQL Server 2000 Enterprise Edition
1	$60,000.00	$19,999.00
2	$120,000.00	$39,998.00
4	$240,000.00	$79,996.00
8	$480,000.00	$159,992.00
16	$960,000.00	$319,984.00
32	$1,920,000.00	$639,968.00

With OLAP and Data Mining

Number of CPUs	Oracle9*i* Enterprise Edition	SQL Server 2000 Enterprise Edition
1	$80,000.00	$19,999.00
2	$160,000.00	$39,998.00
4	$320,000.00	$79,996.00
8	$640,000.00	$159,992.00
16	$1,280,000.00	$319,984.00
32	$2,560,000.00	$639,968.00

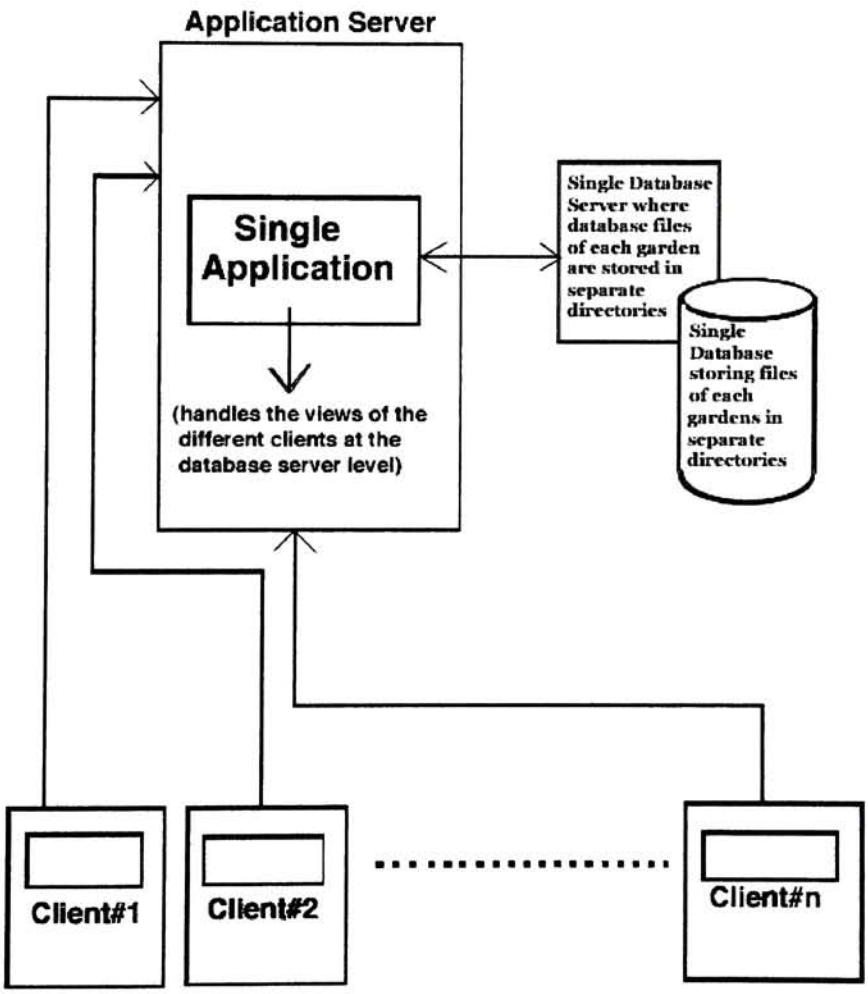
Oracle9*i* Standard Edition and SQL Server 2000 Standard Edition

Number of CPUs	Oracle9*i* Standard Edition	SQL Server 2000 Standard Edition
1	$15,000.00	$4,999.00
2	$30,000.00	$9,998.00
4	$60,000.00	$19,996.00
8	$120,000.00	$39,992.00

16	$240,000.00	$79,984.00
32	$480,000.00	$159,968.00

1

- The final option (i.e., option#5) is to choose only only one computer at the head office, which consists of an application program and a single database program, but files of all tea gardens are stored in different directories. So, if the data entry clerk of a tea garden wants to store information about that particular garden in the computer at the head office, there should be a program which will connect that user to the corresponding directory and he/she will be able to access only that particular directory. Figure#5 depicts this scenario.



Figure#5 : One server with a single database, but different directories for each garden

Thus, in my humble opinion, option#5 is the best option, since the amount of data is too small — the total amount of data for each garden for an year is 12.73 MB. If a person or a company owns 15 tea gardens, then the total amount of space needed for an year is (12.73*15) MB = 190.95 MB; whereas the size of a Random Access Memory (RAM) of

today's computer is 256MB and the size of the hard disk is 20GB to 40 GB. Examples of such computers and their prices are listed as follows :

Product Name	Price
Gateway 300S Celeron, 1.3 GHz, 256 MB RAM, 40 GB hard disk, 17" display, Microsoft Windows XP, 1 year limited warranty	$849.00
Gateway 300SE Celeron, 1.3 GHz, 256 MB RAM, 40 GB hard disk, 17" display, Microsoft Windows XP, 1 year limited warranty	$849.00
Dell Dimension 4400 (Pentium 4, 1.6 GHz, 256 MB, 20 GB) Pentium 4, 1.6 GHz, 256 MB RAM, 20 GB hard disk, 15" display, Microsoft Windows XP Home Edition, 1 year limited warranty	$859.00

[2]

The price of a clone Pentium computer is US $775.00.

Also, a Network Interface Card (NIC) is needed to connect a computer with the network. The prices of a NIC is shown as follows :

Product Name	Product Number	Price
3Com® OfficeConnect® Fast Ethernet NIC	3CSOHO100-TX	$32.00

Thus, the minimum price of a computer with a NIC will be
= US $(775.00 + 32.00) = US $807.00
and the maximum price of a computer with a NIC will be
= US $(859.00 + 32.00) = US $891.00.

References :

[1] http://www.microsoft.com/sql/evaluation/compare/pricecomparison.asp
[2] http://computers.cnet.com/hardware/0-1017.html?tag=dir

Available Telecommunication Technologies in Bangladesh : both Private and Government

In this part, I have discussed about all the telecommunication technologies available in Bangladesh. There are eleven technologies currently available in Bangladesh. They are listed as follows :

SL. NO.	Name of the Technology
1.	X.25 Leased Line
2.	X.28 Leased Line
3.	X.28 Dial-up Line
4.	Digital Subscriber Line (DSL)
5.	Cable
6.	E1
7.	Single-Channel Radio Link
8.	Wireless Local Loop
9.	Global System for Mobile Communications (GSM)
10.	Code Division Multiple Access (CDMA)
11.	Satellite Wireless

For the above technologies, I have discussed the following factors in later chapters :

Coverage Area
Topology Dependent?
Media to be used
Available Bandwidth
Necessary Customer Premises Equipment (CPE)
Security Measurements
Cost
Strengths
Weaknesses

Bangladesh Telephone and Telegraph Board (BTTB) is planning to introduce Asynchronous Transfer Mode (ATM), Frame Relay, and Synchronous Optical NETwork (SONET) in future to the public. Since, the exact date for the introduction of these technologies is not known, these three technologies are not being discussed. BTTB is currently using SONET for their own purpose.

The currency rate is : US $1.00 = BD Tk. 57.00.

X.25 Leased Line

Coverage Area

X.25 leased line, a kind of packet-switch data network, is provided by BTTB (Bangladesh Telephone and Telegraph Board), which operates throughout the country. So, a customer willing to take X.25 leased line can have it from the telephone exchange nearest to his/her premises wherever it is situated across the country.

Topology Dependent?

Currently, BTTB is using star topology (with Dhaka as the center) for all its available technologies, but mesh topology will be introduced in the near future. So, X.25 is topology independent.[1]

Media to be used

Currently, BTTB is using microwave radio link as the backbone for all its technologies (excluding DSL and E1).[1] But, as soon as undersea fibre-optic is introduced as the backbone, use of microwave will be gradually eliminated. The project for undersea fibre-optic lines will be finished by December, 2003.[2] For customer's premises, twisted pair or coaxial cable is used.[1]

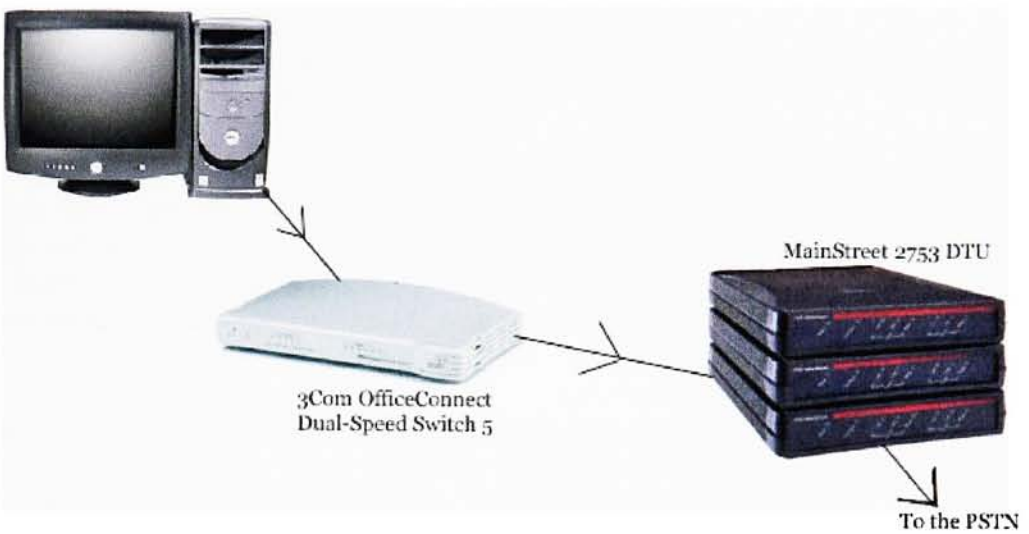
Available Bandwidth

X.25 leased line can provide a bandwidth of 19.2 kbps to 64 kbps.[1]

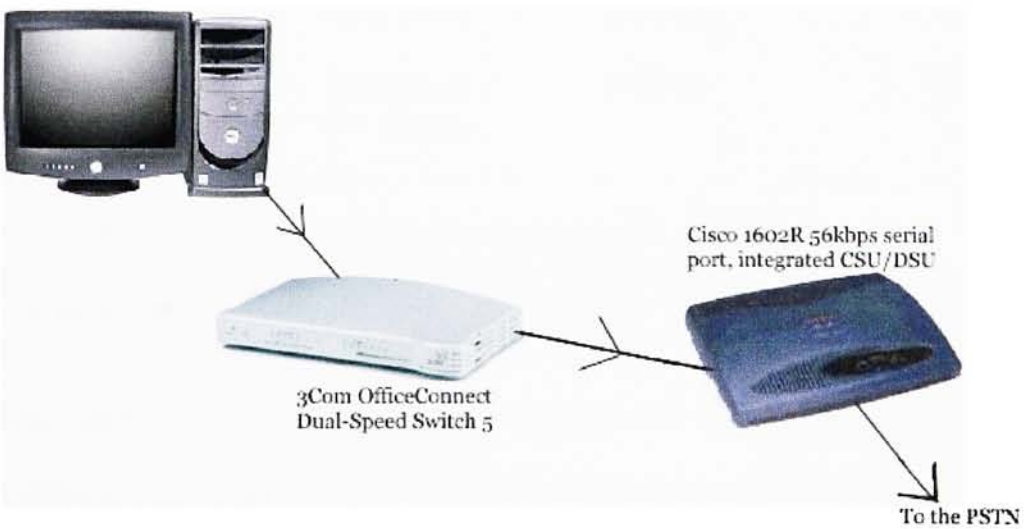
Necessary Customer Premises Equipment

Customer Premises Equipment for the X.25 leased line are given as follows :

Name of the Equipment	Cost (in US $)	Cost (in BD Taka)
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
Cisco 1602R 56 kbps serial port, integrated CSU/DSU[4], or,	1,225.00	69,825.00
64/128 kbps, Model — MainStreet 2703/2753, Manufacturer — Alcatel CID[5]	1,403.51	80,000.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING X.25 LEASED LINE (OPTION#1)



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING X.25 LEASED LINE (OPTION#2)

Security Measurements

Since, a leased line is dedicated to only two or three users, there is no need to take any security measurements.

Cost

(i) The installation cost for X.25 leased line is US $52.6316 (= Tk. 3,000.00) per kilometer[8] [US $1.00 = Tk. 57.00].

All tea gardens are 16.093 to 32.186 kilometers away from their nearest telephone exchanges. So, a tea garden situated 16.093 kilometers away from its nearest telephone exchange will have to pay the installation cost of Tk. (3,000.00*16.093) = Tk. 48,279.00 (= US $847.00) and a tea garden situated 32.186 kilometers away from its nearest telephone exchange will have to pay the installation cost of Tk. (3,000.00*32.186) = Tk. 96,558.00 (= US $1,694.00).

The approximate distance between one end of Motijheel Commercial Area (Dhaka) and the other is 2.6 kilometers. Thus, installing X.25 leased line at one office in Motijheel will not cost more than Tk. (3,000.00*2.6) = Tk. 7,800.00 (= US $136.84).

(ii) Customer premises equipment for X.25 leased line are listed as follows :

Name of the Equipmment	Cost (in US $)	Cost (in BD Taka)
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
Cisco 1602R 56 kbps serial port, integrated CSU/DSU[4], or,	1,225.00	69,825.00
64/128 kbps, Model — MainStreet 2703/2753, Manufacturer — Alcatel CID[5]	1,403.51	80,000.00

Thus, the minimum total cost of CPE for the X.25 leased line will be
= US $(109.00 + 1,225.00) = US $1,334.00 = Tk. 76,038.00
and the maximum total cost of CPE for the X.25 leased line will be
= US $(109.00 + 1,403.51) = US $1,512.51 = Tk. 86,213.00.

(iii) The rental charge of X.25 leased line is US $263.15 (= Tk. 15,000.00) per year.[6]

Volume charges (i.e., Data Transfer Charges) using X.25 leased line are provided as follows :

Peak hour (09:00 a.m. to 05:00 p.m.) : Tk. 5.00 (= 0.087 cents) per Kilo Segment.
Mid-peak hour (05:00 p.m. to 11:00 p.m.) : Tk. 3.00 (= 0.052 cents) per Kilo Segment.
Off-peak hour (11:00 p.m. to 09:00 a.m.) : Tk. 2.00 (= 0.035 cents) per Kilo Segment.

1 Kilo Segment = 64 Kilo Bytes.[6]

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred
= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits = (101850.968÷8) kilobytes = 12731.371 kilobytes
= (12731.371÷64) kilo segments = 198.9276719 kilo segments ≈ 198.93 kilo segments.

If data are transferred during peak hour every day, then the charge for the whole year will be = Tk. {15,000.00 + (198.93*5)} = Tk. (15,000.00 + 994.65) = Tk. 15,994.65 (= US $280.61).
If data are transferred during mid-peak hour every day, then the charge for the whole year will be = Tk. {15,000.00 + (198.93*3)} = Tk. (15,000.00 + 596.79) = Tk. 15,596.79 (= US $273.63).
If data are transferred during off-peak hour every day, then the charge for the whole year will be = Tk. {15,000.00 + (198.93*2)} = Tk. (15,000.00 + 397.86) = Tk. 15,397.86 (= US $270.14).

Different types of costs associated with X.25 leased line are listed as follows :

Type of cost	Cost (in US $)	Cost in BD Taka
Installation Cost for the head office	136.84	7,800.00
Minimum installation cost for tea garden	847.00	48,279.00
Maximum installation cost for tea garden	1,694.00	96,558.00
Minimum total CPE cost	1,334.00	76,038.00
Maximum total CPE cost	1,512.51	86,213.00
Minimum annual rental charge	270.14	15,397.86
Maximum annual rental charge	280.61	15,397.86

Strengths

1. X.25 can decrease network costs, since off-the-shelf software and hardware are readily available.[7]
2. X.25 gives the user a virtual high quality digital network at low cost. It is economical for the same reason that it is usually cheaper to use the mail than to run the user's own postal service : there are tremendous savings to be made if multiple parties share the same infrastructure.[8]
3. The installation cost of X.25 leased line is quite cheap — Tk. 3,000.00 per kilometer.
4. The rental charge of X.25 is quite reasonable — Tk. 15,000.00 per year.

5. Volume charge for the whole year is negligible (Tk. 994.65) compared to the rental charge (Tk. 15,000.00).

Weaknesses

1. X.25 leased line is quite slow for today's bandwidth-intensive applications (19.2-64 kbps), though work involving database can be done smoothly (256.96-410.168 kilobits per day).
2. There is an inherent delay caused by the store-and-forward mechanism. On most single networks, the turnaround delay is about 0.6 seconds. This has no effect on large block transfers (like data to be transferred from tea plantations to head offices and vice versa), but in flip-flop types of transmissions, the delay can be very noticeable.[9]

References

[1] Mr. Sayed-Ur Rahman (sayed@bttb.net.bd)
[2] http://bangladesh-web.com/news/dec/c20122001.htm
[3] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[4] http://www.tribecaexpress.com/cisco1600.htm
[5] Mr. Ishteaq Hossain (avanti@bttb.net.bd)
[6] http://www.bttb.net/home/main/psdn_rates.htm
[7] X.25 and Related Protocols — Uyless Black
[8] http://www.ssuet.edu.pk/taimoor/athar/ce-5101/x25/sld043.htm
[9] http://www.ssuet.edu.pk/taimoor/athar/ce-5101/x25/sld044.htm

X.28 Leased Line

Coverage Area

X.28 leased line, a kind of packet-switch data network, is provided by BTTB (Bangladesh Telephone and Telegraph Board), which operates throughout the country. So, a customer willing to take X.28 leased line can have it from the telephone exchange nearest to his/her premises wherever it is situated across the country.

Topology Dependent

Currently, BTTB is using star topology (with Dhaka as the center) for all its available technologies, but mesh topology will be introduced in the near future. So, X.28 is topology independent.[1]

Media to be used

Currently, BTTB is using microwave radio link as the backbone for all its technologies (excluding DSL and E1).[1] But, as soon as the submarine fibre-optic is introduced as the backbone, use of microwave will be gradually eliminated. The project for undersea fibre-optic lines is expected to be finished by December 2003.[2] For customer's premises, twisted pair or coaxial cable is used.[1]

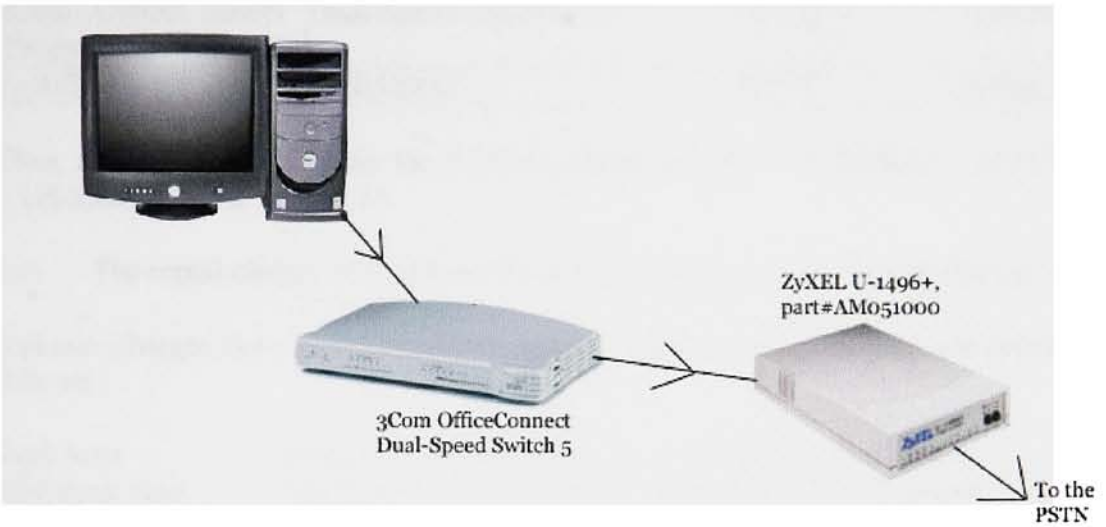
Available Bandwidth

X.28 leased line can provide a bandwidth of up to 128 kbps.[1]

Necessary Customer Premises Equipment

Necessary customer premises equipment for X.28 leased line are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
ZyXEL U-1496+, part# AM051000[4]	297.95	16,983.15



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING X.28 LEASED LINE

Security Measurements

Since, a leased line is dedicated to only two or three users, there is no need to take any security measurements.

Cost

(i) The installation cost for X.28 leased line is US $35.0877 (= Tk. 2,000.00) per kilometer[5] [US $1.00 = Tk. 57.00].

All tea gardens are 16.093 to 32.186 kilometers away from their nearest telephone exchanges. So, a tea garden situated 16.093 kilometers away from its nearest telephone exchange will have to pay the installation cost of Tk. (2,000.00*16.093) = Tk. 32,186.00 (= US $564.67) and a tea garden situated 32.186 kilometers away from its nearest telephone exchange will have to pay the installation cost of Tk. (2,000.00*32.186) = Tk. 64,372.00 (= US $1,129.33). The approximate distance between one end of Motijheel Commercial Area (Dhaka) and the other is 2.6 kilometers. Thus, installing X.28 leased line at one office in Motijheel will not cost more than Tk. (2,000.00*2.6) = Tk. 5,200.00 (= US $91.23).

(iii) Customer premises equipment for X.28 leased line are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
ZyXEL U-1496+, part# AM051000[4]	297.95	16,983.15

Thus, the total cost of CPE for the X.28 leased line will be = US $(109.00 + 297.95) = US $306.95 = Tk. 17,092.15.

(iv) The rental charge of X.28 leased line is US $175.44 (= Tk. 10,000.00) per year.[5]

Volume charges (i.e., Data Transfer Charges) using X.28 leased line are provided as follows :

Peak hour (09:00 a.m. to 05:00 p.m.) : Tk. 5.00 per Kilo Segment.
Mid-peak hour (05:00 p.m. to 11:00 p.m.) : Tk. 3.00 per Kilo Segment.
Off-peak hour (11:00 p.m. to 09:00 a.m.) : Tk. 2.00 per Kilo Segment.

1 Kilo Segment = 64 Kilo Bytes.[5]

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred
= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits = (101850.968÷8) kilobytes = 12731.371 kilobytes
= (12731.371÷64) kilo segments = 198.9276719 kilo segments ≈ 198.93 kilo segments.

If data are transferred during peak hour every day, then the charge for the whole year will be = Tk. {10,000.00 + (198.93*5)} = Tk. (10,000.00 + 994.65) = Tk. 10,994.65 (= US $192.89).
If data are transferred during mid-peak hour every day, then the charge for the whole year will be = Tk. {10,000.00 + (198.93*3)} = Tk. (10,000.00 + 596.79) = Tk. 10,596.79 (= US $185.91).
If data are transferred during off-peak hour every day, then the charge for the whole year will be = Tk. {10,000.00 + (198.93*2)} = Tk. (10,000.00 + 397.86) = Tk. 10,397.86 (= US $182.42).

Different types of costs associated with X.25 leased line are listed as follows :

Type of cost	Cost (in US $)	Cost in BD Taka
Installation Cost for the head office	91.23	5,200.00

Minimum installation cost for tea garden	564.67	32,186.00
Maximum installation cost for tea garden	1,129.33	64,372.00
Total CPE cost	306.95	17,092.15
Minimum annual rental charge	182.42	10,397.86
Maximum annual rental charge	192.89	10,994.65

Strengths

1. X.28 leased line provides a bandwidth of 128 kbps, which is enough for handling data for tea plantation (256.96-410.168 kilobits each day).
2. The installation cost of X.28 leased line is quite cheap : Tk. 2,000.00 per kilometer.
3. The rental charge of X.28 leased line is quite reasonable : Tk. 10,000.00 per year.
4. Volume charge for the whole year is negligible (Tk. 994.65) compared to the rental charge (Tk. 10,000.00).
5. The installation cost of X.28 leased line (Tk.2,000 per kilometer) is cheaper than X.25 leased line (Tk.3,000.00 per kilometer).
6. The rental charge of X.28 leased line (Tk.10,000.00 per year) is cheaper than X.25 leased line (Tk.15,000.00 per year).
7. X.28 leased line gives more bandwidth (128 kbps) than X.25 leased line (19.2-64 kbps).

Weakness

The rental charge of X.28 leased line (Tk. 10,000.00 per year) is ten times higher than that of X.28 dial-up line (Tk. 1,000.00 per year).

References

[1] Sayed-Ur Rahman (sayed@bttb.net.bd)
[2] http://bangladesh-web.com/news/dec/20/c20122001.htm
[3] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[4] Mr. Ishteaq Hossain (avanti@bttb.net.bd)
[5] http://www.bttb.net/home/main/psdn_rates.htm

X.28 Dial-up Line

Coverage Area

X.28 dial-up line, a kind of packet-switch data network, is provided by BTTB (Bangladesh Telephone and Telegraph Board), which operates throughout the country. So, a customer willing to take X.28 dial-up line can have it from the telephone exchange nearest to his/her premises wherever it is situated across the country.

Topology Dependent

Currently, BTTB is using star topology (with Dhaka as the center) for all its available technologies, but mesh topology will be introduced in the near future.[1] So, X.28 is topology independent.

Media to be used

BTTB uses microwave radio link as the backbone for all its technologies (excluding DSL and E1).[1] But, as soon as the submarine fibre-optic is introduced as the backbone, use of microwave will be gradually diminished. The project for undersea fibre-optic lines is expected to be completed by December 2003.[2] For customer's premises, twisted pair or coaxial cable is used.[1]

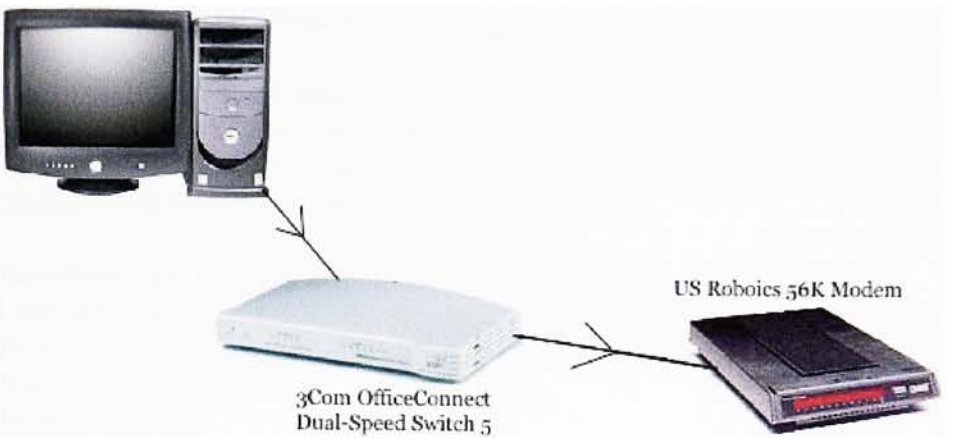
Available Bandwidth

X.28 dial-up line can provide the maximum bandwidth of 128 kbps.[1]

Necessary Customer Premises Equipment

Customer Premises Equipment needed for X.28 dial-up line are listed as follows :

Name of the equipment	Cost in US $	Cost in Bangladeshi Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
US Robotics 56K modem[4]	105.26	6,000.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING X.28 DIAL-UP LINE

Security Measurements

Since, data is transferred by dial-up, computers are connected only for a short period. So, there is no need for security measurements for that short span of time.

Cost

(i) Setting up the X.28 dial-up line at each end (the head office and the tea garden) will cost Tk. 20,300.00 (= US $356.14) for the phone line and Tk. 20,000.00 for the Internet dial-up line (= US $350.88) — a total of Tk. 40,300.00 (= US $707.02).[1]

(ii) Customer Premises Equipment needed for X.28 dial-up line are listed as follows :

Name of the equipment	Cost in US $	Cost in Bangladeshi Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
US Robotics 56K modem[4]	105.26	6,000.00

Thus, the total cost of CPE for the X.28 dial-up line will be = US $ (109.00 + 105.26) = US $214.26 = Tk. 12,213.00.

(iii) The rental charge of X.28 dial-up line is Tk. 1,000.00 (= US $17.54) per year.[5]

Usage charges for X.28 dial-up line are given as follows :
Tk. 0.50 per minute for Peak hours (8:00 a.m. to 11:00 p.m.) and
Tk. 0.30 per minute for Off Peak hours (11:00 p.m. to 8:00 a.m.)[6]

Tk. 0.50 per minute for Peak hours (8:00 a.m. to 11:00 p.m.) and
Tk. 0.30 per minute for Off Peak hours (11:00 p.m. to 8:00 a.m.)[6]

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred
= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits.

If data are transferred during peak hour every day, then the charge for the whole year will be = Tk. [1,000.00 + {(101,850.968÷128)*0.50}] = Tk. {1,000.00 + (795.711*0.50)}
= Tk. (1,000.00 + 397.866) = Tk. 1,397.866 (= US $24.52).
If data are transferred during off-peak hour every day, then the charge for the whole year will be = Tk. [1,000.00 + {(101,850.968÷128)*0.30}] = Tk. {1,000.00 + (795.711*0.30)}
= Tk. (1,000.00 + 238.713) = Tk. 1,238.713 (= US $21.73).

Different types of costs associated with X.28 dial-up line are listed as follows :

Type of cost	Cost (in US $)	Cost in BD Taka
Installation Cost for each end	707.02	40,300.00
Total CPE cost	214.26	12,213.00
Minimum annual rental charge	21.73	1,397.866
Maximum annual rental charge	24.52	1,238.713

Strengths

8. X.28 dial-up line provides a bandwidth of 128 kbps, which is enough for handling data for tea plantation (256.96-410.168 kilobits each day).
9. The rental charge of X.28 leased line is quite reasonable : Tk. 1,000.00 per year.
10. Total per minute charge of X.28 dial-up line for the whole year is negligible (Tk. 397.866) compared to the volume charge of X.25 and X.28 leased lines for the whole year (Tk. 994.65).
11. The rental charge of X.28 dial-up line (Tk. 1,000 per year) is much cheaper than X.28 leased line (Tk.10,000.00 per year) and X.25 leased line (Tk. 15,000.00 per year).
12. X.28 dial-up line gives more bandwidth (128 kbps) than X.25 leased line (19.2-64 kbps).

Weakness

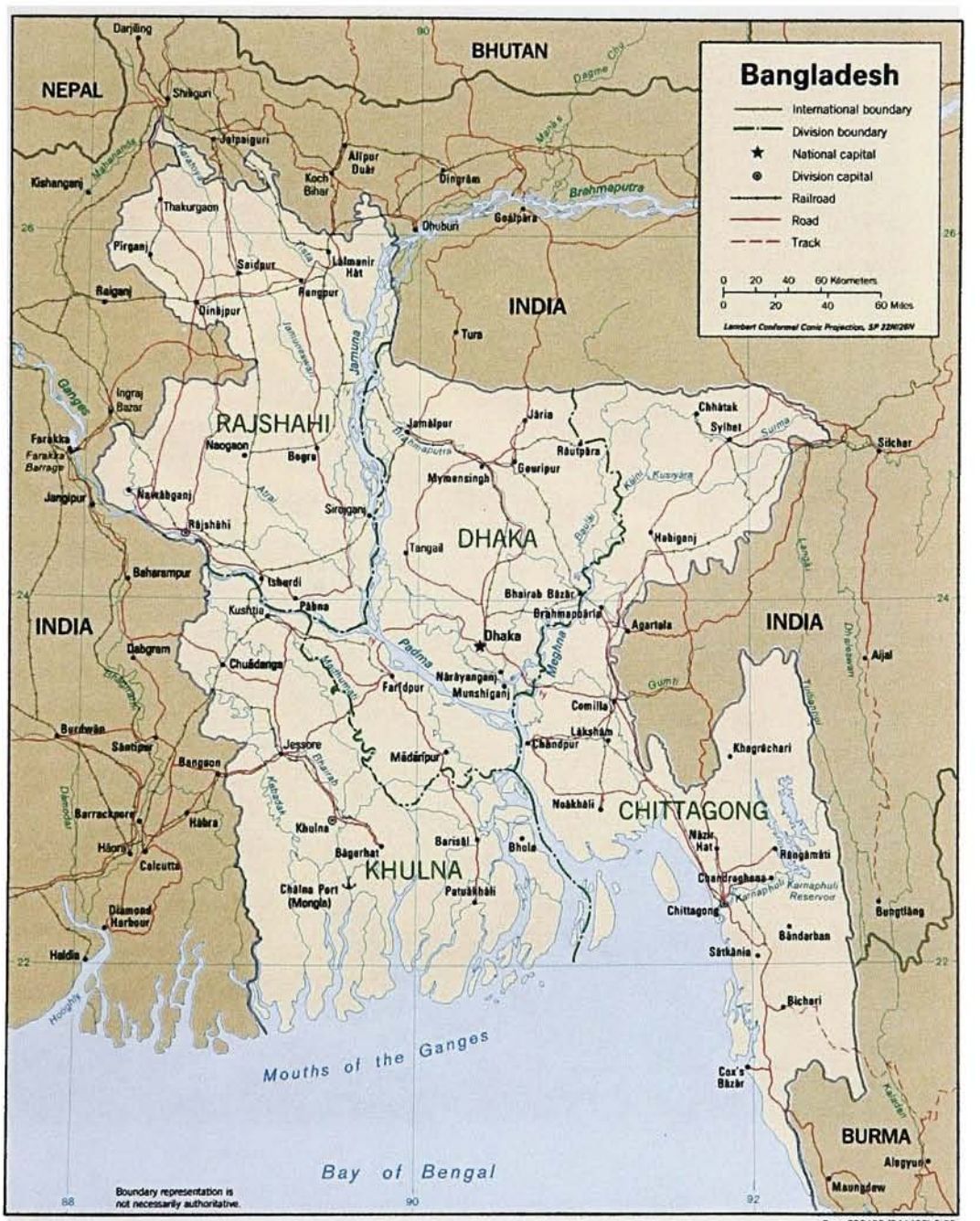
The user has to dial up each time he/she wants to be online.

References

[1] Mr. Sayed-Ur Rahman (sayed@bttb.net.bd)
[2] http://bangladesh-web.com/news/dec/20/c20122001.htm
[3] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[4] Mr. Ishteaq Hossain (avanti@bttb.net.bd)
[5] http://www.bttb.net/home/main/rates/ddn_rates.htm#X25
[6] http://www.bttb.net/home/main/rates/ddn_rates.htm#Internet

DSL

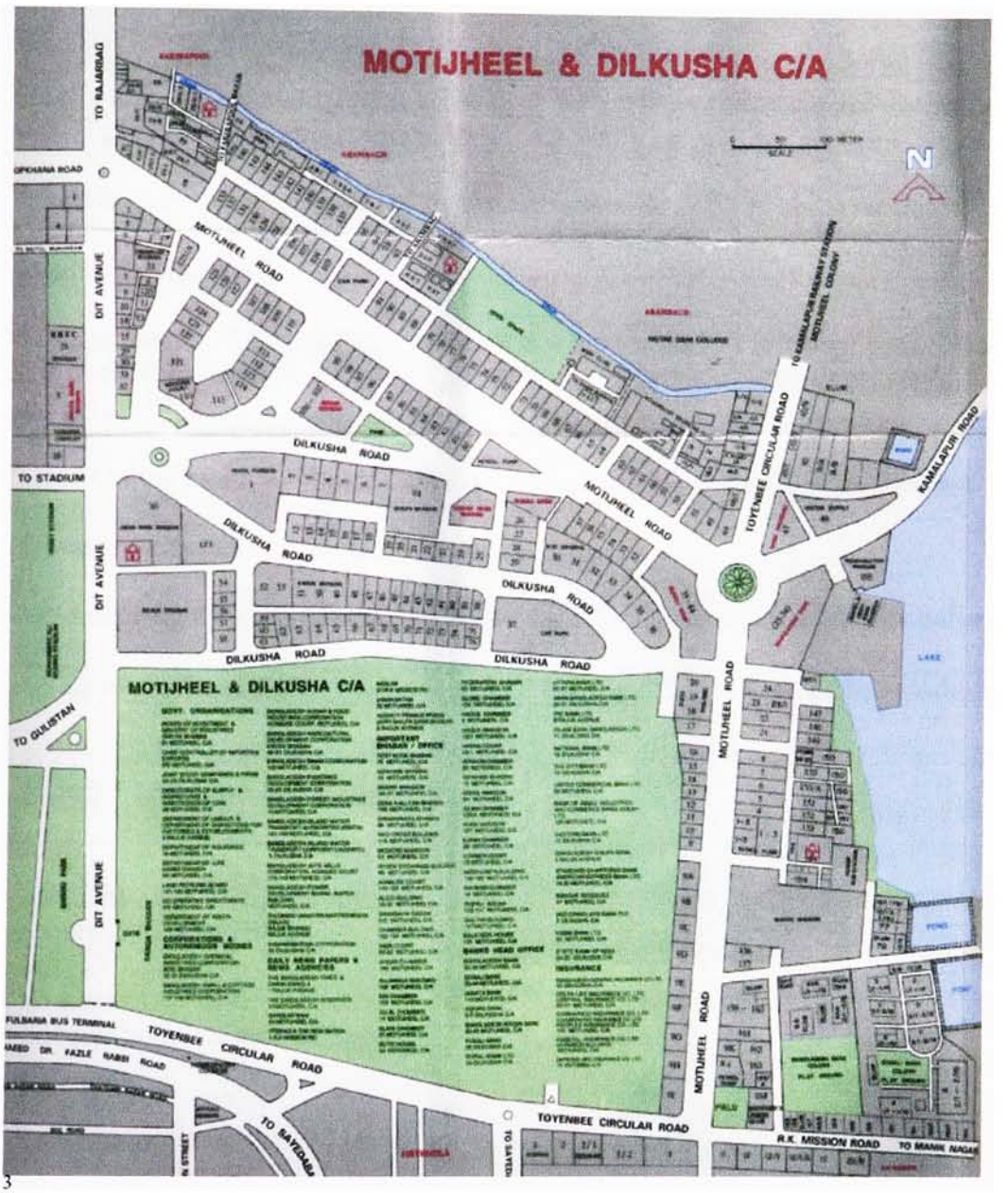
Coverage Area



1

BTTB's DDN (Digital Data Network) uses two kinds of DSL (Digital Subscriber Line) as its technology : (i) SDSL (Symmetric Digital Subscriber Line) and (ii) HDSL (High-

bit rate Digital Subscriber Line). There are six DSL exchanges in Dhaka city, one DSL exchange in Chittagong city, one in Khulna city, one in Sylhet city, one in Bogra city, and one in Rajshahi city. BTTB plans to introduce DSL in all 64 district headquarters in the near future.[2]



3

Apart from BTTB, Intech Online Limited, a private company is also offering DSL in Motijheel, Dilkusha, and Purana Paltan area of Dhaka city.[4]

Topology Dependent

Currently, BTTB is using star topology (with Dhaka as the center) for all its available technologies, but mesh topology will be introduced in the near future. So, DSL is topology independent.

Media to be used

BTTB is using E1 as the backbone of its DSL. For BTTB's 64 Kbps DSL connection to users' premises, coaxial cable is offered. If the user wants fiber optics as the media, Tk. 100.00 per kilometer additional charge is imposed.[6]

Intech Online uses its own VSAT as well as radio link of BTTB as the media of its DSL.[7]

Available Bandwidth

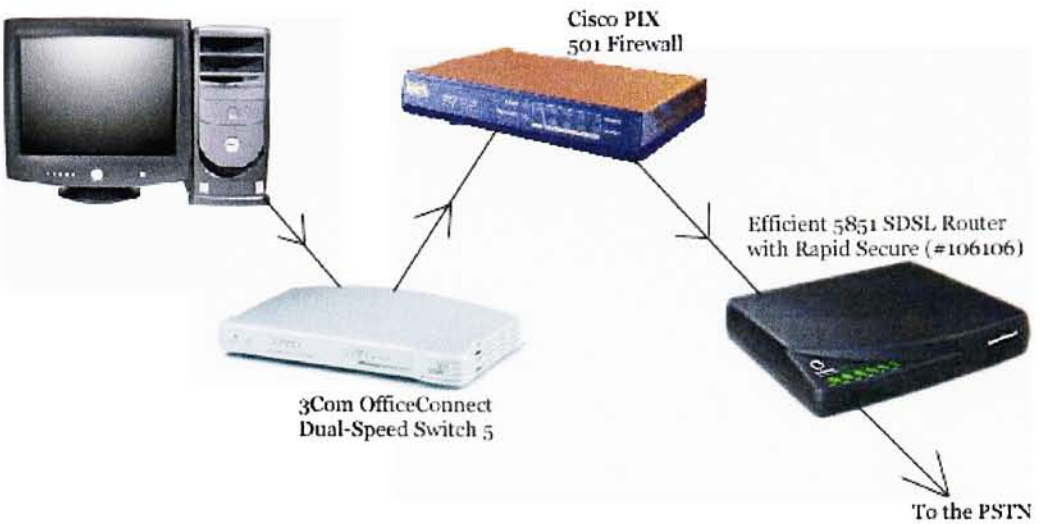
BTTB offers ten different DSL bandwidths : (i) 64 kbps, (ii) 128 kbps, (iii) 256 kbps, (iv) 320 kbps, (v) 384 kbps, (vi) 256 kbps, (vii) 512 kbps, (viii) 768 kbps, (ix) 1.024 mbps, and (x) 2.048 mbps.[8]

Intech Online Limited offers 32 kbps, 64 kbps, and 128 kbps of DSL bandwidth.[7]

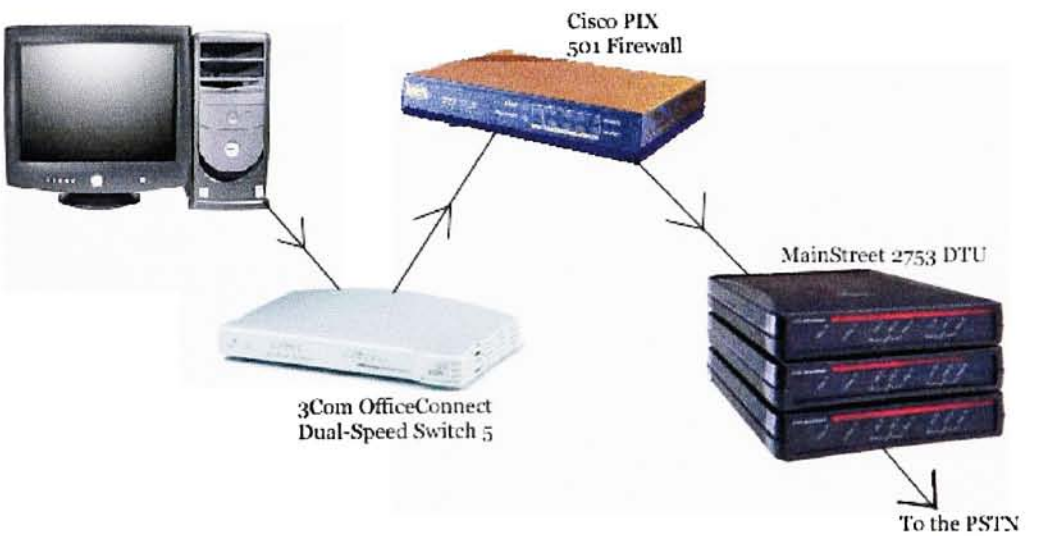
Necessary Customer Premises Equipment

Customer Premises Equipment needed for the DSL connection are listed as follows :

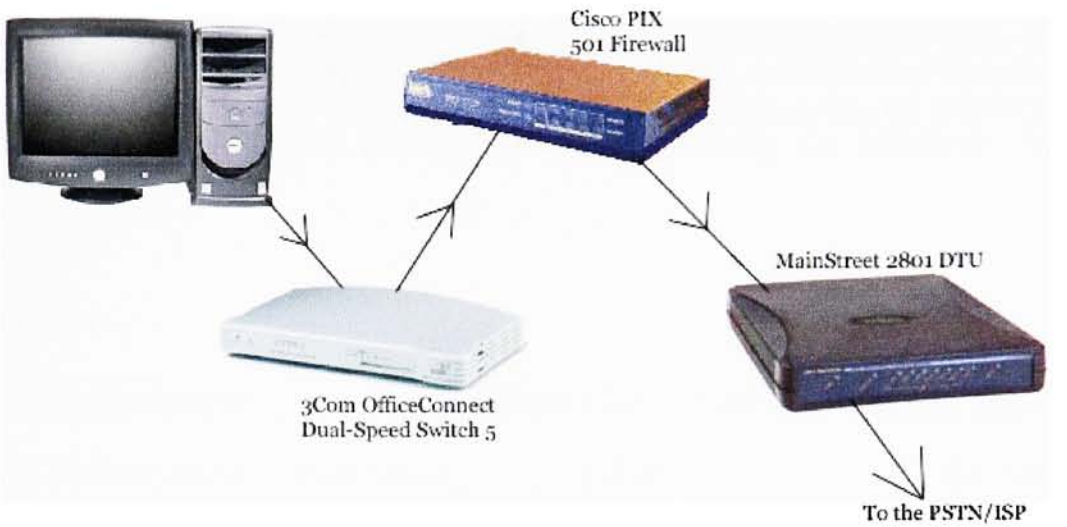
Name of the Equipment	Cost in US $	Cost in Bangladeshi Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[9]	109.00	6,213.00
Efficient 5851 SDSL Router with Rapid Secure (Product#106106)[10],	390.25	22,244.25
or,		
Mainstreet 2703 DTU (Data Termination Unit) for 64 kbps,	1,403.51	80,000.00
or,		
Mainstreet 2753 DTU (Data Termination Unit) for 128 kbps,	1,578.95	90,000.00
or,		
Mainstreet 2801 DTU (Data Termination Unit) for 256 kbps,	3245.61	185,000.00
or,		
Mainstreet 2902 DTU (Data Termination Unit) for 1024 kbps.[11]	4122.81	235,000.00



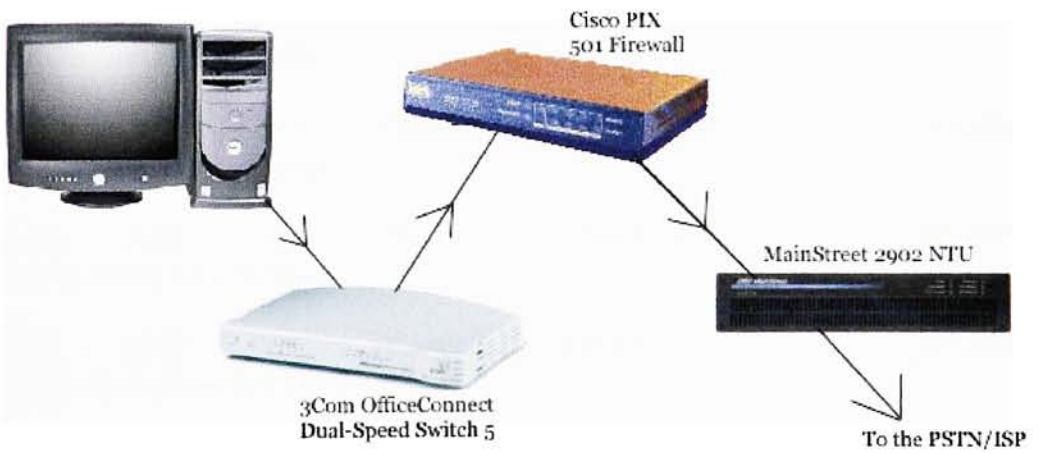
CUSTOMER PREMISES EQUIPMENT FOR EACH END USING DSL



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING DSL (OPTION#1)



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING DSL (OPTION#2)



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING DSL (OPTION#3)

Security Measurements

There are two kinds of network security for DSL services. They are :

- Firewall in a box (Security Appliances); e.g., SonicWALL SOHO/10 — supports upto 10 PCs and costs US $495.00 (= Tk. 28,215.00).[12]

- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[12]

Cost

Cost of CPE :

Name of the Equipment	Cost in US $	Cost in Bangladeshi Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[9]	109.00	6,213.00
Efficient 5851 SDSL Router with Rapid Secure (Product#106106)[10],	390.25	22,244.25
or,		
Mainstreet 2703 DTU (Data Termination Unit) for 64 kbps,	1,403.51	80,000.00
or,		
Mainstreet 2753 DTU (Data Termination Unit) for 128 kbps,	1,578.95	90,000.00
or,		
Mainstreet 2801 DTU (Data Termination Unit) for 256 kbps,	3245.61	185,000.00
or,		
Mainstreet 2902 DTU (Data Termination Unit) for 1024 kbps.[11]	4122.81	235,000.00
SonicWALL SOHO/10 — supports upto 10 PCs,	495.00	28,215.00
or,		
ZoneAlarm,	20.00	1,140.00
or,		
Sybergen Secure Desktop,	30.00	1,710.00
or,		
BlackIce Defender,	40.00	2,280.00
or,		
Conseal Private Desktop,	50.00	2,850.00
or,		
Norton Internet Security 2000.[12]	60.00	3,420

Firewall in a box (Security Appliances); e.g., and costs US $495.00 (= Tk. 28,215.00), or, Personal firewalls costing US $20.00 (= Tk. 1,140.00) to US $60.00 (Tk. 3,420.00).[12]

Thus, the minimum total cost of CPE will be = US $(109.00 + 390.25 + 20.00)
= US $519.25 = Tk. 29,597.25
and the maximum total cost of CPE will be = US $(109.00 + 4122.81 + 495.00)
= US $4,726.81 = Tk. 2,69,428.00.

(I) BTTB's DDN Charges :

(a) Registration Charge (One Time) : [13]

Speed of Port	Registration Fee (One time)	Installation & Testing fee of ports (One Time)	Annual rental of ports
64 kbps	US $175.43 = Tk. 10,000	US $175.43 = Tk. 10,000	US $7,368.42 = Tk. 4,20,000
128 kbps	US $350.87 = Tk. 20,000	US $175.43 = Tk. 10,000	US $10,701.75 = Tk. 6,10,000
256 kbps	US $701.75 = Tk. 40,000	US $175.43 = Tk. 10,000	US $17,543.85 = Tk. 10,00,000
512 kbps	US $701.75 = Tk. 40,000	US $175.43 = Tk. 10,000	US $28,070.17 = Tk. 16,00,000
1 mbps	US $701.75 = Tk. 40,000	US $175.43 = Tk. 10,000	US $43,859.64 = Tk. 25,00,000
2 mbps	US $701.75 = Tk. 40,000	US $175.43 = Tk. 10,000	US $70,175.43 = Tk. 40,00,000

(b) Installation and Testing Charge (One Time) : [6]

SL.	Speed	Installation	Additional Charge for CPE (Modem)
1	64 Kbps & 128 Kbps	US $350.87 = Tk. 20,000.00	US $1,578.94 = Tk. 90,000 for each end
2	192 Kbps to 512 Kbps	US $350.87 =	US $3.333.33 = Tk. 1.90.000 for

		Tk. 20,000.00	each end
3	576 Kbps to 1024 Kbps	US $438.59 = Tk. 25,000.00	US $3,333.33 = Tk. 1,90,000 for each end
4	2048 Kbps	US $526.31 = Tk. 30,000.00	US $5,614.03 = Tk. 3,20,000 for each end

(c) (i) Annual Rental Charges (for 64 KBPS) : [6]

First 30 KM : US $1,684.21 = Tk. 96,000

From 30 to 100 KM : US $1,684.21 + Charges of Additional Distance @ US $17.54 Per Kilometer

= Tk. 96,000 + Charges of Additional Distance @ Tk. 1,000 Per Kilometer.

From 100 to 400 KM : US $2,912.28 + Charges of Additional Distance @ US $14.04 Per Kilometer

= Tk. 1,66,000 + Charges of Additional Distance @ Tk. 800 Per Kilometer.

Beyond 400 KM : US $7,122.80 + Charges of Additional Distance @ US $8.77 Per Kilometer

= Tk. 4,06,000 + Charges of Additional Distance @ Tk. 500 Per Kilometer.

Per KM additional charge if Optical Fibre is used : US $1.75 = Tk. 100

***Multiplication Factor for Multiple speeds of 64 Kbps*:**

Sl. No.	Speed	Multiplication Factor
1	128	1.8
2	192	2.5
3	256	3.1
4	320	3.6
5	384	4.0
6	512	4.8

7	768	6.4
8	1024	8.0
9	2048	12.0

8

Therefore, annual rental charges for

(ii) 128 kbps :

First 30 KM : US $3,031.57 = Tk. 1,72,800

From 30 to 100 KM : US $3,031.57 + Charges of Additional Distance @ US $31.57 Per Kilometer

= Tk. 1,72,800 + Charges of Additional Distance @ Tk. 1,800 Per Kilometer.

From 100 to 400 KM : US $5,242.11 + Charges of Additional Distance @ US $25.26 Per Kilometer

= Tk. 2,98,800 + Charges of Additional Distance @ Tk. 1,440 Per Kilometer.

Beyond 400 KM : US $12,821.05 + Charges of Additional Distance @ US $15.79 Per Kilometer

= Tk. 7,30,800 + Charges of Additional Distance @ Tk. 900 Per Kilometer.

Per KM additional charge if Optical Fibre is used : US $3.15 = Tk. 180

(iii) 192 kbps :

First 30 KM : US $4,210.52 = Tk. 2,40,000

From 30 to 100 KM : US $4,210.52 + Charges of Additional Distance @ US $43.86 Per Kilometer

= Tk. 2,40,000 + Charges of Additional Distance @ Tk. 2,500 Per Kilometer.

From 100 to 400 KM : US $7,280.70 + Charges of Additional Distance @ US $35.09 Per Kilometer

= Tk. 4,15,000 + Charges of Additional Distance @ Tk. 2,000 Per Kilometer.

Beyond 400 KM : US $17,807.02 + Charges of Additional Distance @ US $21.93 Per Kilometer

= Tk. 10,15,000.00 + Charges of Additional Distance @ Tk. 1,250.00 Per Kilometer.

Per KM additional charge if Optical Fibre is used : US $4.39 = Tk. 250.00

(iv) 256 kbps :

First 30 KM : US $5,221.05 = Tk. 2,97,600

From 30 to 100 KM : US $5,221.05 + Charges of Additional Distance @ US $54.38 Per Kilometer

= Tk. 2,97,600 + Charges of Additional Distance @ Tk. 3,100 Per Kilometer.

From 100 to 400 KM : US $9,028.07 + Charges of Additional Distance @ US $43.51 Per Kilometer

= Tk. 5,14,600 + Charges of Additional Distance @ Tk. 2,480 Per Kilometer.

Beyond 400 KM : US $22,080.70 + Charges of Additional Distance @ US $27.19 Per Kilometer

= Tk. 12,58,600 + Charges of Additional Distance @ Tk. 1,550 Per Kilometer.

Per KM additional charge if Optical Fibre is used : US $5.44 = Tk. 310

(II) Intech Online's DSL Charges :

Bandwidth/Rates Ratio			
Bandwidth	32/32 kbps	64/64 kbps	128/128 kbps
Connection Fee	Nil	Nil	Nil
Usage Charge / month	Tk. 38,000	Tk. 65,000	Tk. 1,20,000

	+ 15% VAT	+ 15% VAT	+ 15% VAT
	= Tk. 38,000 + Tk. 5,700	= Tk. 65,000 + Tk. 9,750	= Tk. 1,20,000 + Tk. 18,000
	= Tk. 43,700	= Tk. 74,750	= Tk. 1,38,000
	= US $766.67	= US $1,311.40	= US $2,421.05
Usage Charge / year	Tk. (43700 * 12) = Tk. 5,24,400	Tk. (74,750 * 12) = Tk. 8,97,000	Tk. (1,38,000 * 12) = Tk. 16,56,000
	= US $9,200.00	= US $15,736.85	= US $29,052.63
Annual License Fee [7]	Nil	Nil	Nil

Cost Comparison (I)

Category	Monthly Charge 32 kbps	Monthly Charge 64 kbps	Monthly Charge 128 kbps	Infrastructural Investment (one time)	Annual Licensing Fee / Government charge
InTech Online Ltd's DSL Solution	US $666.67 = Tk. 38,000	US $1,140.35 = Tk. 65,000	US $2,105.26 =Tk. 1,20,000	Cost of router	NIL
Radio Link Operators	US $877.19 = Tk. 50,000	US $1,385.96 = Tk. 79,000	US $2,754.38 = Tk. 1,57,000	US $7,017.54 (= Tk. 4,00,000) to US $7,894.73 (= Tk. 4,50,000)	US $201.75 = Tk. 11,500
With Own VSAT	Not Available	US $2,105.26 = Tk. 1,20,000	US $3,508.77 = Tk. 2,00,000	US $31,578.94 (= Tk. 18,00,000) or above	US $3,508.77 = Tk. 2,00,000

[7]

Cost Comparison (II)

Category	Yearly Charge 32 kbps	Yearly Charge 64 kbps	Yearly Charge 128 kbps	Infrastructural Investment (one time)	Annual Licensing Fee / Government charge

InTech Online Ltd's DSL Solution	US $8,000.00 = Tk. 4,56,000	US$13,684.21 = Tk. 7,80,000	US$25,263.15 = Tk. 14,40,000	Cost of router	NIL
Radio Link Operators	US$10,526.31 = Tk. 6,00,000	US$16,631.57 = Tk. 9,48,000	US$33,052.63 = Tk. 18,84,000	US $7,017.54 (= Tk. 4,00,000) to US $7,894.73 (= Tk. 4,50,000)	US $201.75 = Tk. 11,500
With Own VSAT	Not Available	US$25,263.15 = Tk. 14,40,000	US$42,105.26 = Tk. 24,00,000	US $31,578.94 (= Tk. 18,00,000) or above	US $3,508.77 = Tk. 2,00,000

Different types of costs associated with DSL are shown as follows :

(i) Registration Fee for BTTB's DSL :

Different bandwidths	Cost in US$	Cost in BD Taka
64 Kbps	175.43	10,000.00
128 Kbps	350.87	20,000.00
256 Kbps to 2.048 Mbps	701.75	40,000.00

(ii) Installation costs :

Company Name	Bandwidth	Cost in US$	Cost in BD Taka
BTTB	64 Kbps and 128 Kbps	350.87	20,000.00
BTTB	192 Kbps to 512 Kbps	350.87	20,000.00
BTTB	576 Kbps to 1.024 Mbps	438.59	25,000.00
BTTB	2.048 Mbps	526.31	30,000.00
Intech Online (with radio link)	32 Kbps, 64 Kbps, and 128 Kbps	7,017.54 to 7,894.73	4,00,000.00 to 4,50,000.00
Intech Online (with own VSAT)	32 Kbps, 64 Kbps, and 128 Kbps	31,578.94 or above	18,00,000.00 or above

(iii) CPE costs :

Different types of costs	Cost in US$	Cost in BD Taka
Minimum total CPE cost	519.25	29,597.25
Maximum total CPE cost	4,726.81	2,69,428.00

(iv) Annual Rental Charges :

Company Name	Bandwidth	Cost in US $	Cost in BD Taka
BTTB	64 Kbps (First 30 k.m.)	1,684.21	96,000.00
BTTB	128 Kbps (First 30 k.m.)	3,031.57	1,72,800.00
BTTB	192 Kbps (First 30 k.m.)	4,210.52	2,40,000.00
BTTB	256 Kbps (First 30 k.m.)	5,221.05	2,97,600.00
Intech Online Ltd's DSL Solution	32 Kbps	8,000.00	4,56,000.00
Intech Online Ltd's DSL Solution	64 Kbps	13,684.21	7,80,000.00
Intech Online Ltd's DSL Solution	128 Kbps	25,263.15	14,40,000.00
Intech Online Ltd. (With Radio Link Operators)	32 Kbps	10,526.31	6,00,000.00
Intech Online Ltd. (With Radio Link Operators)	64 Kbps	16,631.57	9,48,000.00
Intech Online Ltd. (With Radio Link Operators)	128 Kbps	33,052.63	18,84,000.00
Intech Online Ltd. (With its own VSAT)	64 Kbps	25,263.15	14,40,000.00
Intech Online Ltd. (With its own VSAT)	128 Kbps	42,105.26	24,00,000.00

Strengths

- The user can leave the Internet connection open and still use the phone line for voice calls.[14]
- The speed is significantly higher than the regular modem (64 Kbps vs. 56 Kbps).
- DSL does not require new wiring; it makes use of the existing phone line.[14]

Weaknesses

- A DSL connection works more efficiently when the user is closer to the provider's central office.[14]
- DSL is extremely expensive in Bangladesh.
- DSL service is not available everywhere.[14]

References

[1] http://www.lib.utexas.edu/maps/middle_east_and_asia/bangladesh_pol96.jpg
[2] http://www.bttb.net/home/Report/Key_note_Paper.htm
[3] http://www.bol-online.com/map_motijheel.html
[4] http://www.intechworld.net
[5] Mr. Sayed-Ur Rahman (sayed@bttb.net.bd)

[6] http://www.bttb.net/home/main/rates/ddn_rates.htm#National
[7] http://www.intechworld.net/broadband.htm
[8] http://www.bttb.net/home/main/rates/ddn_rates.htm#PSTN
[9]http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[10] http://www.expercom.com/product_detail.html?PRODUCT_ID=123532
[11] Mr. Ishteaq Hossain (avanti@bttb.net.bd)
[12] DSL FOR DUMMIES (2nd Edition) — David Angell
[13] http://www.bttb.net/home/main/rates/ddn_rates.htm#Internet
[14] http://www.howstuffworks.com/dsl.htm

Cable

Coverage Area

There are four companies providing cable for the Internet in Dhaka city. They are :

(i) C.G.S. Communication — located at Dhanmondi, has a backbone capacity of 4 mbps, and operates in Dhanmondi, Elephant Road, Green Road, Shahbagh, Baily Road, Kakrail, Segunbagicha, Panthopath, Asadgate, Dhaka University, Prime Minister's Secretary, Bangladesh Secretary.[2]

(ii) Grameen Cybernet — situated at Gulshan, has a backbone capacity of 3 mbps, and offers fiber optics technology.[3]

(iii) Intech Online Limited — situated at Purana Paltan, in the heart of the Downtown area in Dhaka, owns 3.8 meter Prodelin VSAT, has a backbone capacity of 1 mbps, and operates at Motijheel, Dilkusha and Purana Paltan, the premier business district of Dhaka City.[4]

(iv) Dominox — located at Gulshan, has a backbone capacity of 1mbps.[5]

Cable service is going to be offered in Chittagong and Sylhet city by December 2002.[6]

Topology Dependent

Cable is topology-independent.

Media to be used

Companies providing cable have their own VSATs; however, they use coaxial cable and/or fiber optics according to user's choice.

Available Bandwidth

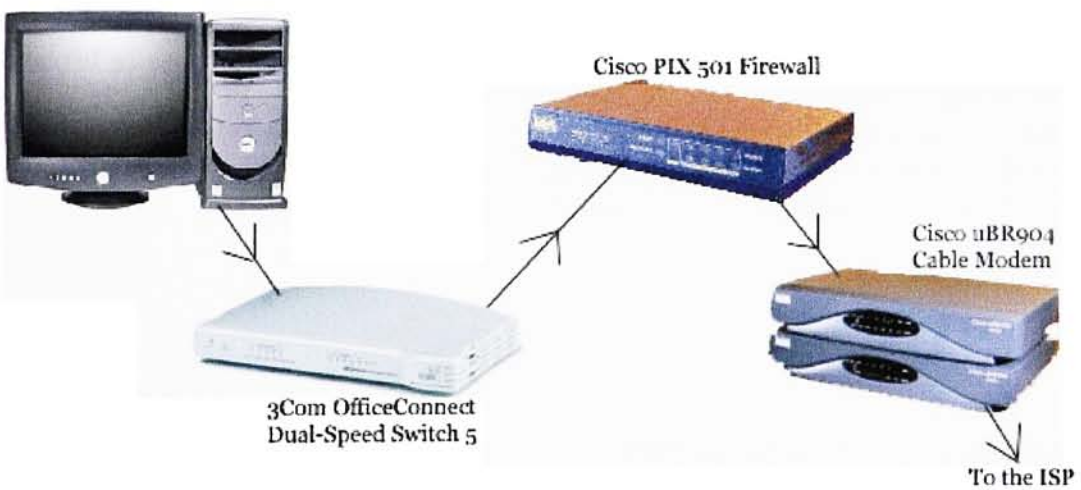
Grameen Cybernet provides 16 kbps, 32 kbps, 64 kbps, and 128 kbps of cable bandwidth.[7]

Intech Online Limited provides 32 kbps, 64 kbps, and 128 kbps of shared cable bandwidth.[8]

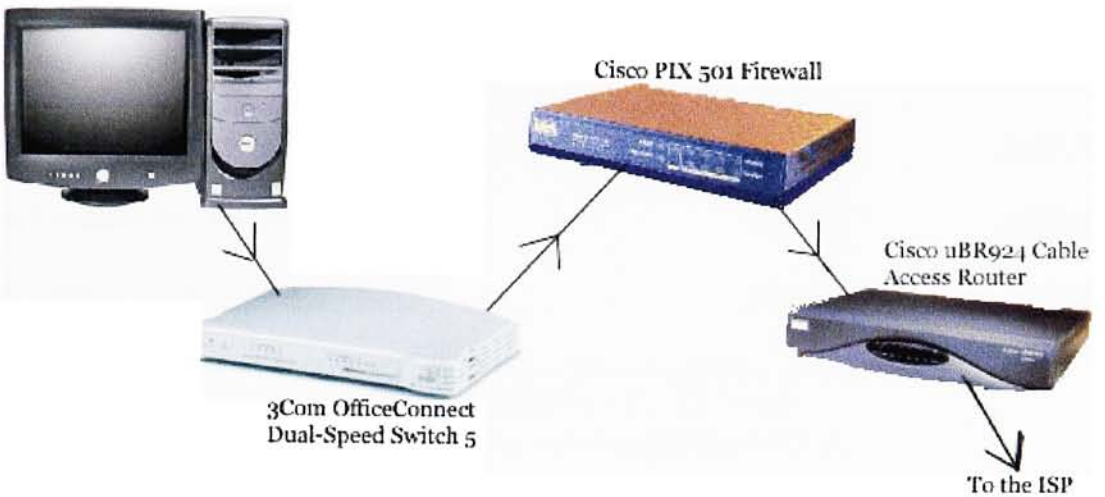
Necessary Customer Premises Equipment

Customer Premises Equipments necessary for the cable connection are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[9]	109.00	6,213.00
Cisco uBR904 Cable Modem,[10] or,	699.00	39,843.00
Cisco uBR924 Cable Access Router.[11]	899.00	51,243.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING CABLE (OPTION#1)



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING CABLE (OPTION#2)

Security Measurements

There are two kinds of security measurements :

- Firewall in a box; e.g., (i) SonicWALL SOHO/10 — supports upto 10 PCs and costs US $495.00 (= Tk. 28,215.00),[12] (ii) Cisco PIX® 501 Firewall, (which includes Integrated auto-sensing, auto-MDIX 4-port 10/100 switch, RJ45), costing US $595.00 (= Tk. 33,915.00);[13] or,
- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[12]

Cost

(i) ***Costs of CPE*** :

Name of the Equipment	**Cost in US $**	**Cost in BD Taka**
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[9]	109.00	6,213.00
Cisco uBR904 Cable Modem,[10] or,	699.00	39,843.00
Cisco uBR924 Cable Access Router.[11]	899.00	51,243.00
SonicWALL SOHO/10,[12]	495.00	28,215.00
or, Cisco PIX® 501 Firewall,[13]	595.00	33,915.00

or, ZoneAlarm,[12]	20.00	1,140.00
or, Sybergen Secure Desktop,[12]	30.00	1,710.00
or, BlackIce Defender,[12]	40.00	2,280.00
or, ConSeal Private Desktop,[12]	50.00	2,850.00
or, Norton Internet Security 2000.[12]	60.00	3,420.00

Thus, the minimum total cost of CPE for the cable connection will be
= US $(109.00 + 699.00 + 20.00) = US $828.00 = Tk. 47,196.00
and the maximum total cost of CPE for the cable connection will be
= US $(109.00 + 899.00 + 595.00) = US $1,603.00 = Tk. 91,371.00.

(ii) ***Cable Charges*** :

Rate of Broadband Internet for Individual Users (Grameen Cybernet)

Option 1: Single Dedicated User

Speed/User	Unlimited Usage/Month **	Unlimited Usage/Year
Upto 16 kbps Bandwidth	Tk. 1,500.00 + 15% VAT = Tk. 1,725.00 = US $30.263	Tk. 20,700.00 = US $363.16

One time setup charge including Cable Modem and Configuration Tk. 18,000.00 = US $315.79 (One Time)

Option 2: Broadband Internet Connectivity

Registration Fee Only (Without Modem) **** Tk. 3,000.00 = US $52.63 Per User (One Time)

Rate of Broadband Internet for Corporate Users (Grameen Cybernet)

Speed	Unlimited Usage/Month**	Unlimited Usage/Year
32 Kbps	Tk. 6,000.00 + 15% VAT = Tk. 6,900.00 = US $121.05	Tk. 82,800.00 = US $1,452.63
64 Kbps	Tk. 10,000.00 + 15% VAT = Tk. 11,500.00 = US $201.75	Tk. 1,38,000.00 = US $2,421.05
128 Kbps	Tk. 22,000.00 + 15% VAT = Tk. 25,300.00 = US $443.86	Tk. 3,03,600.00 = US $5,326.32

Option 1 :

One time Registration fee including Cable Modem and Configuration Tk. 20,000.00 = US $350.88 (One Time)

Registration fee Only (Without Modem) **	Tk. 4,000.00 = US $70.18 Per User (One Time)

[7]

Intech Online Limited's cable charges :

Account type: Intech Regular

Bandwidth	Unlimited usage
32 Kbps shared	Tk. 3,000.00 + 15% VAT = Tk. 3,450.00 (= US $60.53) per month; Tk. 41,400.00 (= US $726.32) per year

One time setup charge, installation and Cable Modem Tk. 18,000.00 (= US $315.79)

Account type: Intech Prime

Bandwidth	Unlimited usage
64 Kbps shared	Tk. 5,000.00 + 15% VAT = Tk. 5,750.00 (= US $100.88) per month; Tk. 69,000.00 (= US $1,210.53) per year

One time setup charge, installation and Cable Modem Tk. 18,000.00 (= US $315.79)

Account type: Intech Supreme

Bandwidth	Unlimited usage
128 Kbps shared	Tk. 8,000.00 + 15% VAT = Tk. 9,200.00 (= US $161.40) per month; Tk. 1,10,400.00 (= US $1,936.84) per year

One time setup charge, installation and Cable Modem Tk. 18,000.00 (= US $315.79)

Additionally, InTech also offers Complete Corporate Package @ Tk.10,000.00 (= US $175.44) per year. Facilities include :

- Domain Name Registration : To have user's own place and company information on the Web, Intech offers domain registration and hosting services. Intech's Customized servers and fast Backbone connectivity offer the best e-commerce solutions.

- Single page Webpage and Hosting : Intech offers single page Webpage in this package. A user will have one graphic and company information on this page so that prospective clients or business partners can get the company information.

- Create and Manage user's own Email Account : A users will have the discretion to create and manage his/her own e-mail account according to the company needs.[8]

Different kinds of costs associated with cable are shown as follows :

(i) Installation Charge (including modem) :

Company Name	Bandwidth	Cost in US $	Cost in BD Taka
Grameen Cybernet	16 Kbps	315.79	18,000.00
Grameen Cybernet	32 Kbps	350.88	20,000.00
Grameen Cybernet	64 Kbps	350.88	20,000.00
Grameen Cybernet	128 Kbps	350.88	20,000.00
Intech Online Limited	32 Kbps	315.79	18,000.00
Intech Online Limited	64 Kbps	315.79	18,000.00
Intech Online Limited	128 Kbps	315.79	18,000.00

(ii) Total CPE costs :

Different CPE costs	Cost in US $	Cost in BD Taka
Minimum total CPE cost	828.00	47,196.00
Maximum total CPE cost	1,603.00	91,371.00

(iii) Annual Rental Charge :

Company Name	Bandwidth	Cost in US $	Cost in BD Taka
Grameen Cybernet	16 Kbps	363.16	20,700.00
Grameen Cybernet	32 Kbps	1,452.63	82,800.00
Grameen Cybernet	64 Kbps	2,421.05	1,38,000.00
Grameen Cybernet	128 Kbps	5,326.32	3,03,600.00
Intech Online Ltd.	32 Kbps	726.32	41,400.00
Intech Online Ltd.	64 Kbps	1,210.53	69,000.00
Intech Online Ltd.	128 Kbps	1,936.84	1,10,400.00

Strengths

(i) A cable connection is "always on", and speeds fall into the general range, up to 1.5 mbps.[14]
(ii) Since the user does not need the phone line to connect to the Internet, he/she can obviously talk on the phone line while surfing the Net.[14]
(iii) The user can also watch the television while online without affecting the reception, since the Internet and television use different frequencies of the cable.[14]

Weaknesses

(i) Cables used to carry data are shared by multiple users and are therefore sensitive to heavy traffic. So, if everyone in the neighborhood on the same cable node surfs at the same time, the speed of one's connection can be affected.[14]
(ii) Some cable systems have what are known as one-way cable connections, which only allow subscribers to receive Internet data. With those systems, users would still need to use a phone line to send information over the Net.[14]
(iii) Since cable Internet connections use a fixed IP address, they can be more vulnerable to breaches of security.[14]

References

[1] http://www.bangladeshgov.org/bdmaps/bdadmin.jpg
[2] http://www.cgscomm.net
[3] http://www.citecho.net
[4] http://www.intechworld.net
[5] http://www.dominox.com
[6] Mr. Iftekhar Zaman (iftezam@aitlbd.net)
[7] http://www.grameenjobs.com/cable/cable_rate.html
[8] http://www.intechworld.net/cable.html
[9] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[10] http://www.alliancedatacom.com/new-cisco-list-prices.htm
[11] http://www.alliancedatacom.com/new-cisco-list-prices.htm
[12] DSL FOR DUMMIES (2nd Edition) — David Angell
[13] www.cisco.com/warp/public/cc/pd/fw/sqfw500/prodlit/px501_ds.htm
[14] http://www.earthlink.net/blink/feb01/cover2.html

E1

Coverage Area

E1 is provided to ISPs[1] by BTTB (Bangladesh Telephone and Telegraph Board), which operates throughout the country. So, a customer (ISPs as well as other users, if they want) willing to take E1 can have it from the telephone exchange nearest to his/her premises wherever it is situated across the country.

Topology Dependent

E1 can range from a simple point-to-point topology, wherein two E1 multiplexers operate on one 2.048 mbps link, or they can employ with digital cross connect (DCS) that add, drop, and/or switch payload as necessary across multiple links.[2]

Media to be used

Communication link between Digital Trunk Interface (DTI) of Exchange and customer premise equipment is through optical fibre, co-axial cable or radio, whatever he/she wants to install.[2]

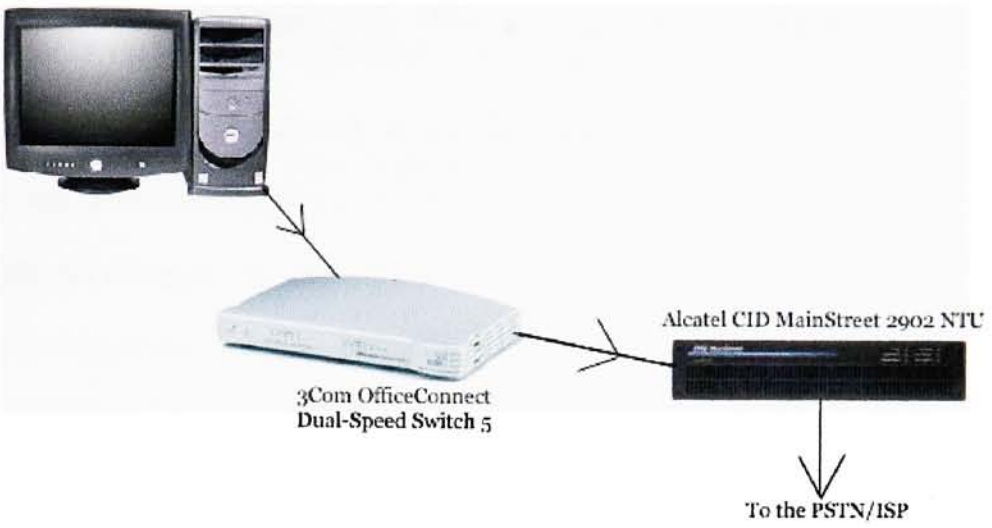
Available Bandwidth

BTTB's E1 can provide a bandwidth of 2.048 mbps.[1]

Necessary Customer Premises Equipment

Customer Premises Equipments needed for E1 are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
Alcatel CID Mainstreet 2902 [4]	6,140.35	3,50,000.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING E1 CONNECTION

Security Measurements

Since, E1 is a kind of dedicated connection, it does not require any kind of security measurements.[5]

Cost

(i) Registration Fee : Tk. 10,000.00 = US $175.44 (One Time).[1]

(ii) Costs of CPE :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
Alcatel CID Mainstreet 2902 [4]	6,140.35	3,50,000.00

Thus, the total cost of CPE = US $(109.00+6,140.35) = US $6,249.35 = Tk. 3,56,213.00.

(iii) Installation & Testing Charges (One time) :

Speed	Installation
2.048 Mbps	Tk. 30,000.00 (= US $526.32) per kilometer.

1

All tea gardens are 16.093 to 32.186 kilometers away from their nearest telephone exchanges. So, a tea garden situated 16.093 kilometers away from its nearest telephone

exchange will have to pay the installation cost of Tk. (30,000.00*16.093) = Tk. 4,82,790.00 (= US $8,470.00) and a tea garden situated 32.186 kilometers away from its nearest telephone exchange will have to pay the installation cost of Tk. (30,000.00*32.186) = Tk. 9,65,580.00 (= US $16,940.00).

The approximate distance between one end of Motijheel Commercial Area (Dhaka) and the other is 2.6 kilometers. Thus, installing X.25 leased line at one office in Motijheel will not cost more than Tk. (30,000.00*2.6) = Tk. 78,000.00 (= US $1,368.40).

(iv) ***Rental Charges*** **:** Tk. 76,000.00 (= US $1,333.33) per annum.[1]

Different kinds of costs associated with E1 are listed as follows :

Different kinds of costs	**Cost in US $**	**Cost in BD Taka**
Registration Fee (One Time)	175.44	10,000.00
Installation cost at the head office	1,368.40	78,000.00
Minimum installation cost at the garden	8,470.00	4,82,790.00
Maximum installation cost at the garden	16,940.00	9,65,580.00
Total CPE cost	6,249.35	3,56,213.00
Annual Rental Charge	1,333.33	76,000.00

Strengths

E1 gives high bandwidth (2.048 Mbps) at users' premises.[1]

Weaknesses

(i) E1 provides very little support for end-user control for the provisioning of services.[2]
(ii) Installation cost of E1 (Tk. 30,000.00 per kilometer) is much higher than that of X.25 leased line (Tk. 3,000.00 per kilometer) and X.28 leased line (Tk. 2,000.00 per kilometer).
(iii) Rental charge of E1 (Tk. 76,000.00) is much higher than that of X.25 leased line (Tk. 15,000.00), X.28 leased line (Tk. 10,000.00), and X.28 dial-up line (Tk. 1,000.00).

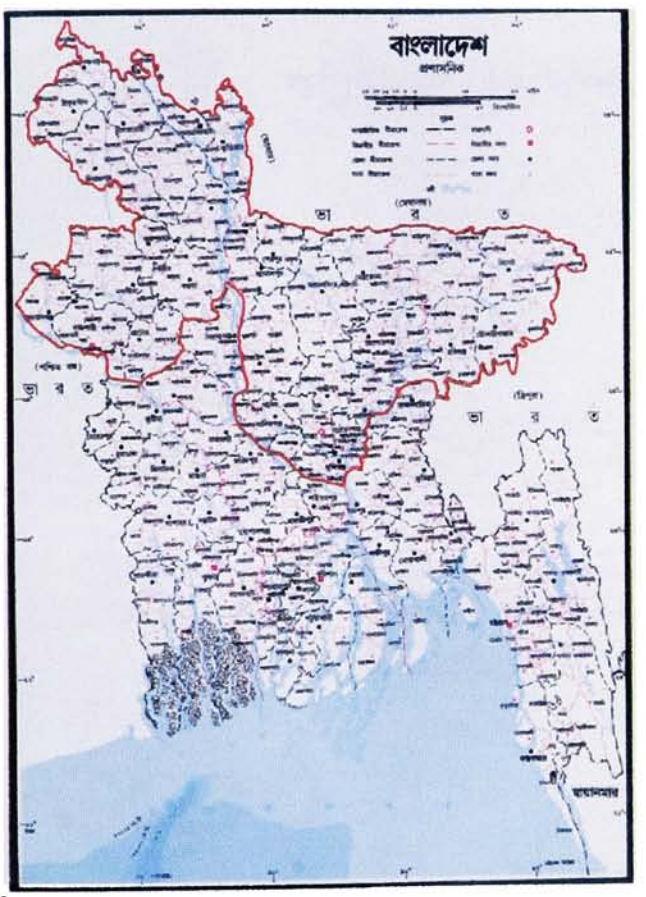
References

[1] http://www.bttb.net/home/main/rates/ddn_rates.htm#PSTN
[2] Emerging Communication Technologies — Uyless Black
[3] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[4] Mr. Ishteaq Hossain (avanti@bttb.net.bd)
[5] Professor Sylvia Perez-Hardy (sph@it.rit.edu)

Wireless Local Loop

Coverage Area

There are two companies providing wireless local loop in Bangladesh. They are : (i) Bangladesh Rural Telecom Authority (BRTA) operating in the northern part of the country and (ii) Sheba Telecom Limited operating in the southern part of the country.[1]



তালিকা-৩

বি আর টি এ গ্রাহক সেবার আওতাভূক্ত এলাকা

[BRTA Subscriber Service Coverage Area]

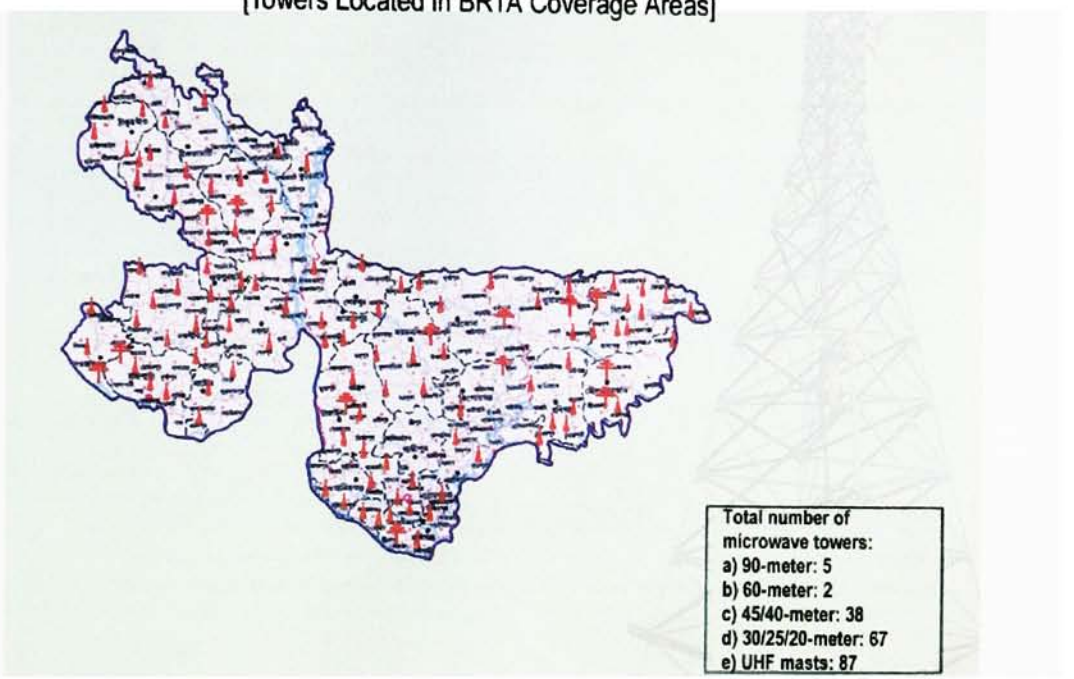
Total number of thanas: 199
Total number of rural growth centres: 820
Total land coverage: 58,380 square kilometers
Total land coverage of BRTA: 39.56%

2

তালিকা-৬

বি আর টি এ'র আওতাভূক্ত এলাকায় অবস্থিত টাওয়ার

[Towers Located in BRTA Coverage Areas]

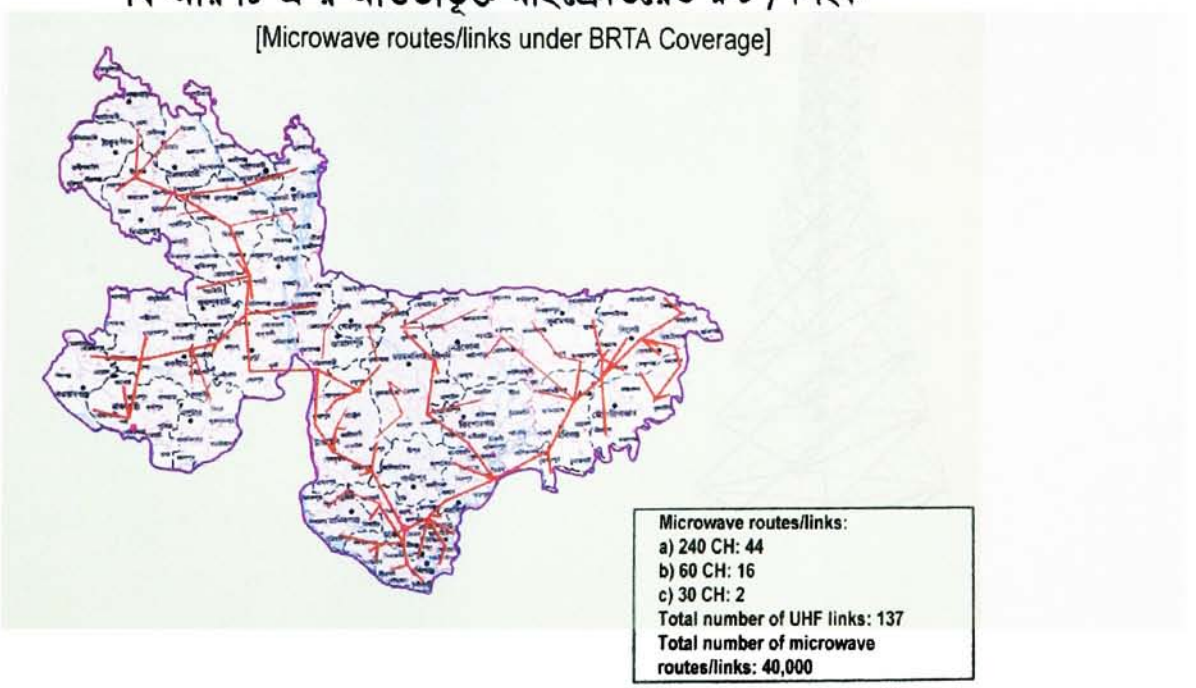


3

তালিকা-৫

বি আর টি এ'র আওতাভূক্ত মাইক্রোওয়েভ রুট / লিংক

[Microwave routes/links under BRTA Coverage]

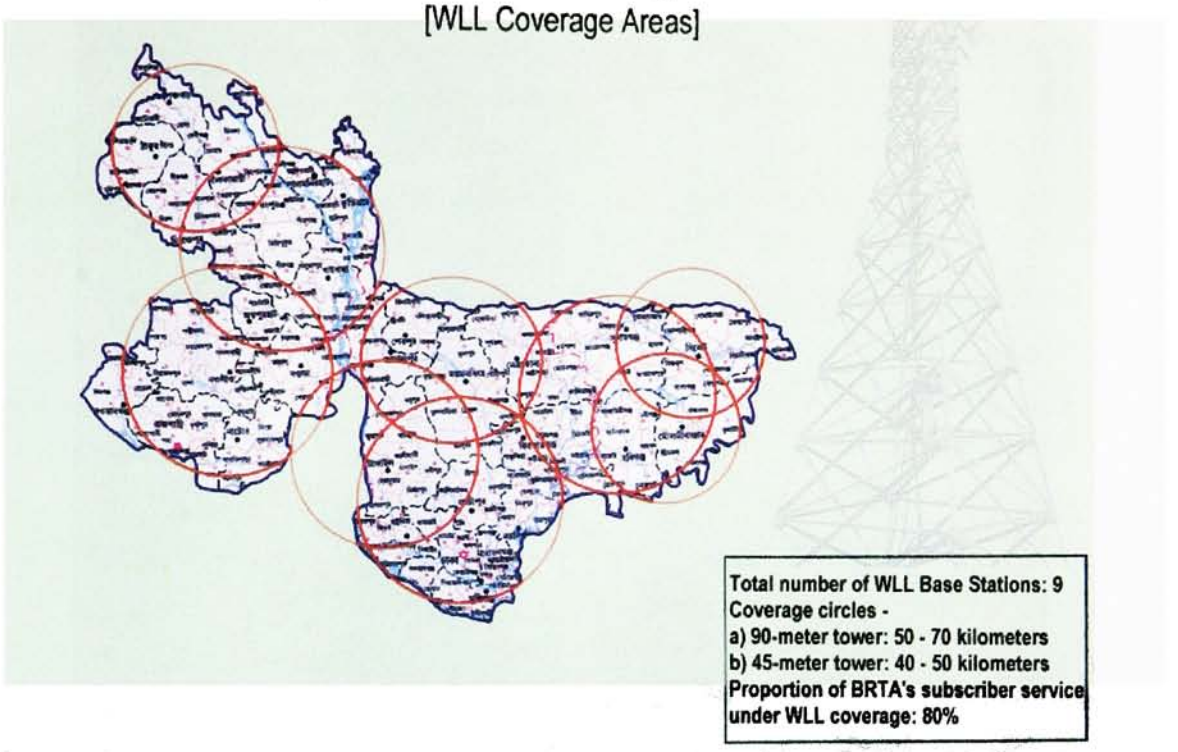


4

তালিকা-৪

ডব্লিউ এল এল আওতাভূক্ত এলাকা

[WLL Coverage Areas]



5

Sheba Telecom has already covered its WLL network in Chittagong, Noakhali, Feni, Comilla, Jessore, Sirajganj, Barisal, Bagerhat, Lakshmipur (partial), Chandpur (partial), Khulna (partial), Gopalganj (partial), Pirojpur (partial), Narail (partial), Jhenaidah (partial), Chuadanga (partial), Satkhira (partial), Magura (partial), Pabna (partial) with a superior network quality.[6]

7

SHEBA TELECOM'S WIRELESS LOCAL LOOP COVERAGE (INDICATED BY MAROON COLOR)

Topology Dependent

BRTA and Sheba's wireless local loop is not following any topology. So, wireless local loop is topology independent.

Media to be used

Both BRTA and Sheba are using BTTB's microwave radio link as its media.[1]

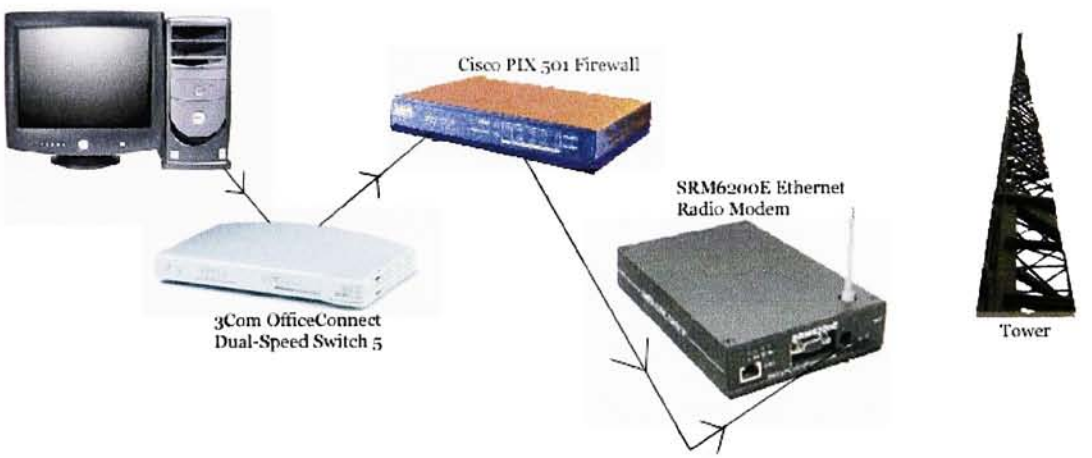
Available Bandwidth

Wireless local loop provides a bandwidth of 8 mbps, 34 mbps, 140 mbps, and 155 mbps.[8]

Necessary Customer Premises Equipment

Customer Premises Equipment for the wireless local loop are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[9]	109.00	6,213.00
SRM6200E Ethernet Radio Modem[10]	2,268.79	1,29,321.03



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING WIRELESS LOCAL LOOP

Security Measurements

Since, wireless airwaves are shared resources, there is a need for taking security measurements. Two kinds of security measurements are listed below :

- Firewall in a box; e.g., (i) SonicWALL SOHO/10 — supports upto 10 PCs[12] and costs US $495.00 (= Tk. 28,215.00)., (ii) Cisco PIX® 501 Firewall, (which includes Integrated auto-sensing, auto-MDIX 4-port 10/100 switch, RJ45),[11] costing US $595.00 (= Tk. 33,915.00); or,
- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender

costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[12]

Cost

(i) ***Costs of Customer Premises Equipments*** **:**

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[9]	109.00	6,213.00
SRM6200E Ethernet Radio Modem[10]	2,268.79	1,29,321.03
SonicWALL SOHO/10,[12]	495.00	28,215.00
or, Cisco PIX® 501 Firewall,[11]	595.00	33,915.00
or, ZoneAlarm,[12]	20.00	1,140.00
or, Sybergen Secure Desktop,[12]	30.00	1,710.00
or, BlackIce Defender,[12]	40.00	2,280.00
or, ConSeal Private Desktop,[12]	50.00	2,850.00
or, Norton Internet Security 2000.[12]	60.00	3,420.00

Thus, the minimum total cost of CPE will be
= US $(109.00 + 2,268.79 + 20.00) = US $2,397.79 = Tk. 1,36,674.03
and the maximum total cost of CPE will be
= US $(109.00 + 2,268.79 + 595.00) = US $2,972.79 = Tk. 1,69,449.03.

(ii) ***Rental Charge and Usage Charge*** **:**

The rental charge of wireless local loop is Tk. 150.00 per kilometer per month, i.e., Tk. (150.00*12) per kilometer per year = Tk. 1,800.00 per kilometer per year = US $31.58 per kilometer per year.[8]

All tea gardens are 16.093 to 32.186 kilometers away from their nearest towers. So, a tea garden situated 16.093 kilometers away from its nearest tower will have to pay the rental charge of Tk. (1,800.00*16.093) = Tk. 28,967.40 (= US $508.20) and a tea garden situated 32.186 kilometers away from its nearest tower will have to pay the rental charge of Tk. (1,800.00*32.186) = Tk. 57,934.80 (= US $1,016.40). The approximate distance between one end of Motijheel Commercial Area (Dhaka) and the other is 2.6 kilometers. Thus, rental charge of wireless local loop at one office in Motijheel will not cost more than Tk. (1,800.00*2.6) = Tk. 4,680.00 (= US $82.105).

Internet service of wireless local loop is connected through an ISP. Since BTTB operates throughout the country, it should be wise to choose BTTB as the ISP for getting wireless local loop Internet service.

Usage charges for BTTB's dial-up line are given as follows :
Tk. 0.50 per minute for Peak hours (8:00 a.m. to 11:00 p.m.)
Tk. 0.30 per minute for Off Peak hours (11:00 p.m. to 8:00 a.m.)[13]

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred
= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits.

If data are transferred during peak hour every day from the garden 16.093 kilometers away from its nearest tower using 8 Mbps connection, then the charge for the whole year will be = Tk. [28,967.40+{(101,850.968÷8,000)*0.50}] = Tk. {28,967.40+(12.73*0.50)} = Tk. (28,967.40 + 6.366) = Tk. 28,973.766 (= US $508.31).

If data are transferred during off-peak hour every day from the garden 16.093 kilometers away from its nearest tower using 8 Mbps connection, then the charge for the whole year will be = Tk. [28,967.40+{(101,850.968÷8,000)*0.30}] = Tk. {28,967.40+(12.73*0.30)} = Tk. (28,967.40 + 3.819) = Tk. 28,971.219 (= US $508.267).

If data are transferred during peak hour every day from the garden 32.186 kilometers away from its nearest tower using 8 Mbps connection, then the charge for the whole year will be = Tk. [57,934.80+{(101,850.968÷8,000)*0.50}] = Tk. {57,934.80+(12.73*0.50)} = Tk. (57,934.80 + 6.366) = Tk. 57,941.166 (= US $1,016.51).

If data are transferred during off-peak hour every day from the garden 32.186 kilometers away from its nearest tower using 8 Mbps connection, then the charge for the whole year will be = Tk. [57,934.80+{(101,850.968÷8,000)*0.30}] = Tk. {57,934.80+(12.73*0.30)} = Tk. (57,934.80 + 3.819) = Tk. 57,938.619 (= US $1,016.467).

Here, charges of only 8 Mbps are taken into account, since this bandwidth seems reasonable enough for the amount of data to be transferred.

Different kinds of costs associated with WLL are listed as follows :

Different kinds of costs	Cost in US $	Cost in BD Taka
Minimum total CPE cost	2,397.79	1,36,674.03

Maximum total CPE cost	2,972.79	1,69,449.03
Minimum annual rental charge	508.267	28,971.219
Maximum annual rental charge	1,016.51	57,941.166

Strengths

(i) The main strength of wireless local loop technology is that it is more secure than other broadband networks. [14]
(ii) Service is not distance sensitive so there is no waiting period for a wired broadband connection.[14]
(iii) The rental charge of wireless local loop is much cheaper than those of cable, DSL, and E1.[14]
(iv) Since the technology is wireless, the phone is dedicated to being exactly that.[14]
(v) The service is available to both business and residential customers with line-of-sight to the cell transmit site.[14]
(vi) It will not be limited to certain neighbourhoods or business districts, as with wired services such as DSL or cable modems.[14]

Weaknesses

(i) WLL is a line-of-sight technology, which means the signal cannot travel through or around obstacles.[15]
(ii) The user must be within 35 miles of the tower.[15]
(iii) Since wireless airwaves are a shared resource, too many users on the system can slow down the performance.[15]

References

[1] Mr. Abdur Raquib Saber (saber@grameenphone.com)
[2] http://www.telecommons.com/villagephone/figures.html#c1
[3] http://www.telecommons.com/villagephone/figures.html#c2
[4] http://www.telecommons.com/villagephone/figures.html#c3
[5] http://www.telecommons.com/villagephone/figures.html#c4
[6] http://www.shebatel.com/take_of.html
[7] http://www.lib.utexas.edu/maps/middle_east_and_asia/bangladesh_pol96.jpg
[8] Mr. Sayed-Ur Rahman (sayed@bttb.net.bd)
[9] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[10] http://www.data-link.com/articles.fldr/I&c0999.fld/I&cs9909.pdf
[11] http://www.cisco.com/warp/public/cc/pd/fw/sqfw500/prodlit/px501_ds.htm
[12] DSL For Dummies (Second Edition) — David Angell
[13] http://www.bttb.net/home/main/internet/fees_rates.htm
[14] http://www.mobilecomms-technology.com/projects/saltriver/
[15] http://www.earthlink.net/blink/feb01/cover3.html

Single Channel Radio Link

Coverage Area

BTTB is providing single-channel radio link all over the country.

Topology Dependent

Currently, BTTB is using star topology (with Dhaka as the center) for all its available technologies, but mesh topology will be introduced in the near future. So, single-channel radio link is topology independent.[1]

Media to be used

As the name suggests, single-channel uses wireless radio link as its media.[1]

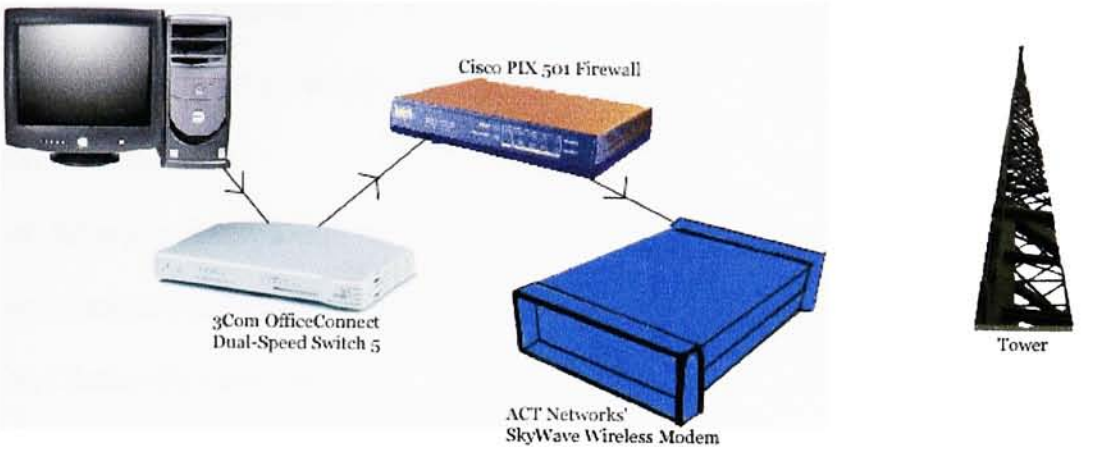
Available Bandwidth

Single-channel radio link provides a bandwidth of 64 kbps.[2]

Necessary Customer Premises Equipment

Customer Premises Equipments for the single-channel radio link are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
ACT Networks' SkyWave Wireless Modem[4]	1,695.00	96,615.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING SINGLE-CHANNEL RADIO LINK

Security Measurements

Since, airwaves are shared resources[5] and BTTB does not provide any security measurements for any of its technologies, security measures have to be taken by customers.

Two kinds of security measurements are given below :

- Firewall in a box; e.g., (i) SonicWALL SOHO/10 — supports upto 10 PCs and costs US $495.00 (= Tk. 28,215.00)[6], (ii) Cisco PIX® 501 Firewall, (which includes Integrated auto-sensing, auto-MDIX 4-port 10/100 switch, RJ45), costing US $595.00 (= Tk. 33,915.00)[7] (www.cisco.com/warp/public/cc/pd/fw/sqfw500/prodlit/px501_ds.htm); or,
- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[6]

Cost

(i) ***Costs of Customer Premises Equipments*** **:**

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 (Product#3C16790-US)[3]	109.00	6,213.00
ACT Networks' SkyWave Wireless Modem[4]	1,695.00	96,615.00

SonicWALL SOHO/10,[6]	495.00	28,215.00
or, Cisco PIX® 501 Firewall,[7]	595.00	33,915.00
or, ZoneAlarm,[6]	20.00	1,140.00
or, Sybergen Secure Desktop,[6]	30.00	1,710.00
or, BlackIce Defender,[6]	40.00	2,280.00
or, ConSeal Private Desktop,[6]	50.00	2,850.00
or, Norton Internet Security 2000.[6]	60.00	3,420.00

Thus, the minimum total cost of CPE will be
= US $(109.00 + 1,695.00 + 20.00) = US $1,824.00 = Tk. 1,03,968.00
and the maximum total cost of CPE will be
= US $ (109.00 + 1,695.00 + 595.00) = US $2,399.00 = Tk. 1,36,743.00.

(ii) ***Rental Charge and Usage Charge*** **:**

The rental charge of single-channel radio link is Tk. 42.00 per kilometer per year.[2]

All tea gardens are 16.093 to 32.186 kilometers away from their nearest towers. So, a tea garden situated 16.093 kilometers away from its nearest tower will have to pay the installation cost of Tk. (42.00*16.093) = Tk. 675.906 (= US $11.858) and a tea garden situated 32.186 kilometers away from its nearest tower will have to pay the installation cost of Tk. (42.00*32.186) = Tk. 1,351.812 (= US $23.716). The approximate distance between one end of Motijheel Commercial Area (Dhaka) and the other is 2.6 kilometers. Thus, installing X.28 leased line at one office in Motijheel will not cost more than Tk. (42.00*2.6) = Tk. 109.20 (= US $1.92).

Internet service of single-channel radio link is connected through an ISP. Since BTTB operates throughout the country, it should be wise to choose BTTB as the ISP for getting single-channel radio link Internet service.

Usage charges for BTTB's dial-up line are given as follows :
Tk. 0.50 per minute for Peak hours (8:00 a.m. to 11:00 p.m.)
Tk. 0.30 per minute for Off Peak hours (11:00 p.m. to 8:00 a.m.)[7]

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred

= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits.

If data are transferred during peak hour every day from the garden 16.093 kilometers away from its nearest tower, then the charge for the whole year will be
= Tk. [675.906 + {(101,850.968÷64)*0.50}] = Tk. {675.906 + (1,591.42*0.50)}
= Tk. (675.906 + 795.71) = Tk. 1,471.616 (= US $25.82).

If data are transferred during off-peak hour every day from the garden 16.093 kilometers away from its nearest tower, then the charge for the whole year will be
= Tk. [675.906 + {(101,850.968÷64)*0.30}] = Tk. {675.906 + (1,591.42*0.30)}
= Tk. (675.906 + 477.426) = Tk. 1,153.33 (= US $20.23).

If data are transferred during peak hour every day from the garden 32.186 kilometers away from its nearest tower, then the charge for the whole year will be
= Tk. [1,351.812 + {(101,850.968÷64)*0.50}] = Tk. {1,351.812 + (1,591.42*0.50)}
= Tk. (1,351.812 + 795.71) = Tk. 2,147.523 (= US $37.68).

If data are transferred during off-peak hour every day from the garden 32.186 kilometers away from its nearest tower, then the charge for the whole year will be
= Tk. [1,351.812 + {(101,850.968÷64)*0.30}] = Tk. {1,351.812 + (1,591.42*0.30)}
= Tk. (1,351.812 + 477.426) = Tk. 1829.238 (= US $32.09).

Different types of costs associated with single-channel radio link are listed as follows :

Different types of costs	Cost in US $	Cost in BD Taka
Minimum total CPE cost	1,824.00	1,03,968.00
Maximum total CPE cost	2,399.00	1,36,743.00
Minimum annual rental charge	20.23	1,153.33
Maximum annual rental charge	37.68	2,147.52

Strengths

(i) Service is not distance sensitive so there is no waiting period for a wired broadband connection.[8]
(ii) The rental charge of single-channel radio link is much cheaper than those of cable, DSL, and E1.[8]
(iii) Since the technology is wireless, the phone is dedicated to being exactly that.[8]
(iv) The service is available to both business and residential customers with line-of-sight to the cell transmit site.[8]
(v) It is limited to certain neighbourhoods or business districts, as with wired services such as DSL or cable modems.[8]

Weaknesses

(i) Single-channel radio link is a line-of-sight technology, which means the signal cannot travel through or around obstacles.[9]
(ii) The user must be within 35 miles of the tower.[9]
(iii) Since wireless airwaves are a shared resource, too many users on the system can slow down the performance.[9]

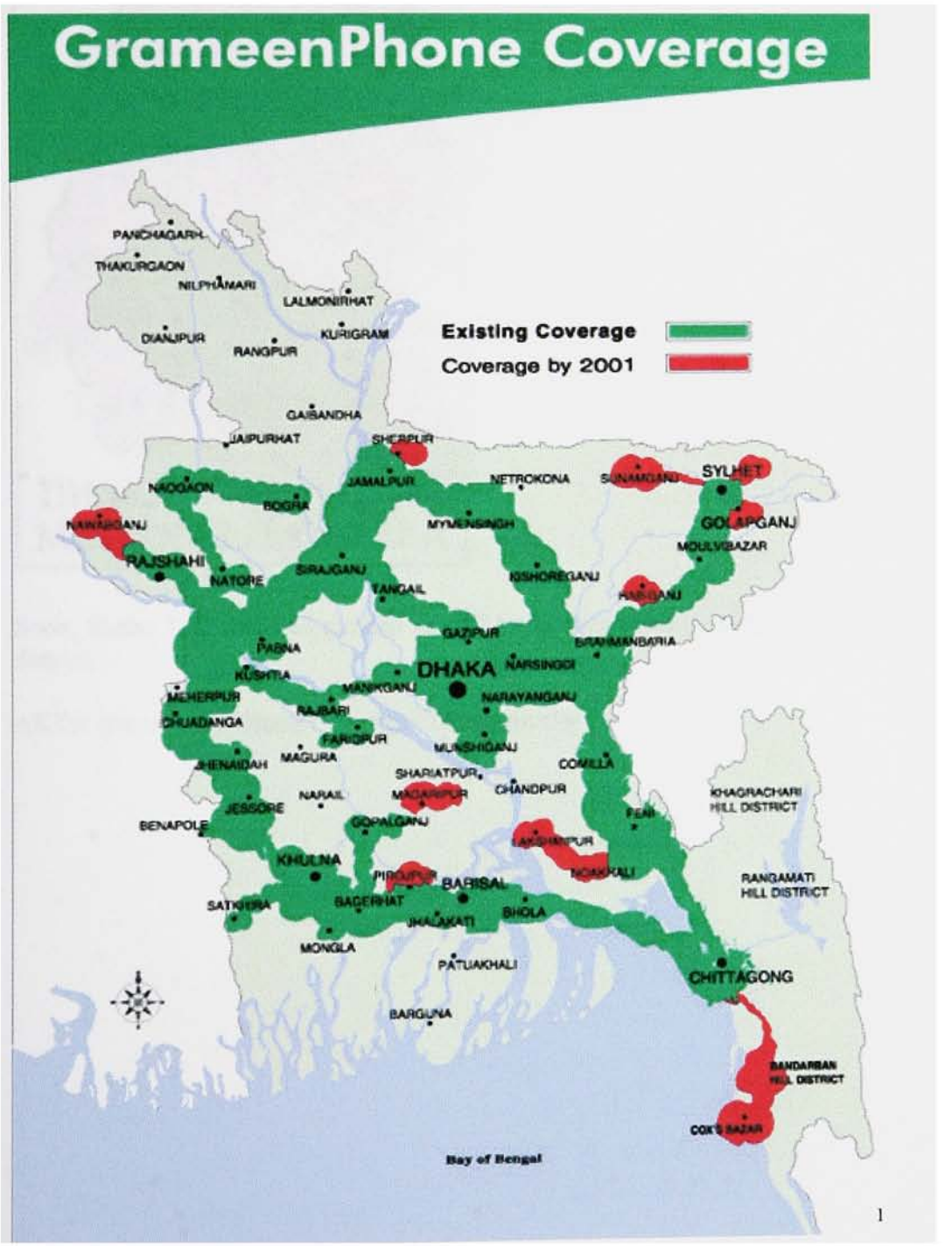
References

[1] Mr. Abdur Raquib Saber (saber@grameenphone.com)
[2] Mr. Sayed-Ur Rahman (sayed@bttb.net.bd)
[3] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[4] http://qsl.net/kb9mwr/projects/wireless/wlan/2400tbl.html
[5] Professor Sylvia Perez-Hardy (sph@it.rit.edu)
[6] DSL For Dummies (Second Edition) — David Angell
[7] http://www.bttb.net/home/main/internet/fees_rates.htm
[8] http://www.mobilecomms-technology.com/projects/saltriver/
[9] http://www.earthlink.net/blink/feb01/cover3.html

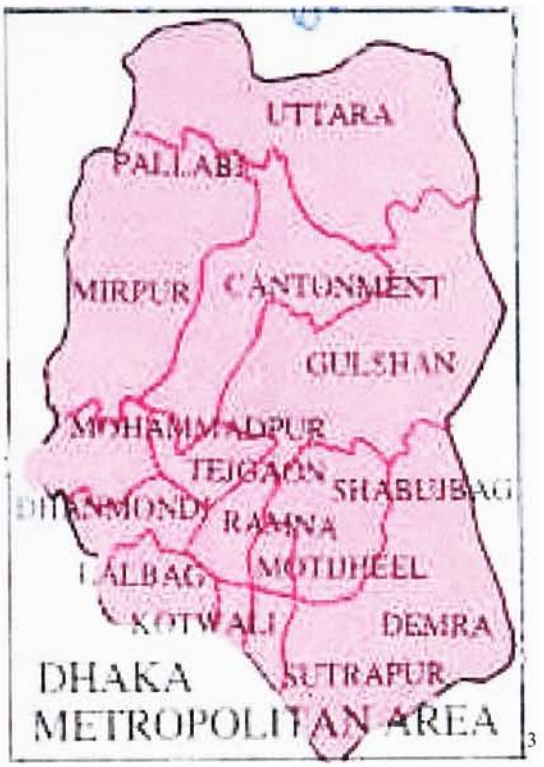
Global System for Mobile Communications (GSM)

Coverage Area

There are three companies providing GSM (Global System for Mobile Communication) in Bangladesh. They are : (i) GrameenPhone, (ii) Sheba Telecom, and (iii) AKTel.



Sheba Telecom has already covered its GSM service to all parts of Dhaka metropolitan city as well as neighboring towns of Dhaka city — Narayanganj, Savar, Joydevpur, and Gazipur with superior network quality.[2]

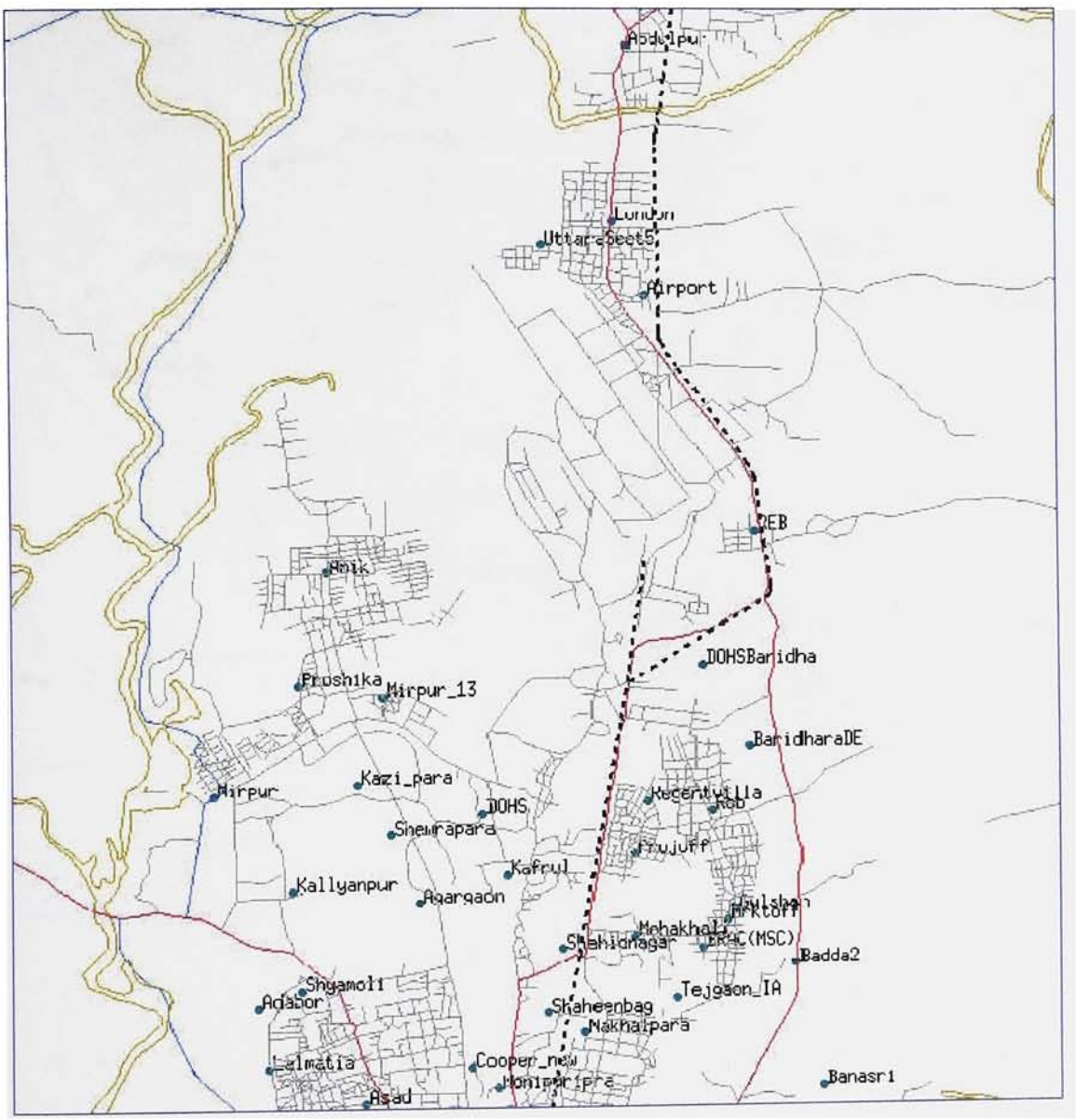


[3]

Soon, Sheba Telecom will expand its GSM coverage to Chittagong district and Sylhet district.[2]

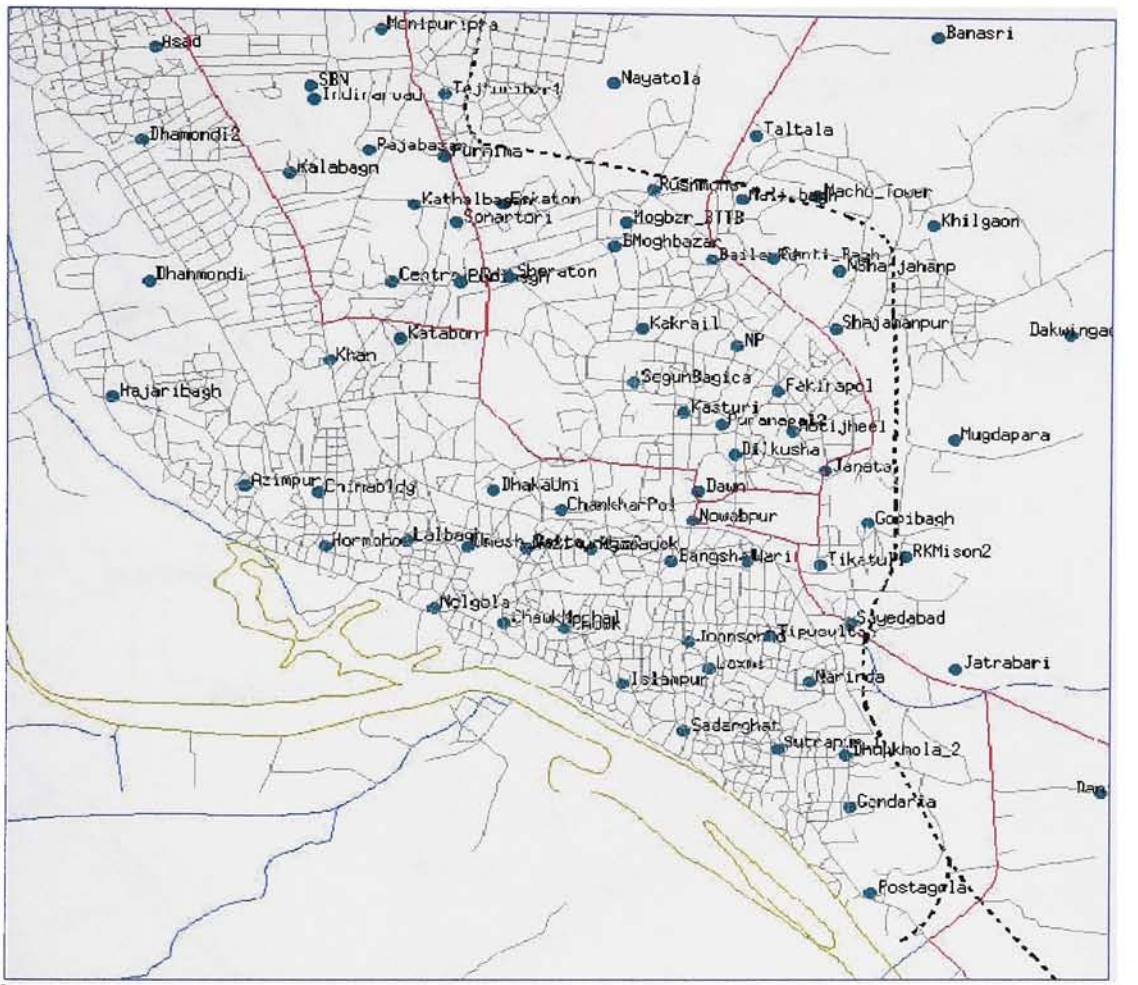
AKTel covers only Dhaka city and Chittagong city.

The following map shows the AKTel coverage in the northern part of Dhaka city.



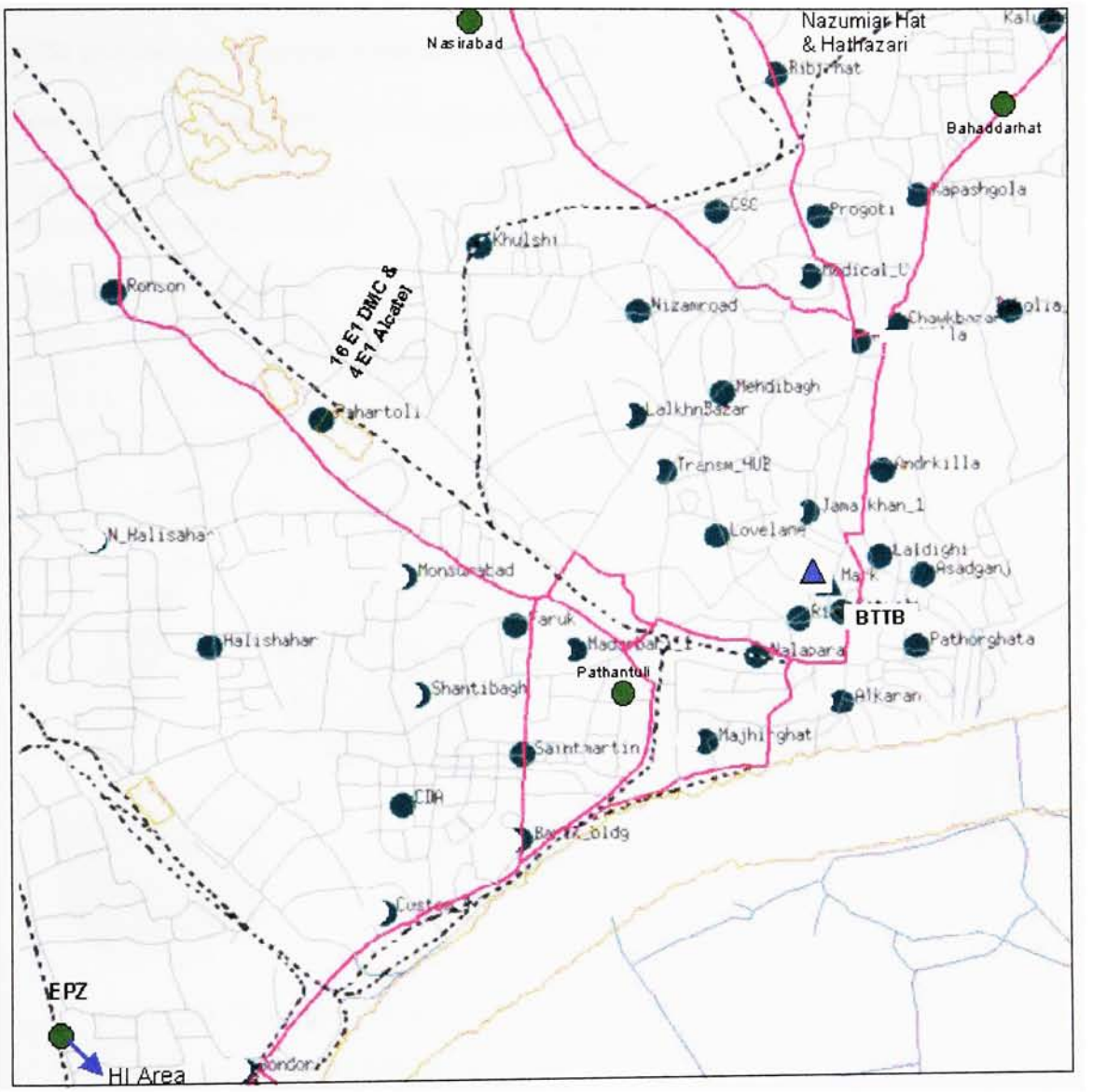
4

The following map shows the AKTel coverage in the southern part of Dhaka city.



5

The following map shows the AKTel coverage in the port city of Chittagong.



6

Topology Dependent

From the above coverage maps, it is obvious that neither of these three companies does not follow any topology. So, GSM is topology-independent.

Media to be used

GrameenPhone uses Bangladesh Railway's optical fiber as the main highway and connects Base Stations at every 35 kilometer for GSM transmission. The Base Stations are located at railway stations.[7]

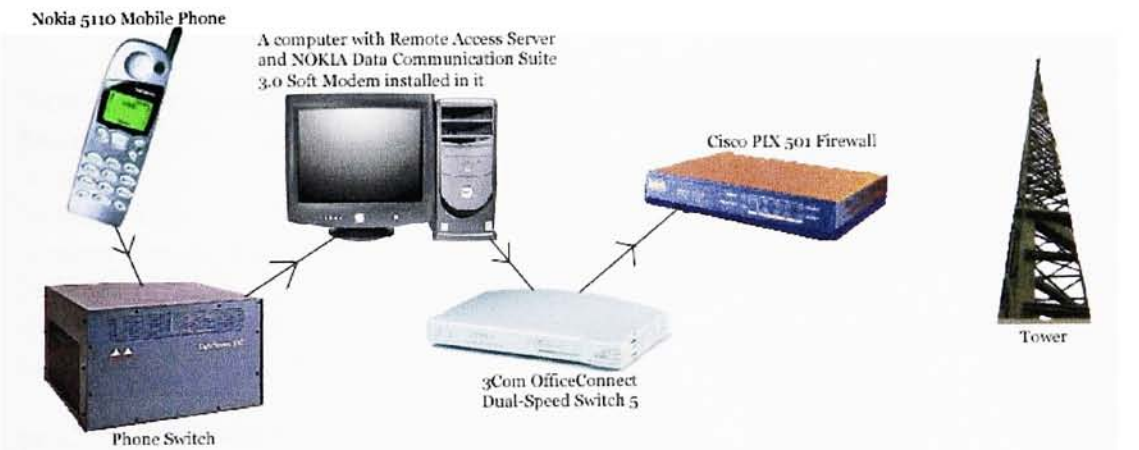
Available Bandwidth

GSM provides a maximum bandwidth of 9.6 kbps.[7]

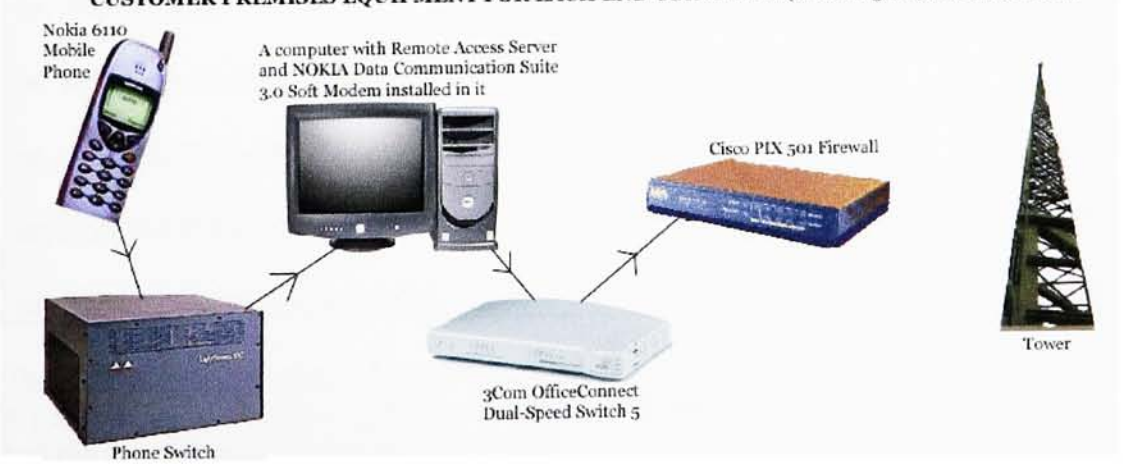
Necessary Customer Premises Equipment

Customer Premises Equipments for connecting Nokia 5110/6110 mobile phone to the Internet are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
Nokia 5110/6110 mobile phone,[7]	190.00	10,830.00
3Com OfficeConnect Dual-Speed Switch 5 [8]	109.00	6,213.00
NOKIA Data Communication Suite 3.0 soft modem (Product#MENOKIADS3)[9]	183.00	10,431.00
NOKIA DATA SUITE 3.0 Upgrade Kit (Product#DATASUITE3.0UPG)[10]	159.00	9,063.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING GSM (NOKIA 5110) CONNECTION



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING GSM (NOKIA 6110) CONNECTION

Security Measurements

There are two kinds of security measurements :

- Firewall in a box; e.g., (i) SonicWALL SOHO/10 — supports upto 10 PCs and costs US $495.00 (= Tk. 28,215.00),[11] (ii) Cisco PIX® 501 Firewall, (which includes Integrated auto-sensing, auto-MDIX 4-port 10/100 switch, RJ45), costing US $595.00 (= Tk. 33,915.00)[12]; or,
- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[11]

Cost

(I) Cost of CPE :

Name of the Equipment	**Cost in US $**	**Cost in BD Taka**
Nokia 5110/6110 mobile phone,[7]	190.00	10,830.00
3Com OfficeConnect Dual-Speed Switch 5 [8]	109.00	6,213.00
NOKIA Data Communication Suite 3.0 soft modem (Product#MENOKIADS3)[9]	183.00	10,431.00
NOKIA DATA SUITE 3.0 Upgrade Kit (Product#DATASUITE3.0UPG)[10]	159.00	9,063.00
SonicWALL SOHO/10,[11]	495.00	28,215.00
or, Cisco PIX® 501 Firewall,[12]	595.00	33,915.00
or, ZoneAlarm,[11]	20.00	1,140.00
or, Sybergen Secure Desktop,[11]	30.00	1,710.00
or, BlackIce Defender,[11]	40.00	2,280.00
or, ConSeal Private Desktop,[11]	50.00	2,850.00
or, Norton Internet Security 2000.[11]	60.00	3,420.00

Thus, the minimum total cost of CPE will be
= US $(190.00 + 109.00 + 159.00 + 20.00) = US $478.00 = Tk. 27,246.00
and the maximum total cost of CPE will be
= US $(190.00 + 109.00 + 159.00 + 595.00) = US $1,053.00 = Tk. 60,021.00.

(II) Charges per minute :

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred
= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits.

(i) The per minute charge of browsing the Net directly by GP's mobile phone is Tk. 2.00 (= US $0.03508) for post-paid and Tk. 3.00 (= US $0.05263) for pre-paid.

If data are transferred using the post-paid service of GrameenPhone, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*2.00} = Tk. (10,609.48*2.00) = Tk. 21,218.95 (= US $372.26).
If data are transferred using the pre-paid service of GrameenPhone, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*3.00} = Tk. (10,609.48*3.00) = Tk. 31,828.43 (= US $558.39).

(ii) The per minute of browsing the Net using Sheba's mobile phone is (a) Tk. 4.00 per minute during Peak Hour (08:00 AM to 07:59 PM for Weekdays) and (b) Tk. 3.00 per minute during Off-Peak Hour (08:00PM to 07:59 Am for Weekdays) and 24 hours during Friday & Public Holidays.[13]

If data are transferred during peak hour everyday, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*4.00} = Tk. (10,609.48*4.00) = Tk. 42,437.90 (= US $744.52).

If data are transferred during off-peak hour everyday, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*3.00} = Tk. (10,609.48*3.00) = Tk. 31,828.43 (= US $558.39).

(iii) The security deposit of AKTel's mobile subscription is Tk. 1,000.00 which is refundable.[14]

The monthly rental for AKTel's mobile subscription is Tk. 300.00 + 15% VAT = Tk. 345.00 (= US $6.05).[14]

Thus, the yearly rental for AKTel's mobile subscription is Tk. (345.00*12)
= Tk. 4,140.00 = US $72.63.

The per minute of browsing the Net using AKTel's mobile phone is Tk. 6.00 per minute + 15% VAT[15] = Tk. 6.90.

If data are transferred AKTel's mobile phone, then the charge for the whole year will be = Tk. [345.00 + {(101,850.968÷9.6)*6.90}] = Tk. {345.00 + (10,609.48*6.90)} = Tk. (345.00 + 73,205.38) = Tk. 73,550.38 (= US $1,290.36).

(iv) The per minute charge of browsing the Net using BTTB connection with GP's mobile phone is Tk. 0.50 per minute for Peak hours (8:00 a.m. to 11:00 p.m.) and Tk. 0.30 per minute for Off Peak hours (11:00 p.m. to 8:00 a.m.).[16]

If data are transferred during peak hours everyday, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*0.50} = Tk. (10,609.48*0.50) = Tk. 5,304.73 (= US $93.07).

If data are transferred during off-peak hours everyday, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*0.30} = Tk. (10,609.48*0.30) = Tk. 3,182.84 (= US $55.84).

The per minute charge of browsing the Net using BTTB connection with Sheba's mobile phone is Tk. 1.70 per minute.[13]

If data are transferred with Sheba's mobile phone connected to BTTB, then the charge for the whole year will be = Tk. {(101,850.968÷9.6)*1.70} = Tk. (10,609.48*1.70) = Tk. 18,036.11 (= US $316.42).

Different types of costs associated with GSM are shown as follows :

Different types of costs	**Cost in US $**	**Cost in BD Taka**
Minimum total CPE cost	478.00	27,246.00
Maximum total CPE cost	1,053.00	60,021.00
Annual rental charge of GP (post-paid)	372.26	21,218.95
Annual rental charge of GP (pre-paid)	558.39	31,828.43
Annual rental charge of Sheba Telecom (during peak hour)	744.52	42,437.90
Annual rental charge of Sheba Telecom (during off-peak hour)	558.39	31,828.43
Annual rental charge of AKTel	1,290.36	73,550.38
Annual rental charge of GP (through BTTB — during peak hour)	93.07	5,304.73
Annual rental charge of GP (through BTTB — during off-peak hour)	55.84	3,182.84
Annual rental charge of Sheba Telecom (through BTTB)	316.42	18,036.11

Strengths

- GSM is already used worldwide with over 450 million subscribers.[17]
- GSM is mature, having started in the mid-80s. This maturity means a more stable network with robust features. CDMA is still building its network.[17]
- GSM's maturity means engineers cut their teeth on the technology, creating an unconscious preference.[17]
- The availability of Subscriber Identity Modules, which are smart cards that provide secure data encryption give GSM m-commerce advantages.[17]

Weaknesses

- High cost,
- Unreliable connections,
- Restricted bandwidth, and
- Exposure to loss of confidentiality and integrity.[18]

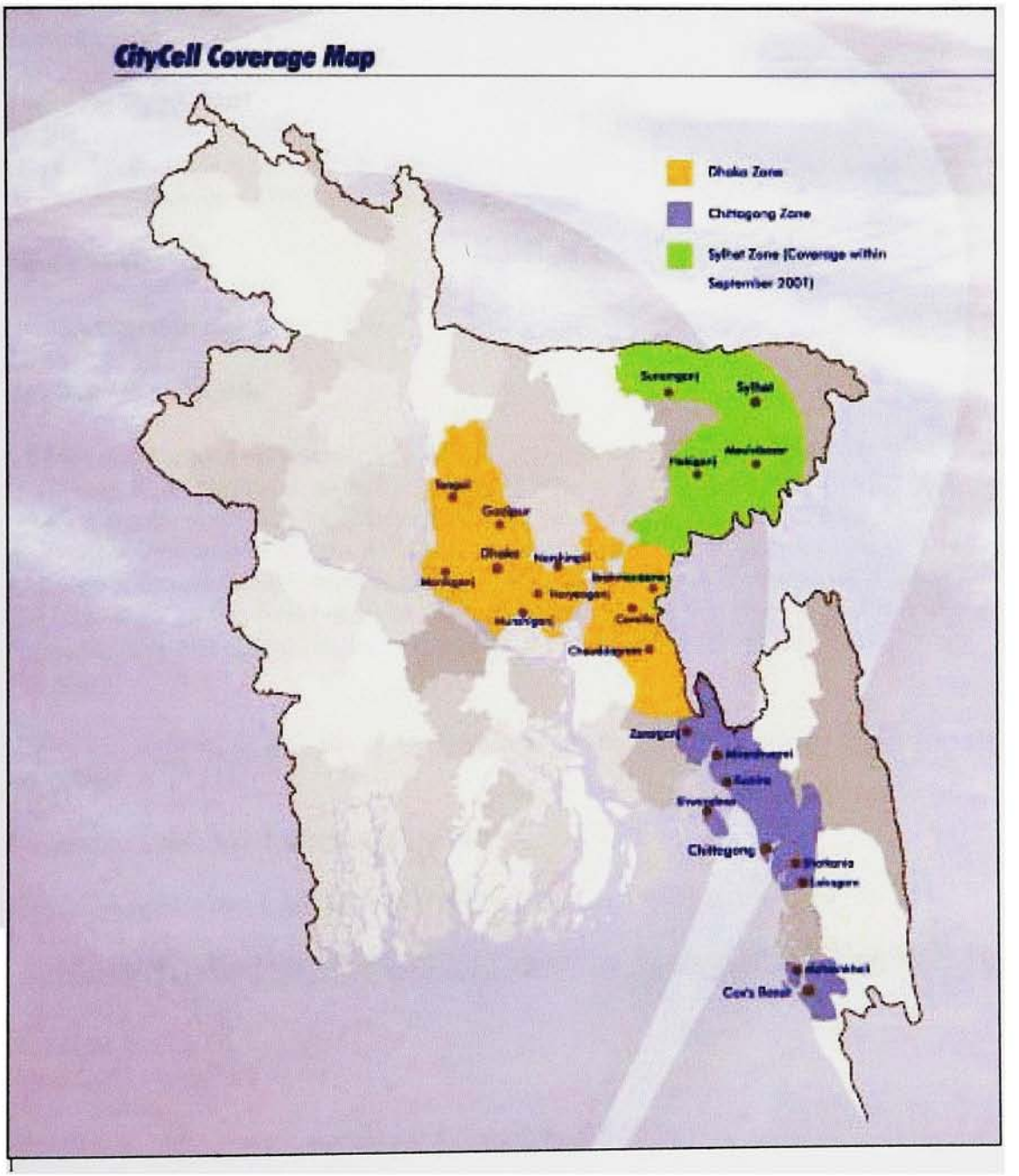
References

[1] http://www.grameenphone.com/cover.htm
[2] http://www.shebatel.com/take_of.html
[3] http://www.bangladeshgov.org/bdmaps/bdadmin.jpg
[4] http://www.aktel.com/cover_Dhaka.htm
[5] http://www.aktel.com/cover_Dhaka1.html
[6] http://www.aktel.com/cover_chittagong.html
[7] Abdur Raquib Saber (saber@grameenphone.com)
[8]http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[9] http://www.vis.com.my/MENokiaDS3.htm
[10] http://www.iphones.ws/nokdatsuit30.html
[11] DSL For Dummies (Second Edition) — David Angell
[12] http://www.cisco.com/warp/public/cc/pd/fw/sqfw500/prodlit/px501_ds.htm
[13] http://www.shebatel.com/tariff_charges_shebaworld.html
[14] http://www.aktel.com/faq4.html
[15] http://www.aktel.com/faq3.html
[16] http://www.bttb.net/home/main/internet/fees_rates.htm
[17] http://www.mcommercetimes.com/Technology/95
[18] http://www.brownsbox.com/gsm.htm

Code Division Multiple Access (CDMA)

Coverage Area

CDMA (Code Division Multiple Access) is provided in Bangladesh only by Pacific Bangladesh Telecom Limited / CityCell.



CityCell has divided its coverage area into three zones :

(i) Dhaka Zone — covers Dhaka city and its neighboring towns named Gazipur, Munshiganj, Narayanganj, Narshingdi, Tangail district, Comilla town, and Brahmanbaria and Chandina in the Comilla district.
(ii) Chittagong Zone — covers Chitagong city, Cox's Bazaar, Feni (in Noakhali district), and many other areas of Chittagong district and Chittagong Hill Tracts.
(iii) Sylhet Zone — covers Sylhet city and Habiganj, Moulvibazaar, and Sunamganj districts.

Topology Dependent

From the coverage map, it is obvious that CityCell is using star topology using Dhaka as its center. However, CDMA is topology-independent.

Media to be used

CDMA uses wireless as its media.

Available Bandwidth

CDMA is a "spread spectrum" technology, which means that it spreads the information contained in a particular signal of interest over a much greater bandwidth than the original signal. A CDMA call starts with a standard rate of 9.6 Kbps. This is then spread to a transmitted rate of about 1.23 Mbps. Spreading means that digital codes are applied to the data bits associated with users in a cell. These data bits are transmitted along with the signals of all the other users in that cell. When the signal is received, the codes are removed from the desired signal, separating the users and returning the call to a rate of 9.6 Kbps.[2]

Citycell's Cyberbell 100 has a built-in modem of 64 Kbps, which facilitates web browsing.[3]

Necessary Customer Premises Equipment

Citycell provides two kinds of mobile phones. They are listed in the following table :

Total price with connection	
1. Motorola 182C	Tk. 12,499.00 = (US $219.28)
2. CyberBell 100	Tk. 11,499.00 = (US $201.74)

Optional : Tk. 500.00 additional deposit for national roaming[4]

Features of these two cell phones are provided below :

Product#1 : Motorola 182C [5]	**Product#2 : CyberBell 100** [3]

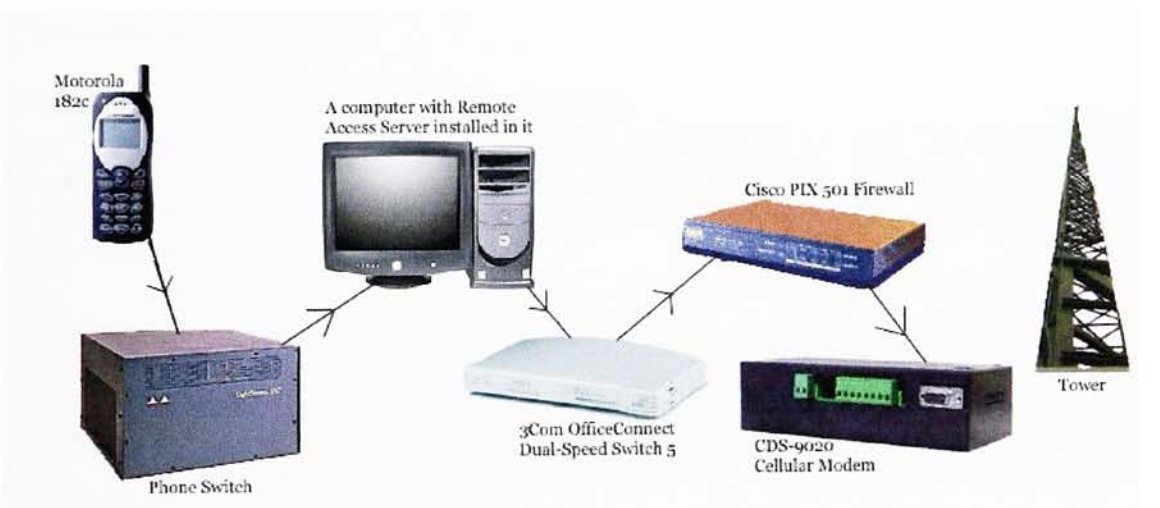
	
• Short Message Service • Short Text Message • Phone Book, 99 positions with capacity for 3 number search • 4 Ringer and 10 Melodies • World timer (Multiple City) • Chronometer (Individual, world, alarm) • Talk time 120 Min • Std-by time 200 hrs • Weight 120 gm • Metal Hydride Battery • Desktop charger • User guide	• Mode : CDMA (800 MHz) • Standard Size : 107(L) * 42.5(W) * 21(H) • Standby Time : About 210 hours • Usage Time : About 250 minutes • Weight : About 99 g • Type-Active Matrix LCD • Schedule (20) • Ringing Tones (15 melodies) • Vibration alert • Ear piece interface • Active Flip • Caller ID • Mute • 200 telephone memories • Calls Log • Call answering with flip • Graphic User Interface • Animations • Dual Time (63 cities) • SMS • Internet Web Browser (WAP) • One-touch Key Lock • Build-in Modem (64 Kbps)

Included Accessories :

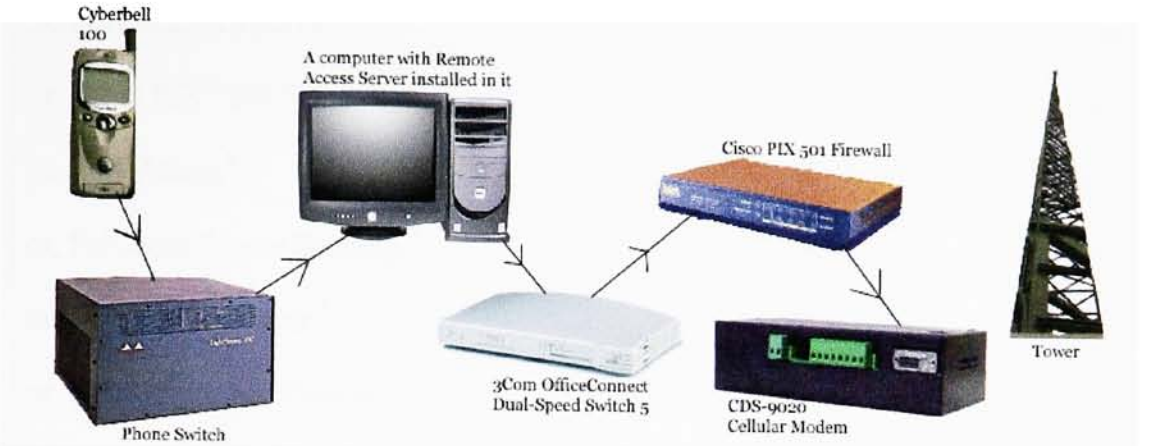
- Lithium Ion Battery
- A/C Adapter Charger
- User's Manual

Necessary Customer Premises Equipment for CDMA are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
Motorola 182C,[5] or	219.28	12,499.00
Cyberbell 100 [3]	201.74	11,499.00
3Com OfficeConnect Dual-Speed Switch 5 [6]	109.00	6,213.00
Qualcomm Wireless Internet CDMA modem and cable,[7]	329.00	18,753.00
or, CDS-9020 Cellular Modem[8]	645.00	36,765.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING CDMA (MOTOROLA 182c) CONNECTION



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING CDMA (CYBERBELL 100) CONNECTION

Security Measurements

There are two kinds of security measurements :

- Firewall in a box; e.g., (i) SonicWALL SOHO/10 — supports upto 10 PCs and costs US $495.00 (= Tk. 28,215.00),[9] (ii) Cisco PIX® 501 Firewall, (which includes Integrated auto-sensing, auto-MDIX 4-port 10/100 switch, RJ45), costing US $595.00 (= Tk. 33,915.00)[10]; or,
- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[9]

Cost

Necessary Customer Premises Equipment for CDMA are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
Motorola 182C,[5] or	219.28	12,499.00
Cyberbell 100 [3]	201.74	11,499.00
3Com OfficeConnect Dual-Speed Switch 5 [6]	109.00	6,213.00
Qualcomm Wireless Internet CDMA modem and cable,[7] or,	329.00	18,753.00
CDS-9020 Cellular Modem[8]	645.00	36,765.00

SonicWALL SOHO/10,[9]	495.00	28,215.00
or, Cisco PIX® 501 Firewall,[10]	595.00	33,915.00
or, ZoneAlarm,[9]	20.00	1,140.00
or, Sybergen Secure Desktop,[9]	30.00	1,710.00
or, BlackIce Defender,[9]	40.00	2,280.00
or, ConSeal Private Desktop,[9]	50.00	2,850.00
or, Norton Internet Security 2000.[9]	60.00	3,420.00

Thus, the minimum total cost of CPE will be = US $(201.74 + 109.00 + 329.00 + 20.00) = US $659.74 = Tk. 37,605.18
and the maximum total cost of CPE will be = US $(219.28 + 109.00 + 645.00 + 595.00) = US $1,568.28 = Tk. 89,391.96.

Service Charge for CityCell 250 Package

Mobile 250			
Normal Scenario Monthly Subscription = Tk. 250.00 = (US $4.39) Yearly Subscription = Tk. (250.00*12) = Tk. 3,000.00 (= US $52.63) Monthly CLI (Caller's Line Identification Protocol) Charge = Tk. 50.00 (= US $0.88) Yearly CLI Charge = (Tk. 50.00*12) = Tk. 600.00 (= US $10.53)			
Calls Inside	Home Zone (Per Minute Charges)		
	Peak (8AM-8PM)	Off-peak (8PM-11PM)	Super Off-peak (11PM-8AM)
Outgoing			
Mobile to BTTB (Local In zone)			1.50 + *
Mobile to Mobile (In Zone)	4.00	3.00	1.50
Mobile to Mobile (Out Zone)	6.00	5.00	Not Applicable
Incoming			
From any Mobile	Free	Free	Free
From BTTB	3.00	2.00	1.00

(Local/NWD/IDD in Dhaka Zone)			
From BTTB (Local / NWD / IDD) in Chittagong (Roaming)	6.00	4.00	Not Applicable

Taka 1.70 per local call to BTTB[11]

Notes:

- Super Off-peak rate is applicable only when the customer is in home zone and is making calls to home zone customers. It is not applicable in roaming scenario and in case of inter-zonal calls.
- Pulse is applicable during Peak, Off-peak and Super Off-peak Hours. The first pulse is 60 seconds and thereafter each pulse is of 15 seconds duration.
- 15 % VAT will be applicable on total monthly bill.
- Monthly credit limit Tk. 1,500.00 only.[11]

Service Charge for CityCell 500 Package

CityCell 500

Normal Scenario

Monthly Subscription = Tk. 500.00 (= US $8.77)

Yearly Subscription = Tk. (500.00*12) = Tk. 6,000.00 (= US $105.263)

Monthly CLI (Caller's Line Identification Protocol) Charge = Tk. 50.00 (= US $0.88)

Yearly CLI Charge = (Tk. 50.00*12) = Tk. 600.00 (= US $10.53)

	Home Zone (Within the Zone) (Per Minute Charges)			Other Zone (Home Zone to Other Zone) (Per Minute Charges)	
	Peak (8AM-8PM)	Off-peak (8PM-11PM)	Super Off-peak (11PM-8AM)	Peak (8AM-8PM)	Off-peak (8PM-8AM)
Outgoing					
CityCell to CityCell	2.50	2.50	1.50	10.00	7.50
CityCell to Other Mobile	4.00	3.00	1.50		
CityCell to Prepaid / Nationwide	4.00	3.00	1.50		

CityCell to T&T (Local / NWD / IDD)	4.00 + *	3.00 + *	1.50 + *		
Incoming					
From any Mobile	Free	Free	Free	Free	Free
From T&T (Local / NWD / IDD)	3.00	2.00	1.00		

12

Tk. 1.70 per local call to BTTB[12]

Roaming Scenario				
Calls Inside	Home Zone (Per Minute Charges)		Other Zone (Per Minute Charges)	
	Peak (8AM-8PM)	Off-peak (8PM-8AM)	Peak (8AM-8PM)	Off-peak (8PM-8AM)
Outgoing				
CityCell to CityCell	2.50	2.50	10.00	7.50
CityCell to Other Mobile	4.00	3.00		
CityCell to Prepaid/Nationwide	4.00	3.00		
CityCell to T&T Local/NWD/IDD	4.00 + *	3.00 + *		
Between two roamer			4.00	3.00
Incoming				
CityCell to CityCell	Free	Free		
CityCell to Other Mobile	Free	Free		
CityCell to Prepaid/Nationwide	Free	Free		
CityCell to T&T Local/NWD/IDD	10.00	7.50		
Between two roamer			Free	Free

12

T&T Actual Rate

Notes:

- Super Off-peak rate is applicable only when the customer is in home zone and is making calls to home zone customers. It is not applicable in roaming scenario and in case of inter-zonal calls.
- Pulse is applicable during Peak, Off-peak and Super Off-peak Hours. The first pulse is 60 seconds and thereafter each pulse is of 15 seconds duration.
- 15 % VAT will be applicable on total monthly bill.[12]

Add BTTB Local NWD IDD charge for any call to BTTB.

Service Charge for CityCell 1000 Package

CityCell 1000			
Normal Scenario Monthly Subscription Tk. 1,000.00 (= US $17.54) Yearly Subscription = Tk. (1,000.00*12) = Tk. 12,000.00 (= US $210.53)			
	Home Zone (Within the Zone) (Per Minute Charges)		Other Zone (Home Zone to Other Zone) (Per Minute Charges)
	Flat Rate	Super Off-peak (11PM-8AM)	Flat Rate
Outgoing			
CityCell to CityCell	2.50	1.50	7.50
CityCell to Other Mobile	3.00	1.50	
CityCell to Prepaid/Nationwide	3.00	1.50	
CityCell to T&T Local / NWD / IDD	3.00 + *	1.50 + *	
Incoming			
CityCell to CityCell	Free		Free
CityCell to Other Mobile	Free		
CityCell to Prepaid/Nationwide	Free		
CityCell to T&T Local / NWD / IDD	2.00	1.00	

13

Tk. 1.70 per local call to BTTB

Roaming Scenario

Calls Inside	Home Zone (Per Minute Charges)	Other Zone (Per Minute Charges)
	Flat Rate	Flat Rate
Outgoing		
CityCell to CityCell	2.50	7.50
CityCell to Other Mobile	3.00	
CityCell to Prepaid/Nationwide	3.00	
CityCell to T&T Local/NWD/IDD	3.00 + *	
Between two roamer		3.00
Incoming		
CityCell to CityCell	Free	Free
CityCell to Other Mobile	Free	
CityCell to Prepaid/Nationwide	Free	
CityCell to T&T Local/NWD/IDD	7.50	
Between two roamer		Free

13

T&T Actual Rate[13]

Notes :

- Super Off-peak rate is applicable only when the customer is in home zone and is making calls to home zone customers. It is not applicable in roaming scenario and in case of inter-zonal calls.
- Pulse is applicable during Peak, Off-peak and Super Off-peak Hours. The first pulse is 60 seconds and thereafter each pulse is of 15 seconds duration.
- 15 % VAT will be applicable on total monthly bill.
- Add BTTB Local NWD IDD charge for any call to BTTB. [13]

From the calculation of total data to be transferred, we see that a total of 256.96 kilobits of data needs to be transferred daily, 410.168 kilobits of data needs to be transferred at the end of the week, 264.152 kilobits of data needs to be transferred at the end of the month, and 264.408 kilobits of data at the end of the year.

So, for the whole year the total amount of data needs to be transferred
= [(256.96*365)+{(410.168-256.96)*52}+{(264.152-256.96)*12}+(264.408-256.96)] kb
= {93790.4 + (153.208*52) + (7.192*12) + 7.448} kilobits
= (93790.4 + 7966.816 + 86.304 + 7.448) kilobits
= 101850.968 kilobits.

The per minute charges of browsing the Net directly by using Citycell 250 and 500 package are Tk. 10.00 during peak hour and Tk. 5.00 during off-peak hour. For the Citycell 1000 package, the per minute charge for the whole day is Tk. 7.50. Using BTTB as the ISP, the per minute charge of all three packages is Tk. 1.70.

If data are transferred during peak hour every day using the Citycell 250 package, then the charge for the whole year will be
= Tk. [3,000.00 + 600.00 + {(101850.968÷64) * 10.00}]
= Tk. {3,600.00 + (1,591.421 * 10.00)} = Tk. (3,600.00 + 15,914.21)
= Tk. 19,514.21 (= US $342.35).

If data are transferred during off-peak hour every day using the Citycell 250 package, then the charge for the whole year will be
= Tk. [3,000.00 + 600.00 + {(101850.968÷64) * 7.50}]
= Tk. {3,600.00 + (1,591.421 * 7.50)} = Tk. (3,600.00 + 11,935.66)
= Tk. 15,535.66 (= US $272.56).

If data are transferred using the Citycell 250 package connected to BTTB as its ISP, then the charge for the whole year will be
= Tk. [3,000.00 + 600.00 + {(101850.968÷64) * 1.70}]
= Tk. {3,600.00 + (1,591.421 * 1.70)} = Tk. (3,600.00 + 2,705.42)
= Tk. 6,305.42 (= US $110.62).

If data are transferred during peak hour every day using the Citycell 500 package, then the charge for the whole year will be
= Tk. [6,000.00 + 600.00 + {(101850.968÷64) * 10.00}]
= Tk. {6,600.00 + (1,591.421 * 10.00)} = Tk. (6,600.00 + 15,914.21)
= Tk. 22,514.21 (= US $394.86).

If data are transferred during off-peak hour every day using the Citycell 500 package, then the charge for the whole year will be
= Tk. [6,000.00 + 600.00 + {(101850.968÷64) * 7.50}]
= Tk. {6,600.00 + (1,591.421 * 7.50)} = Tk. (6,600.00 + 11,935.66)
= Tk. 18,535.66 (= US $325.19).

If data are transferred using the Citycell 500 package connected to BTTB as its ISP, then the charge for the whole year will be
= Tk. [6,000.00 + 600.00 + {(101850.968÷64) * 1.70}]
= Tk. {6,600.00 + (1,591.421 * 1.70)} = Tk. (6,600.00 + 2,705.42)
= Tk. 9,305.42 (= US $163.25).

If data are transferred during off-peak hour every day using only the Citycell 1000 package, then the charge for the whole year will be
= Tk. [12,000.00 + {(101850.968÷64) * 7.50}] = Tk. {12,000.00 + (1,591.421 * 7.50)}
= Tk. (12,000.00 + 11,935.66) = Tk. 23,935.66 (= US $419.92).

If data are transferred using the Citycell 1000 package connected to BTTB as its ISP, then the charge for the whole year will be
= Tk. [12,000.00 + {(101850.968÷64) * 1.70}] = Tk. {12,000.00 + (1,591.421 * 1.70)}
= Tk. (12,000.00 + 2,705.42) = Tk. 14,705.42 (= US $257.99).

Different types of costs associated with CDMA are listed as follows :

Different types of costs	Cost in US $	Cost in BD Taka
Minimum total CPE cost	659.74	37,605.18
Maximum total CPE cost	1,568.28	89,391.96
Annual rental charge for using the Citycell 250 package during peak hour	342.35	19,514.21
Annual rental charge for using the Citycell 250 package during off-peak hour	272.56	15,535.66
Annual rental charge for using the Citycell 250 package through BTTB (as the ISP)	110.62	6,305.42
Annual rental charge for using the Citycell 500 package during peak hour	394.86	22,514.21
Annual rental charge for using the Citycell 500 package during off-peak hour	325.19	18,535.66
Annual rental charge for using the Citycell 500 package through BTTB (as the ISP)	163.25	9,305.42
Annual rental charge for using the Citycell 1000 package during off-peak hour	419.92	23,935.66
Annual rental charge for using the Citycell 1000 package through BTTB (as the ISP)	257.99	14,705.42

Strengths

- Increased cellular communications security.[14]
- Simultaneous conversations.[14]
- Increased efficiency, meaning that the carrier can serve more subscribers.[14]
- Smaller phones.[14]
- Low power requirements and little cell-to-cell coordination needed by operators.[14]
- Extended reach — beneficial to rural users situated far from cells.[14]

Weaknesses

- Due to its proprietary nature, all of CDMA's flaws are not known to the engineering community.[14]
- CDMA is relatively new, and the network is not as mature as GSM.[14]
- CDMA cannot offer international roaming.[14]

References

[1] http://www.citycell.org/carea.htm

[2] http://www.cdg.org/tech/about_cdma.asp

[3] http://www.citycell.org/products_cyberbell_100.htm

[4] http://www.citycell.org/products.htm

[5] http://www.citycell.org/products_motorola_182c.htm

[6] http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US

[7] www.wirelessadvantage.com/cdma.htm

[8] www.arcelet.com/CDS-9020_CDMA_Cell_Modem.htm

[9] DSL For Dummies (Second Edition) — David Angell

[10] http://www.cisco.com/warp/public/cc/pd/fw/sqfw500/prodlit/px501_ds.htm

[11] http://www.citycell.org/packages250.htm

[12] http://www.citycell.org/packages500.htm

[13] http://www.citycell.org/packages1000.htm

[14] http://www.mcommercetimes.com/Technology/95

Satellite Wireless

Coverage Area

There is no such specific coverage area for the satellite wireless — it can be used anywhere, if a two-way satellite dish is installed in that place. In Bangladesh, many companies are using VSAT (Very Small Aperture Terminal) for business purposes.

Topology Dependent

Satellite wireless is topology-independent.

Media to be used

Satellite wireless is a kind of broadband wireless technology, which uses satellite dish as the media.[1]

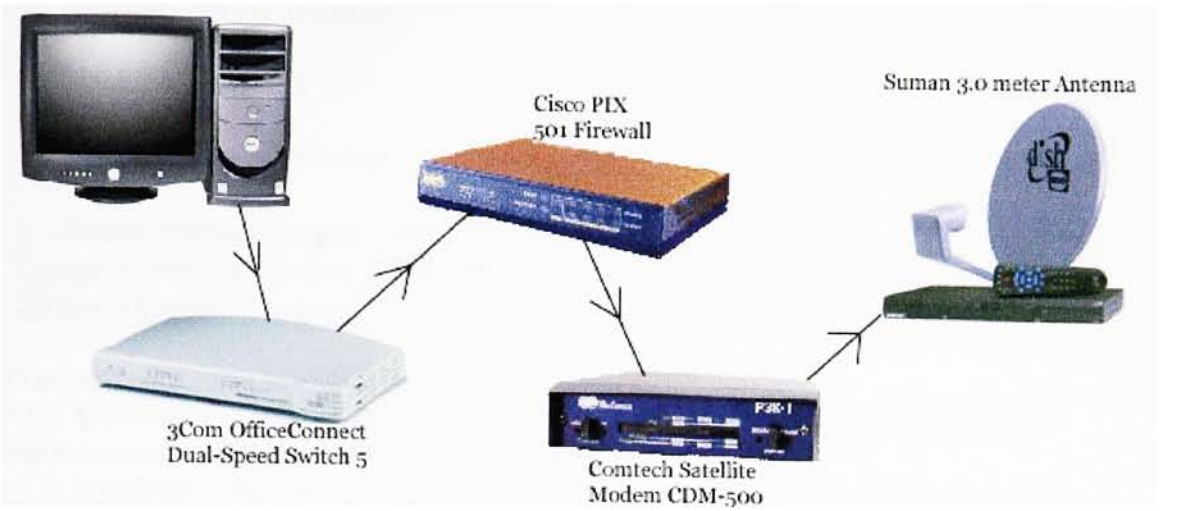
Available Bandwidth

Satellite wireless provides a bandwidth of 392 Kbps.[1]

Necessary Customer Premises Equipment

Customer Premises Equipment for connecting VSAT at each point are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 [2]	109.00	6,213.00
Comtech Satellite Modem CDM-500 [3]	5,000.00	2,85,000.00
Suman 3.0 meter Antenna[3]	8,500.00	4,84,500.00



CUSTOMER PREMISES EQUIPMENT FOR EACH END USING SATELLITE WIRELESS

Security Measurements

There are two kinds of security measurements :

- Firewall in a box; e.g., (i) SonicWALL SOHO/10 — supports upto 10 PCs and costs US $495.00 (= Tk. 28,215.00),[4] (ii) Cisco PIX® 501 Firewall, (which includes Integrated auto-sensing, auto-MDIX 4-port 10/100 switch, RJ45), costing US $595.00 (= Tk. 33,915.00) ();[5] or,
- Personal Firewalls, which can be downloaded in each computer, are not as powerful as security appliances; e.g., (i) ZoneAlarm — free for inividuals and nonprofit groups, US $20.00 (= Tk. 1,140.00) for commercial and government organizations, (ii) Sybergen Secure Desktop costing US $30.00 (= Tk. 1,710.00), (iii) BlackIce Defender costing US $40.00 (= Tk. 2,280.00), (iv) ConSeal Private Desktop costing US $50.00 (= Tk. 2,850.00), and (v) Norton Internet Security 2000 costing US $60.00 (= Tk. 3,420.00).[4]

Cost

Customer Premises Equipment for connecting VSAT at each point are listed as follows :

Name of the Equipment	Cost in US $	Cost in BD Taka
3Com OfficeConnect Dual-Speed Switch 5 [2]	109.00	6,213.00
SonicWALL SOHO/10,[4]	495.00	28,215.00
or, Cisco PIX® 501 Firewall,[5]	595.00	33,915.00
or, ZoneAlarm,[4]	20.00	1,140.00

or, Sybergen Secure Desktop,[4]	30.00	1,710.00
or, BlackIce Defender,[4]	40.00	2,280.00
or, ConSeal Private Desktop,[4]	50.00	2,850.00
or, Norton Internet Security 2000.[4]	60.00	3,420.00
Comtech Satellite Modem CDM-500 [3]	5,000.00	2,85,000.00
Suman 3.0 meter Antenna[3]	8,500.00	4,84,500.00

Thus, the minimum total cost of the CPE will be
= US $(109.00 + 20.00 + 5,000.00 + 8,500.00) US $13,629.00 = Tk. 7,76,853.00
and the maximum total cost of the CPE will be
= US $(109.00 + 595.00 + 5,000.00 + 8,500.00) = US $14,204.00 = Tk. 8,09,628.00.

Recurring Charges of VSAT circuit per year is US $2,200.00 (Tk. 1,25,400.00) and the annual license fee is US $3,500.00 (= Tk. 1,99,500.00).

Thus, the user has to pay the annual total charge of US $(2,200.00 + 3,500.00)
= US $5,700.00 = Tk. 3,24,900.00.

Different types of costs associated with VSAT are listed as follows :

Different types of costs	Cost in US $	Cost in BD Taka
Minimum total CPE cost	13,629.00	7,76,853.00
Maximum total CPE cost	14,204.00	8,09,628.00
Annual total charge	5,700.00	3,24,900.00

Strengths

- VSATs require less space and less power, making them ideal for corporate voice and data networks.[6]
- VSAT connection is "always on" and doesn't tie up user's phone line.[1]
- Since, satellite transmission is not limited to a certain radius from a transmission tower, satellite wireless has the potential to reach many areas fixed wireless can't.[1]
- Since, satellite wireless does not rely on a network of wires and cables, it is a promising broadband solution for people in rural areas that aren't served by cable or aren't able to get DSL access.[1]

Weaknesses

- The installation cost of VSAT is very expensive.
- The yearly charge of VSAT is quite expensive.
- If the user does not have a clear view of the sky (due to inclement weather) in the direction of the satellite, he/she will not be able to receive transmissions.[1]

- Because the signals are covering so much distance between the user, the satellite, and the ISP, there is also a bit of a delay in the transmissions (one-fourth of a second or less).[1]

References

[1] http://www.earthlink.net/blink/feb01/cover3.html
[2]http://www.3com.com/products/en_US/detail.jsp?tab=support&pathtype=purchase&sku=3C16790-US
[3] Mr. Shezad Husain (shezad_husain@bat.com)
[4] DSL For Dummies (Second Edition) — David Angell
[5] http://www.cisco.com/warp/public/cc/pd/fw/sqfw500/prodlit/px501_ds.htm
[6] Introduction to Communications — M. A. Rosengrant

Recommendation of the Technologies to be Deployed

The data that has to be transferred everyday to and from the tea gardens and head office is approximately 256.96 to 410.168 Kilobits. From the study done for all the telecommunications technologies available in Bangladesh, it can be seen that broadband technologies like DSL, Cable, and Satellite Wireless are too expensive and unnecessary for sending the above stated amount of data.

When speed is being considered, the lowest is that of mobiles provided by Grameen-Phone, Sheba Telecom, and AKTel; which provide a bandwidth of 9.6 Kbps. If data is transferred using one of these mobile phones, then it will take 40 to 60 seconds to transfer data each day. Thus, the charge of using the network will only be for that particular period.

The procedure for transferring data as far as I can perceive should be :

From the Tea Garden to the Head Office :

(i) The data entry clerk in the tea garden should insert data of that particular day in the tea garden computer while being off-line.
(ii) After all data has been entered, a button should be clicked which will connect the tea garden computer to the head office computer and transfer all the updates.
(iii) After all the data has been transferred, the data entry clerk should shut off the network.

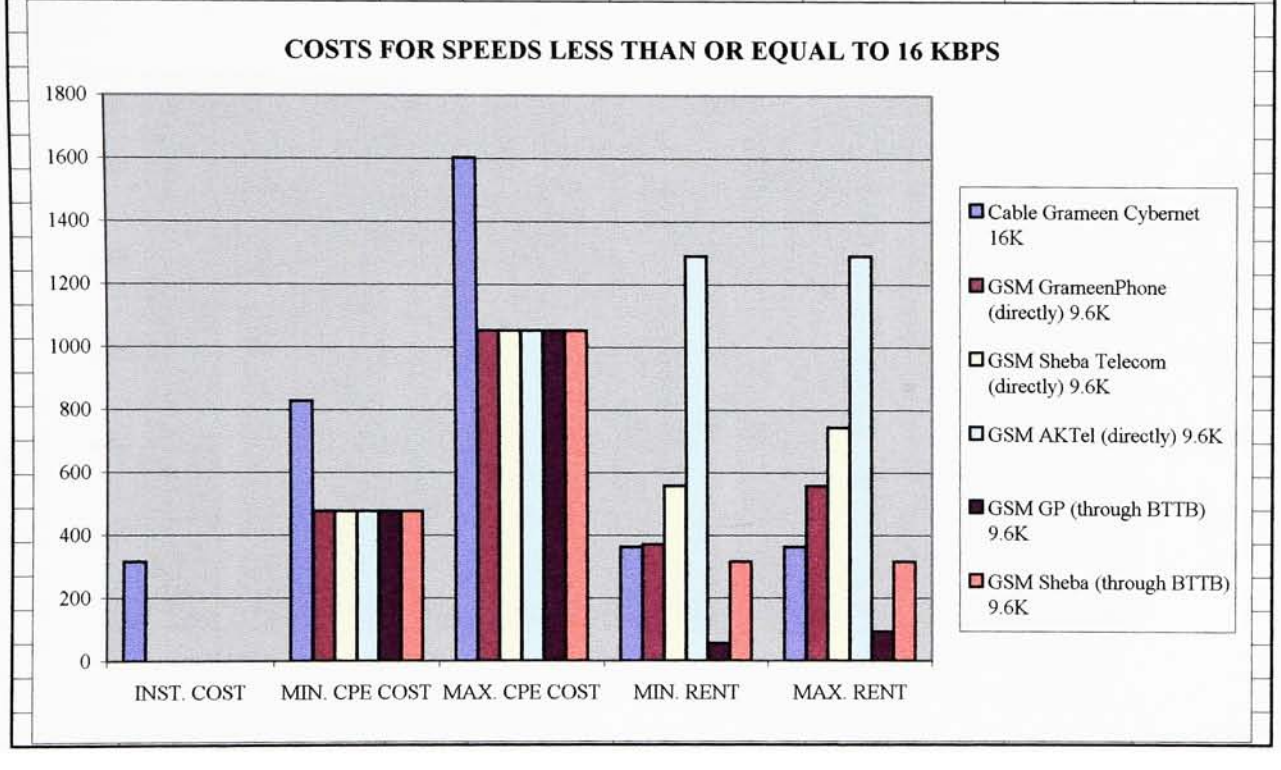
From the Head Office to the Tea Garden :

A valid user (e.g., Chairperson, Managing Director, Director, Secretary) should compose the necessary instructions and make queries, while staying off-line and then send the composed instruction/queries after establishing the connection with the network.

From the tea garden or the head office, the user can view the necessary data while being off-line, since the data are updated in those computers. If a valid user wants to view data from his/her home, then he/she has to connect the home computer with the tea garden or head office computer. So, at least the head office computer(s) should always be on (though not always connected to the network).

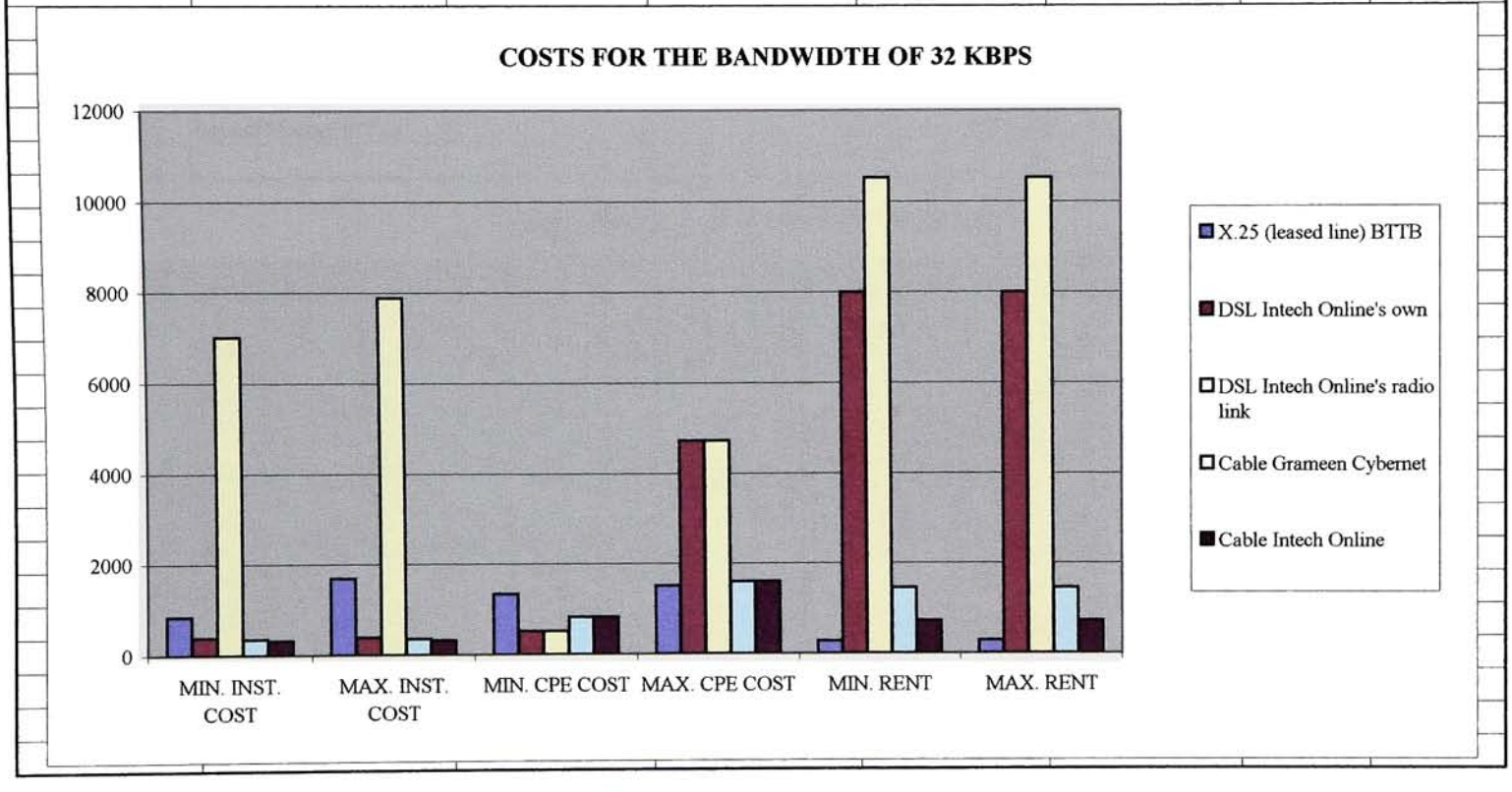
In **Graph#1,** it can be seen that the installation cost of Grameen Cybernet's cable connection is US $315.79, while there is no such installation cost for the GSM technology. The CPE cost of Grameen Cybernet's cable connection ranges from US $828.00 to US $1,603.00, while the CPE cost of GSM mobile phone ranges from US $478.00 to US $1053.00. The rental charge of Grameen Cybernet's cable connection is US $363.16 per year, whereas the rental charge of GrameenPhone's mobile connected through BTTB's dial-up line costs around US $55.84 to US $93.07 per year. It can be observed that all costs of GrameenPhone's moblie connected through BTTB are lowest in

COSTS	FOR SPEEDS LESS	THAN	OR EQUAL	TO 16 KBPS (I	N US $)		
TECH.	COMPANY'S NAME	SPEED	INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
Cable	Grameen Cybernet	16K	315.79	828	1603	363.16	363.16
GSM	GrameenPhone (directly)	9.6K	0	478	1053	372.26	558.39
GSM	Sheba Telecom (directly)	9.6K	0	478	1053	558.39	744.52
GSM	AKTel (directly)	9.6K	0	478	1053	1290.36	1290.36
GSM	GP (through BTTB)	9.6K	0	478	1053	55.84	93.07
GSM	Sheba (through BTTB)	9.6K	0	478	1053	316.42	316.42



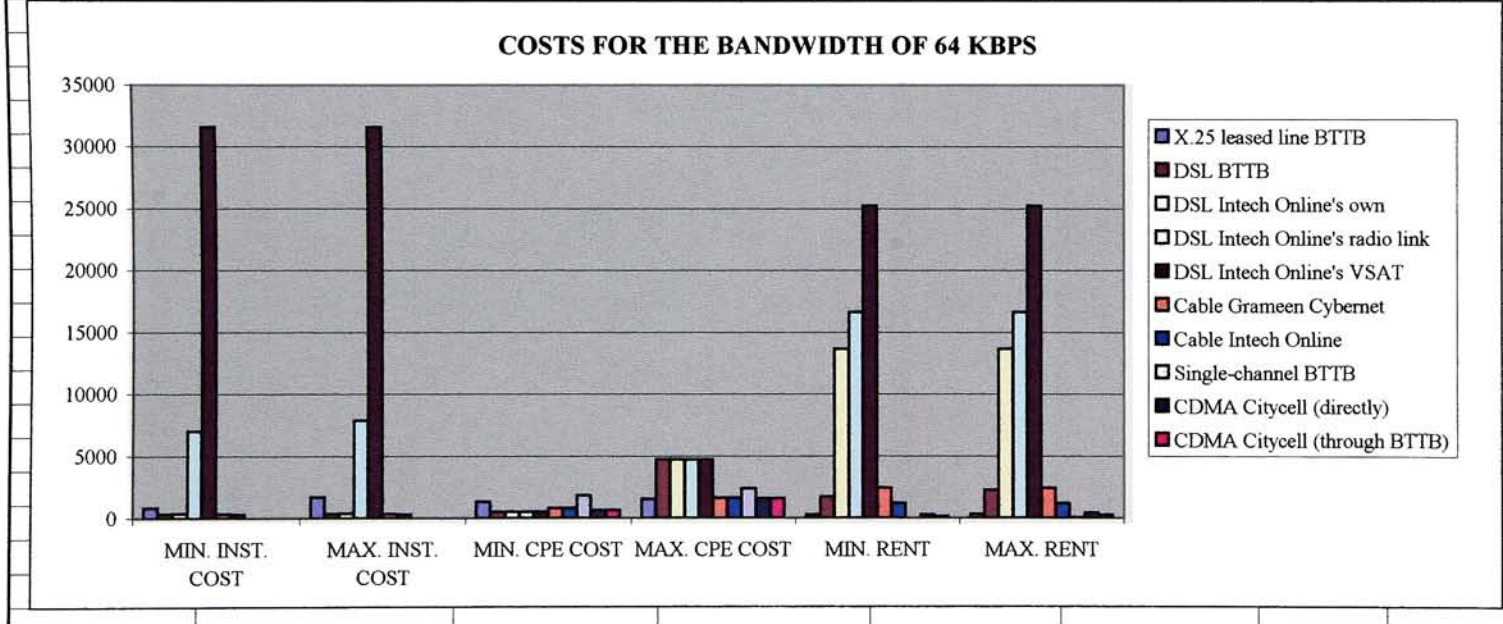
Graph#1

COSTS FOR	THE BANDWIDTH	OF 32 KBPS (IN	US $)				
TECHNOLOGY	COMPANY'S NAME	MIN. INST. COST	MAX. INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
X.25 (leased line)	BTTB	847	1694	1334	1512.51	270.14	280.61
DSL	Intech Online's own	390.25	390.25	519.25	4726.81	8000	8000
DSL	Intech Online's radio link	7017.54	7894.73	519.25	4726.81	10526.31	10526.31
Cable	Grameen Cybernet	350.88	350.88	828	1603	1452.63	1452.63
Cable	Intech Online	315.79	315.79	828	1603	726.32	726.32



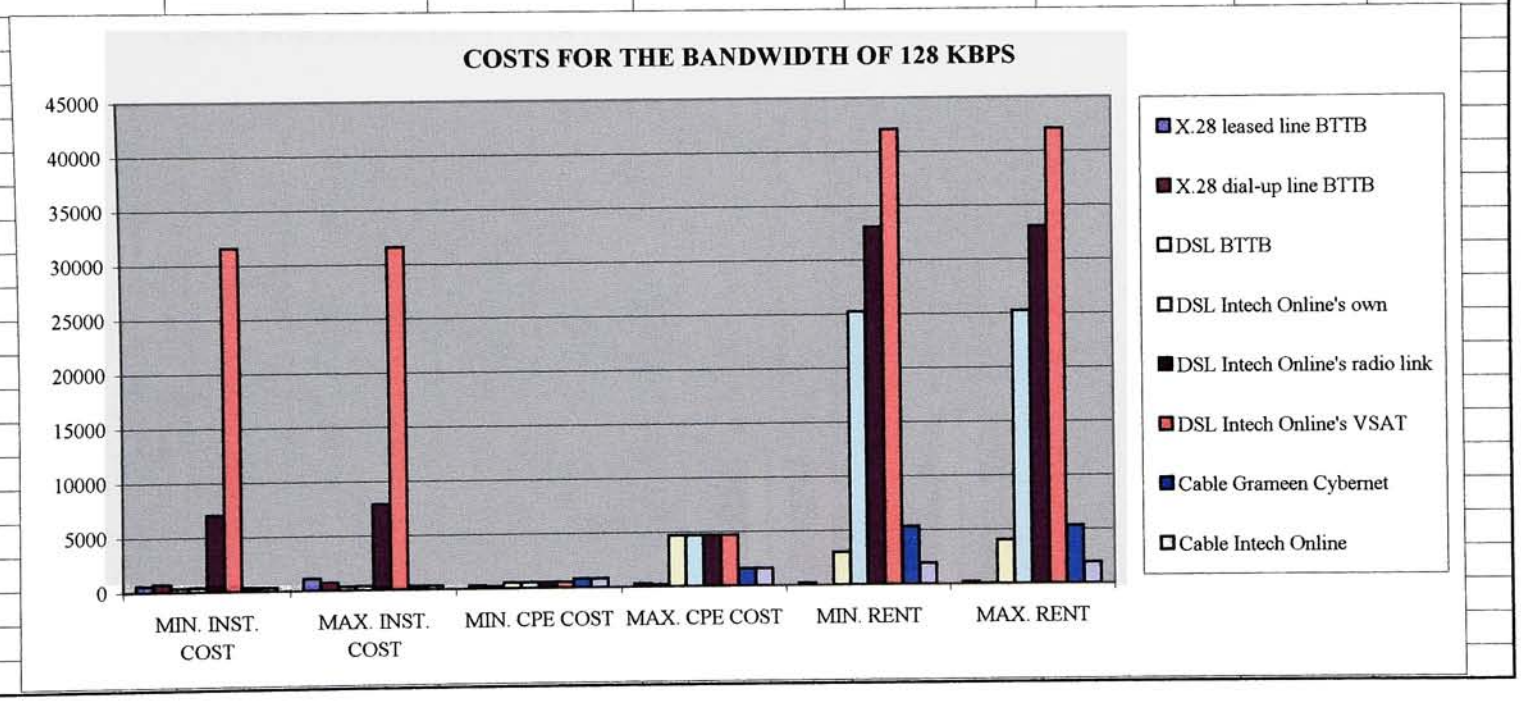
Graph#2

COSTS FOR	THE BANDWIDTH	OF 64 KBPS (IN	US $)				
TECHNOLOGY	COMPANY'S NAME	MIN. INST. COST	MAX. INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
X.25 leased line	BTTB	847	1694	1334	1512.51	270.14	280.61
DSL	BTTB	350.87	350.87	519.25	4726.81	1684.210526	2248.877193
DSL	Intech Online's own	390.25	390.25	519.25	4726.81	13684.21	13684.21
DSL	Intech Online's radio link	7017.54	7894.73	519.25	4726.81	16631.57	16631.57
DSL	Intech Online's VSAT	31578.94	31578.94	519.25	4726.81	25263.15	25263.15
Cable	Grameen Cybernet	350.88	350.88	828	1603	2421.05	2421.05
Cable	Intech Online	315.79	315.79	828	1603	1210.53	1210.53
Single-channel	BTTB	0	0	1824	2399	20.23	37.68
CDMA	Citycell (directly)	0	0	659.74	1,568.28	272.56	419.92
CDMA	Citycell (through BTTB)	0	0	659.74	1,568.28	110.62	257.99



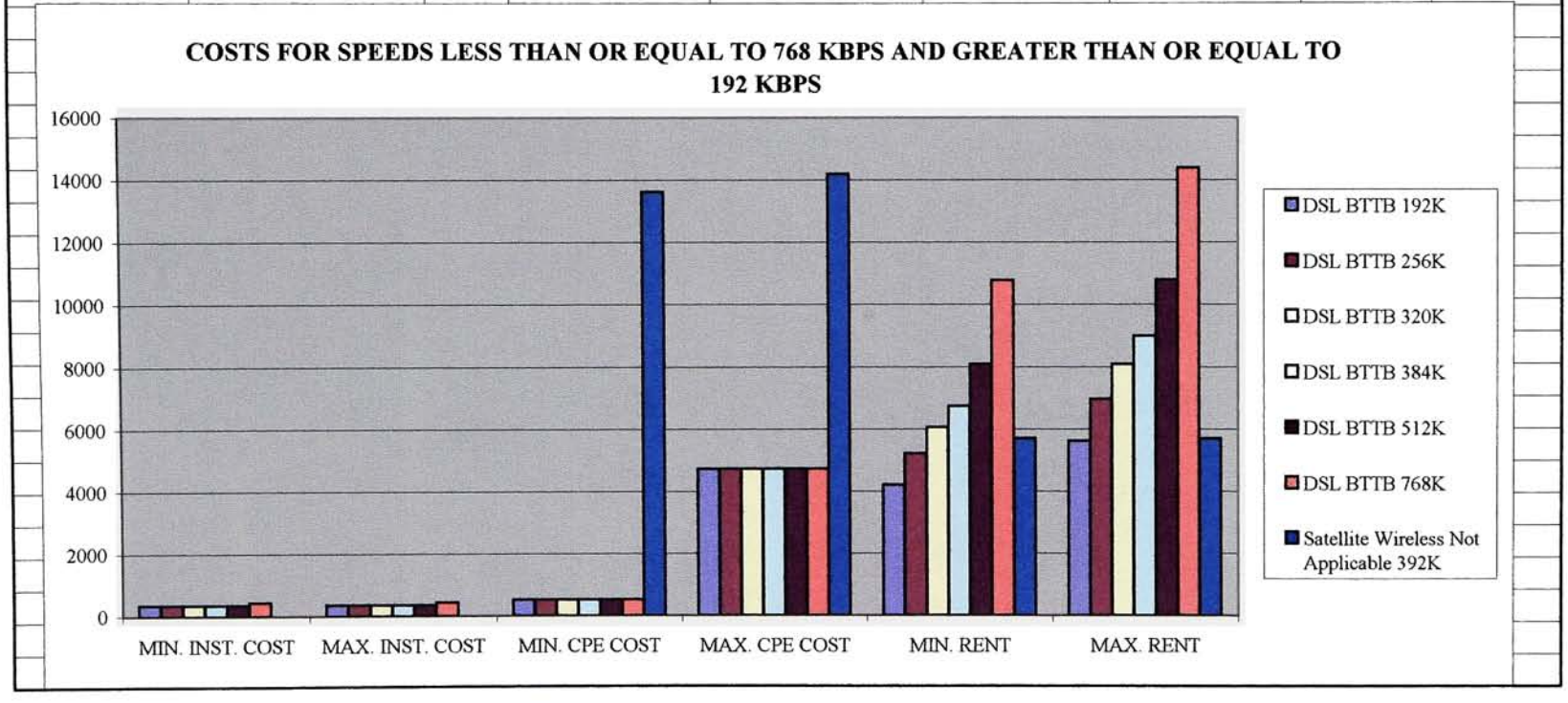
Graph#3

COSTS FOR	THE BANDWIDTH	OF 128 KBPS (I	N US $)				
TECHNOLOGY	COMPANY'S NAME	MIN. INST. COST	MAX. INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
X.28 leased line	BTTB	564.67	1129.33	306.95	306.95	182.42	192.89
X.28 dial-up line	BTTB	707.02	707.02	214.26	214.26	21.73	24.52
DSL	BTTB	350.87	350.87	519.25	4726.81	3031.578947	4047.978947
DSL	Intech Online's own	390.25	390.25	519.25	4726.81	25263.15	25263.15
DSL	Intech Online's radio link	7017.54	7894.73	519.25	4726.81	33052.63	33052.63
DSL	Intech Online's VSAT	31578.94	31578.94	519.25	4726.81	42105.26	42105.26
Cable	Grameen Cybernet	350.88	350.88	828	1603	5326.32	5326.32
Cable	Intech Online	315.79	315.79	828	1603	1936.84	1936.84



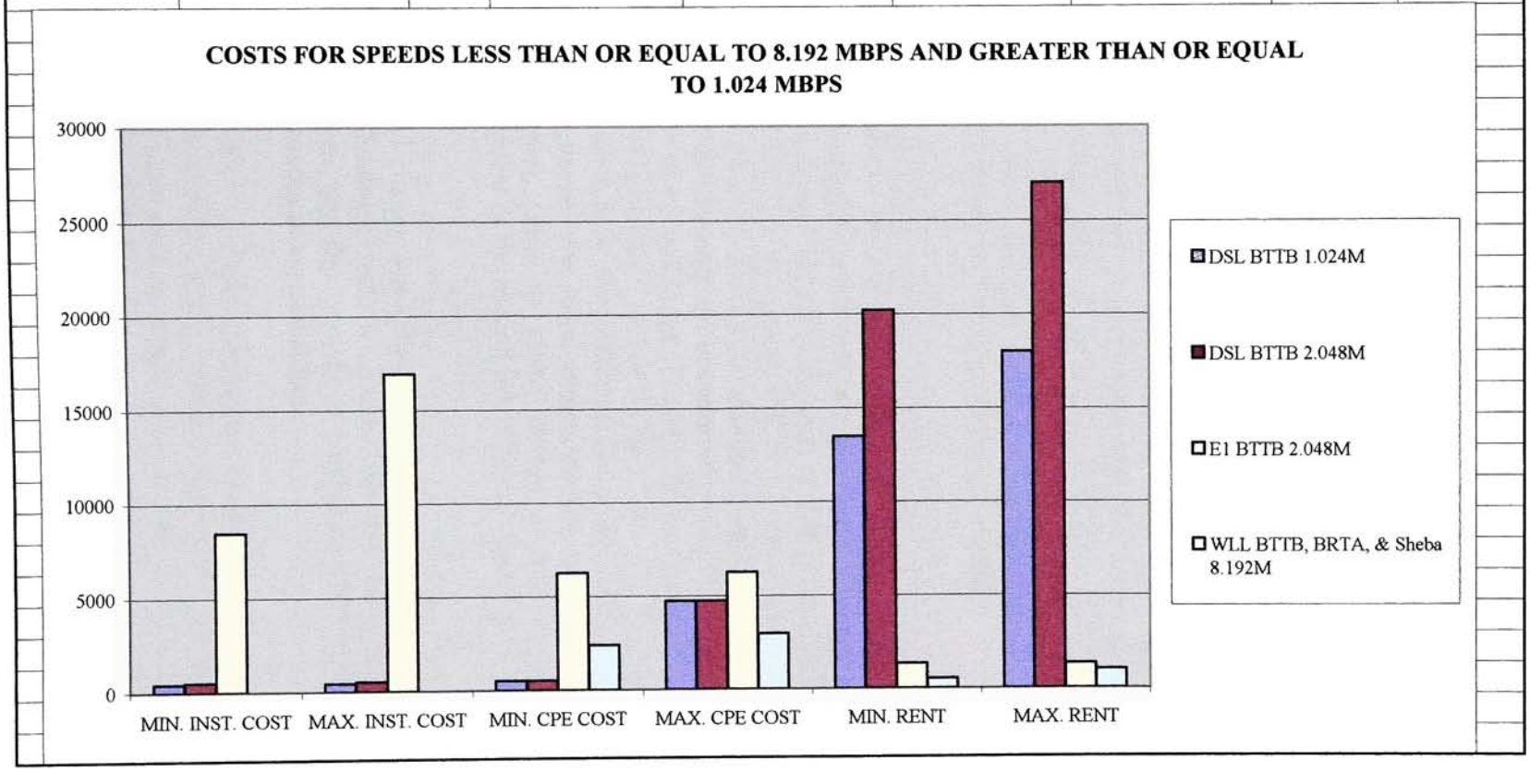
Graph#4

COSTS FOR	SPEEDS LESS THA	N OR	EQUAL TO 768K	BPS AND GREAT	ER THAN OR	EQUAL TO 192	KBPS (IN	US $)
TECHNOLOGY	COMPANY'S NAME	SPEED	MIN. INST. COST	MAX. INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
DSL	BTTB	192K	350.87	350.87	519.25	4726.81	4210.526316	5622.192982
DSL	BTTB	256K	350.87	350.87	519.25	4726.81	5221.052632	6971.519298
DSL	BTTB	320K	350.87	350.87	519.25	4726.81	6063.157895	8095.957895
DSL	BTTB	384K	350.87	350.87	519.25	4726.81	6736.842105	8995.508772
DSL	BTTB	512K	350.87	350.87	519.25	4726.81	8084.210526	10794.61053
DSL	BTTB	768K	438.59	438.59	519.25	4726.81	10778.94737	14392.81404
Satellite Wireless	Not Applicable	392K	0	0	13629	14204	5700	5700



Graph#5

COSTS FOR	SPEEDS LESS THA	N OR	EQUAL TO 8.19	MBPS AND GREA	TER THAN OR	EQUAL TO 1.024	MBPS (IN	US $)
TECHNOLOGY	COMPANY'S NAME	SPEED	MIN. INST. COST	MAX. INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
DSL	BTTB	1.024M	438.59	438.59	519.25	4726.81	13473.68421	17991.01754
DSL	BTTB	2.048M	526.31	526.31	519.25	4726.81	20210.52632	26986.52632
E1	BTTB	2.048M	8470	16940	6249.35	6249.35	1333.333333	1333.333333
WLL	BTTB, BRTA, & Sheba	8.192M	0	0	2397.79	2972.79	508.267	1016.51



Graph#6

this group and they are within the reach of individual tea planters. So, this is the only chosen technology in this group.

In **Graph#2,** it is seen that the rental charge of X.25 leased line ranges from US $270.14 to US $280.61 per year, which is the lowest in this group and also within the tea planter's budget. But, the CPE cost of X.25 leased line is the highest amongst this group and it ranges from US $1,334.00 to US $1,512.51. Also, the installation cost of X.25 leased line is the second highest in this group — ranging from US $847.00 to US $1,694.00. Since, installation and CPE costs are one-time charges and the rental charge has to pe paid annually, X.25 leased line can easily be chosen from this group.

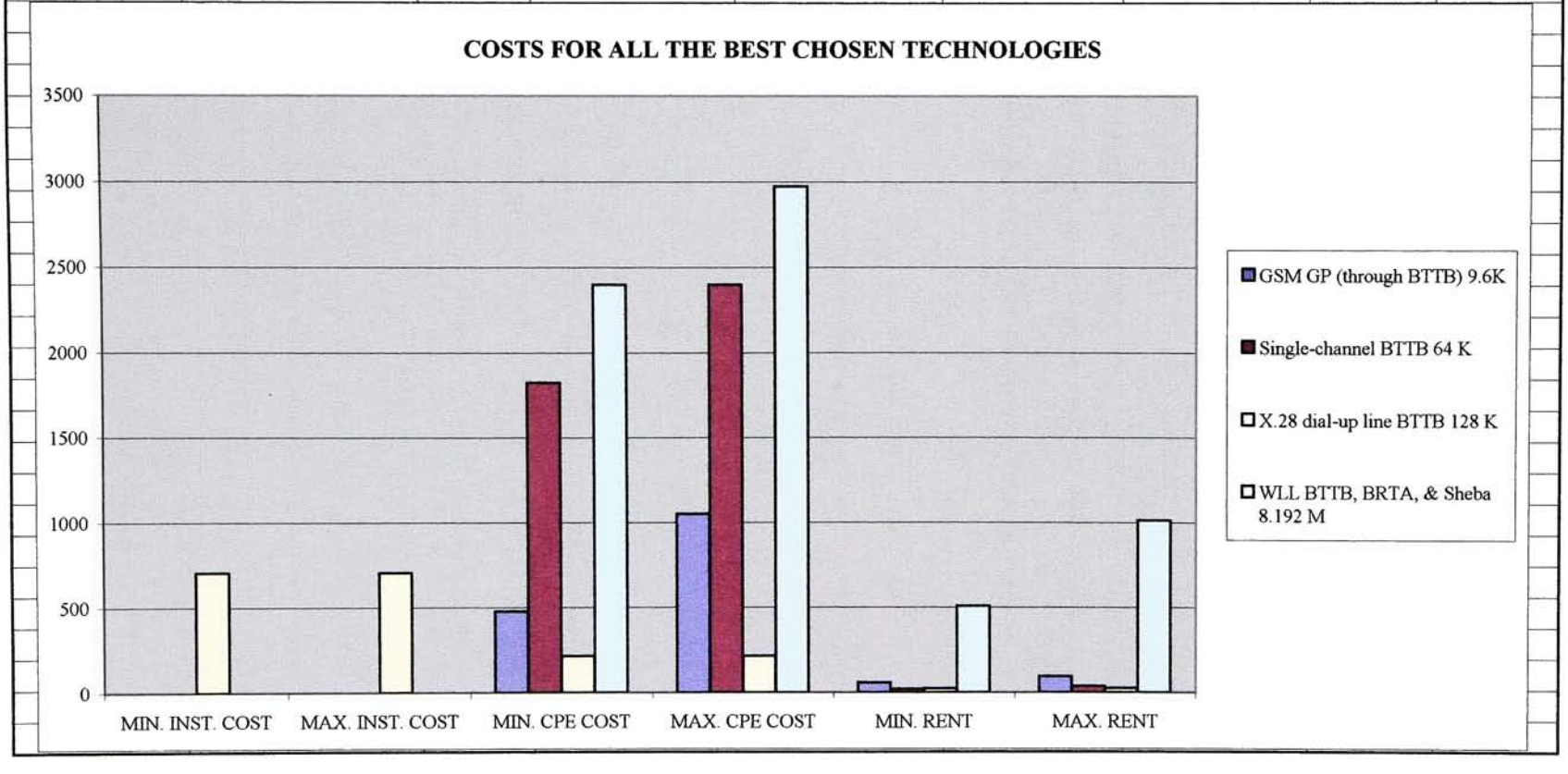
In **Graph#3,** all costs of X.25 leased line have been repeated, since the bandwidth of X.25 leased line ranges from 19.2 Kbps to 64 Kbps. Here, it can be seen that the rental charge of single-channel radio link is the lowest, ranging from US $20.23 to US $37.64 per year and there is no installation cost of single-channel radio link. Though, the minimum CPE cost of single-channel radio link is the highest (US $1,824.00), the maximum CPE cost of single-channel radio link is the second highest (US $2,399.00). Since, the CPE cost is a one-time charge, there is no installation cost of single-channel radio link and its rental charge per year is the lowest. Therefore, single-channel radio link can be chosen over X.25 leased line, which was recommended in **Graph#2.**

In **Graph#4,** it can be seen that the rental charge of X.28 dial-up line is the lowest — ranging from US $21.73 to US $24.52 and the rental charge of X.28 leased line is the second lowest in this group — ranging from US $182.42 to US $192.89 per year. The CPE cost of X.28 dial-up line is the lowest (US $214.26) and the CPE cost of X.28 leased line is the second lowest (US $306.95) in this group. But, the installation cost of X.28 leased line (ranging from US $564.67 to US $1,129.33) is higher than the installation cost of BTTB's DSL, which is US $350.87. Though, the installation cost of X.28 leased line is not the highest in this group, it falls in the mid range. The installation cost of X.28 dial-up line (US $707.02) is higher than the installation cost of BTTB's DSL (US $350.87). Also, the installtion cost X.28 dial-up line falls in the middle in this group. Since, installation and CPE costs are one-time charges and the rental chages are recurring charges, X.28 dial-up line can easily be chosen, since its rental charge is the lowest and is approximately 11 percent to 12 percent of the second lowest rental charge (i.e., the rental charge of X.28 leased line).

In **Graph#5,** we see that all rental charges are within the range of US $4,210.53 to US $14,392.81. So, one of these technologies can ba chosen from this group, since these rental charges are recurring charges and this amount of bandwidth (192 Kbps to 768 Kbps) is not required for the networking of tea plantation.

In **Graph#6,** it can be seen that WLL provides the highest bandwidth, which is 8.192 Mbps, there is no installation cost of WLL, and its rental charge is the lowest, ranging from US $508.267 to US $1,016.51 per year. Although, the CPE cost of WLL falls in the middle in this group (ranging from US $2,397.79 to US $2,972.79), th CPE cost is a one-time chage and the rental charge is the recurring one. So, WLL can easily be chosen from

COSTS FOR	ALL THE BEST	CHOSEN	TECHNOLOGIES	TO BE DEPLOYE	D (IN US $)			
TECHNOLOGY	COMPANY'S NAME	SPEED	MIN. INST. COST	MAX. INST. COST	MIN. CPE COST	MAX. CPE COST	MIN. RENT	MAX. RENT
GSM	GP (through BTTB)	9.6K	0	0	478	1053	55.84	93.07
Single-channel	BTTB	64 K	0	0	1824	2399	20.23	37.68
X.28 dial-up line	BTTB	128 K	707.02	707.02	214.26	214.26	21.73	24.52
WLL	BTTB, BRTA, & Sheba	8.192 M	0	0	2397.79	2972.79	508.267	1016.51



Graph#7

this group, since there is no installation cost of WLL and its rental charge is the lowest in this group.

In **Graph#7,** I have chosen all the affordable technologies and also which have the bandwidth for transferring data of the tea plantation. These figures are chosen from Graphs #1, #3, #4, and #6. Here, we see that the minimum rental charge of single-channel radio link is the lowest (US $20.23) and the minimum rental charge of X.28 dial-up line is the second lowest (US $21.73). The maximum rental charge of X.28 dial-up line is the lowest (US $24.52) and the maximum rental charge of single-channel radio link is the second lowest (US $37.68). Though, there is no installation cost of single-channel radio link and the installation cost of X.28 dial-up line is US $707.02, the CPE cost of single-channel radio link is the second highest (ranging from US $1,824.00 to US $2,399.00) and the CPE cost of X.28 dial-up line is US $214.26, which is the lowest CPE cost in this group. The installation cost plus the CPE cost of single-channel radio link ranges from US $1,824.00 to US $2,399.00. Also, the user has to pay the minimum of US $600.00 for an encryption program if he/she wants to use single-channel radio link, since airwaves are shared resources and the data can be hacked during its journey. The installation cost plus the CPE cost of X.28 dial-up line is US $921.28, which is lower compared to the single-channel radio link. So, X.28 dial-up line can easily be chosen from this group.

Conclusion

Availing of the telecommunication technologies in Bangladesh makes data transfer faster to and from the tea gardens and the head office — hence supervising the tea gardens from a distance (i.e., the head office) becomes much easier and more efficient. Instructions to the tea gardens can be sent on a daily basis and the daily operational information from the tea gardens can be sent to the head office as a form of database files.

Carrying information of operations in the tea garden once a week (more, in case of emergencies) to the head office and then carrying back instructions, money draft for the garden expenditure from the head office to the tea garden are done by messengers. They make the journey partially in cycle rickshaws (three wheelers), change buses, and change trains — before finally reaching their destination. This is a slow, outdated, tedious, and sometimes hazardous means of commuting, which dates back nearer to the time, when tea gardens first came into existence, way back in the 19th century in the Indian Sub-Continent.

Telecommuting certainly involves a certain amount of expenditure — installation costs, CPE charges, rental charges, etc.. However, sending a messenger too involves costs — transportation, boarding, and lodging whilst in the city where the head office is situated. In order to keep abreast with the changing scenario, in my humble opinion, I feel that telecommunicating for data transfer should be adopted by all tea planters.

Telecommunicating will help the tea gardens become more productive — fast instructions to be followed for carrying out regular tasks or during any disruption of work like factory machine breakdowns, pests, labor problems, etc., messages can be sent to head offices, where decisions can be made and instructions can be sent off almost immediately for dealing with such situations.

Maximum tea production will boost up the tea industry. Tea is a cash crop bringing in foreign exchange. A profitable tea industry will be a major thrust towards the upliftment of the country and its economy. Thus, telecommunications will go a long way in the enhancement of this agro-based labor-intensive industry.

APPENDICES

X.25

Introduction

In the late 1960s and early 1970s, organizations did not have to adhere to any common conventions for their data communications protocols, since individual organizations provided services exclusively to itself by their private networks. The organizations satisfied their requirements by using specialized protocols in their networks. Thus, many companies/government agencies/organizations created their own data communications.

It was during this time various companies and telephone administrations in the U.S., Canada, and Europe implemented public data networks with the conception of providing a data traffic service paralleling the voice traffic of the telephone system. Public packet networks (PPN), public packet switched networks (PPSN), and packet switched data networks (PSDN) are the names by which they are known. This is primarily the reason for the coming about of X.25. People, specially the network owners, working on these nascent networks saw the need for a common network interface protocol. The impetus and direction of many telecommunications organizations, specially the European telecommunication administrations developed X.25. The original document was based on proposals from three new packet-switching networks — Datapac (Canada), Tymnet and Telenet (U.S.).

X.25 is called the X.25 Recommendation by CCITT *(Comité Consultatif International Télégraphique et Téléphonique)/(International Consultative Committee for Telegraphy and Telephony)*. The first publication was in 1974 and the first draft of X.25 was issued by CCITT (known as the "Gray Book"). Further revisions were made in 1976, 1978, 1980, and 1984 with the "Red Book" Recommendation publication. X.25 was revised and republished every four years till 1988. The recommended standard has been expanded to cover many options, services, and facilities, since its inception. Presently, X.25 is the prevalent interface standard to wide area packet networks.

X.25 Configurations

Procedures for exchanging data between a user device, identified as data terminal equipment (DTE), and a network node, identified as data circuit terminating equipment (DCE).

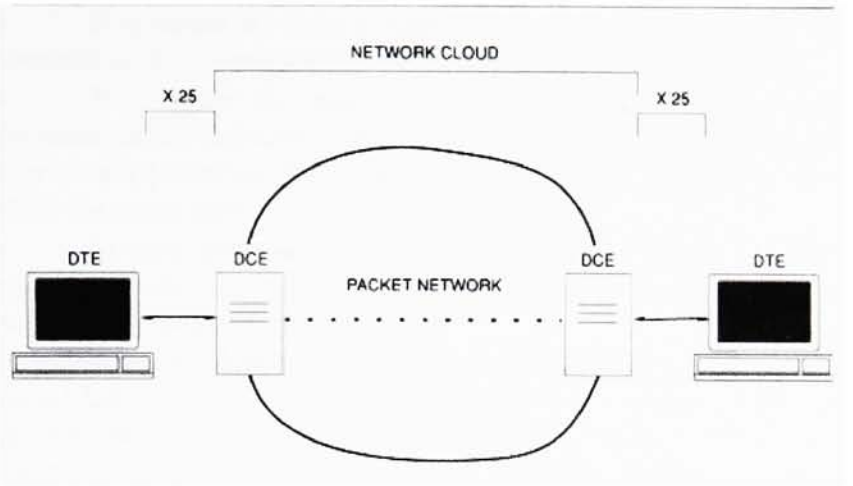


Figure 1.1 : The X.25 Interface and the Packet Network

All DCE operations cited in X.25 are not performed by DCE. These operations are performed by a network packet switch, making them available at the DTE-DCE interface. Provision of common procedures between a user DTE and a packet network DCE in order to establish a network connection, exchanging data with another DTE, and releasing the connection is the main idea of the X.25 Recommendation. Functions like identifying the packets of specific user terminals or computers (with logical channel numbers or LCNs) acknowledging/rejecting packets, error recovery provision and flow control are all included in the procedures. Inclusion of useful facilities like charging the transmitted packets to the receiving DTE than the transmitting DTE are done by X.25.

There are no routing algorithms in X.25 Recommendations. Fixed or dynamic packet-switching schemes are features within a network and are left to specific vendor implementations, since they are internal to a vendor's product. "X.25 network" means the interface to a packet data network is governed by the X.25 protocol. Several networks use the recommendation for defining certain operations between the packet nodes within the network cloud.[1]

Advantages and disadvantages of using X.25

Like any other communications protocol, X.25 has its advantages and disadvantages.

Advantages :

- Since a common standard is adopted among vendors, provision of an easy way to interface different vendors' products is possible.[1]
- X.25 standard is relatively mature, having gone through numerous revisions. In 1976, several systems were implemented and since 1980, its use has been considerable. Changes and adaptations in the 1988 document show sufficient industry-wide experience with packet network interfaces.[1]
- X.25 can decrease network costs, since off-the-shelf software and hardware are readily available.[1]

- It is easier to write a request-for-proposal to a vendor stating the network must conform to X.25 than writing a lengthy specification document.[1]
- X.25 gives the user a virtual high quality digital network at low cost. It is economical for the same reason that it is usually cheaper to use the mail than to run the user's own postal service : there are tremendous savings to be made if multiple parties share the same infrastructure.[2]
- In most parts of the world, X.25 is paid for by a monthly connect fee plus packet charges. There is usually no holding charge, making X.25 ideal for organizations that need to be online all the time.[2]
- A transmission link using conventional line protocols (for example, High Level Data Link Control or HDLC) provides for error recovery and data accountability only on one link between the DTE and the network (and perhaps on the links between the packet-switching nodes within the network). X.25 provides a higher level of support by defining many operations that enhance the reliability of data transfer between each sending DTE and its DCE (the entrance packet node to the network) and each receiving DTE and its DCE (the exit packet node from the network). More end-to-end support is given than a link protocol like HDLC.[1]

Many systems use X.25 as a DTE-to-DCE interface. Others use it to manage such resources as peripheral devices, applications programs, databases, and even the "windows" on a workstation CRT screen. Though X.25 was not written for a non-DCE interface, the industry has adapted it as such, because of its availability, offering of numerous functions supporting a user-network connection.[1]

X.25, a widely used convention for network connection enables communication between different vendors' equipment (if they all use the convention). This, however, does not mean that equipment made by different manufacturers can exchange meaningful information. Levels of protocol besides X.25 are required for end-to-end communication.[1]

Disadvantages :

- There is an inherent delay caused by the store-and-forward mechanism. On most single networks, the turnaround delay is about 0.6 seconds. This has no effect on large block transfers, but in flip-flop types of transmissions, the delay can be very noticeable.[3]
- The four-year revision cycle for X.25 make people feel that it has been too frequent for achieving stability in communications product lines. Some manufacturers opine that the increasing number of functions and services being written into X.25 makes it too large and complex for effective and efficient use.[1]
- It is not well-suited to certain environments — transaction-based, point-of-sale applications.[1]

Logical Channels and Virtual Circuits

Statistical time-division multiplexing is used by X.25 DCEs and DTEs to transfer the users' traffic into and out of the network.

For multiplexing, multiple user sessions into a single communications line is the joint responsibility of the DTE and the network — instead of using dedicated one line to each user, the DTE and DCE interleaves the multiple users' bursty traffic across an X.25 interface (the interface is between the DTE and the DCE). Although, the user perceives that a line is dedicated to his/her application, it is being shared with other users.

One aspect of an important feature of X.25 is called the virtual circuit. It is the multiplexing of more than one user onto the physical communications line.

Virtual circuit is the end-to-end connection or relationship (through a network) between two user devices (DTEs). Since intermediate packet switches are used to route the data through the network, the virtual circuit usually consists of multiple physical circuits between the switches, which collectively make up the virtual circuit. The network is responsible for maintaining the end-to-end connection of the users.

X.25 uses the term *logical channel* to describe one aspect of this concept.

Logical channel is the local connection between the user device and the packet exchange. The logical channel has significance only at the DTE and DCE interface on *each* side of the network. Therefore, a logical channel exists on each side of the network cloud. The network *maps* the two logical channels to a virtual circuit.

Switching and Routing in Networks

There are many networks which have hundreds of computers and terminals which communicate with each other. Since, a computer or terminal cannot have a direct (point-to-point) connection to every other component, placing **switches** on the transmission path is the solution. The user stations communicate with each other by sending data through a switch (or set of switches). The data is relayed by the switch to the receiving computer terminal, telephone, or some other components.

A data communications switching system uses one or a combination of the following switches (X.25 is used in the first and third types of networks) : *circuit switches, message switches,* and *packet switches.*

Circuit Switches

In a circuit-switching technology, a **direct** connection is created through the switches residing between the communicating stations. It was designed originally for voice traffic, which needed a dedicated line for conversation between two people. The two users do not have direct wires through a circuit-switched network, but the intervening switches have electronic connectors that "couple" the communications links directly to each other.

Message Switches

Message switching is designed mainly for data traffic. Like circuit switching, the communications lines are connected to a switching facility. However, there is no direct physical connection between end users. The message is transmitted to the switch, and stored on direct access media (such as disk) for delivering at a later time. The term *store-and-forward* is associated with message-switching networks.

Packet Switches

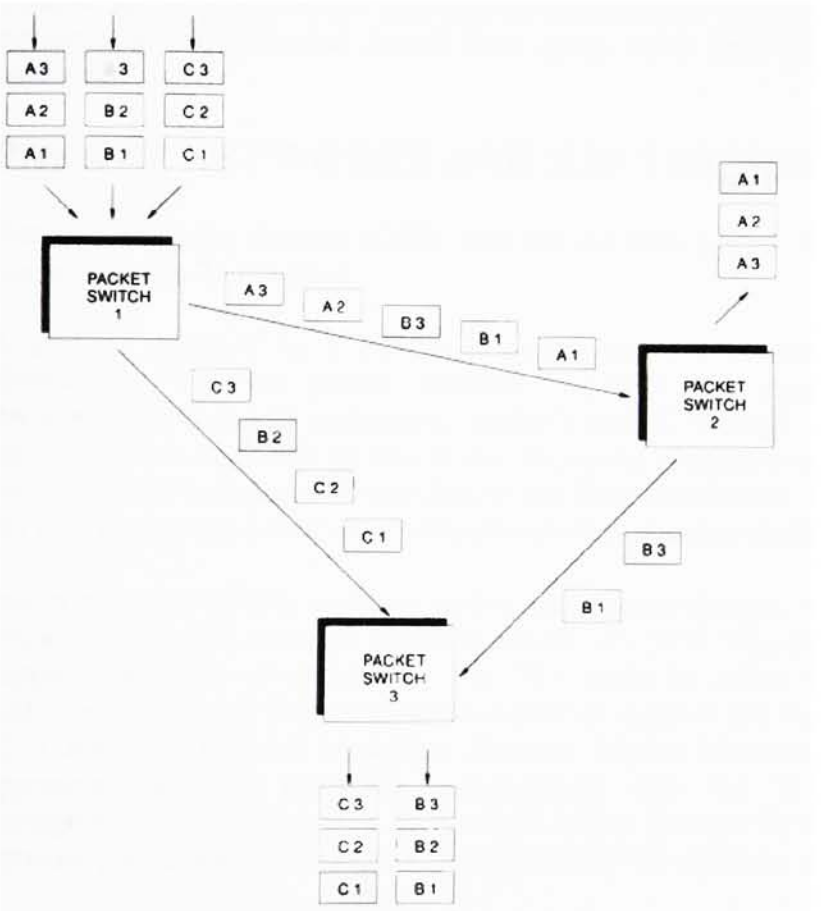


Figure 1.3: Packet Switching Networks

The prevalent switching technique for data communications networks is packet switching. It is used in private branch exchanges (PBXs), local area networks (LANs), and even multiplexers. The name packet switching has been given since users' data (messages) are separated and transmitted in small units called **packet**. The transmission line is only occupied by each packet only for the duration of transmission. There are limitations on packet size so that occupation of the line by packets for a long time can be avoided.

Multiple routes are used in packet-switched networks. Routing of packets across the paths are done depending on traffic congestion, error conditions, the shortest end-to-end path, etc..

Topology the packet network is different from that of message switching. (i) Packet-switched networks use more switches, thus traffic load is distributed to other switchs. (ii) Attaching three or more lines to switches enables the network to route the packets around failed or busy switches and lines. Thus, a user has access to better availability/reliability in a packet-switched network rather than a message-switched network.

Time to set up a connection may take several seconds in a circuit-switched (telephone) system. Use of dedicated leased lines gives users immdiate availability in packet switching.

PACKET NETWORKS AND X.25 TERMINOLOGY

Between the user devices (DTE) and the network packet exchange (DCE) lies the conventional X.25 interface.

A network interface for a DTE is provided with a PAD function (packet assembly / disassembly) by the packet network. Devices like asynchronous terminals or asynchronous personal computers, sophisticated X.25 logic needed for the network interface is not supported by user DTEs. So, by the placement of the data inside the X.25 packet, a PAD transports the user data to and from the network. Because of this approach, the user device can use its own protocols which is usually simpler and cost-effective.

Interconnection of two or more packet networks/exchanges, supporting the end users session, is another network interface option. An STE (Signaling Terminal Exchange) supports this type of connection. The STE could be (often is) a packet switch with additional software. This software is coded to support the X.75 recommendation. An X.25 interface with an Integrated Services Digital Network (ISDN) is yet another approach. The two networks communicate with the X.31 protocol, with this configuration. The connection of the X.25 station through the ISDN node to the packet network (called a packet handler), is supported by the interface device.

X.25 systems are designed to be used on a non-switched, dedicated channel (between the DTE and the network). For users needing a dial-in capability into the network, the X.32 Recommendation is available. Specification of a procedure for authenticating the user to the network, before the X.25 session begins.

The following figure shows another specification defining a protocol for using X.25 on LANs, the ISO 8881 standard. It uses an IWU (internetworking unit) providing a gateway between LAN, the X.25 station and another local network or X.25 node.

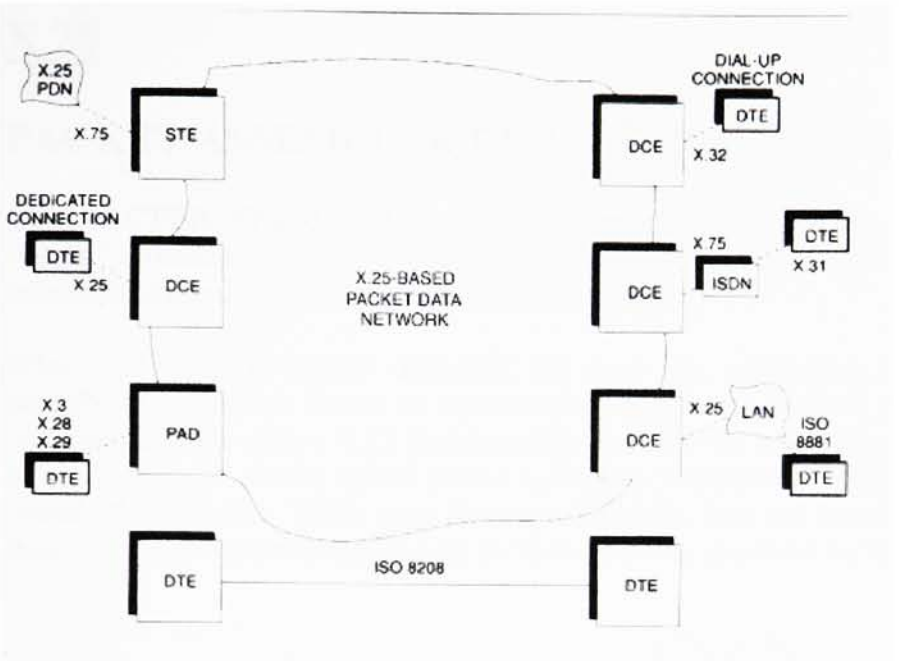


Figure 1.4 : X.25 Interface Options

X.25 is now used in many non-network interfaces, e.g., direct DTE-to-DTE communications are presently common. The ISO 8208 standard defines the procedures for using X.25 in non-network interface. The above figure and the following list of terminologies gives a summary of the major packet network interface support devices :

- *PAD (packet assembly/disassembly)* : Provides packet network interface support to DTEs that have no packet logic. Uses the X.3, X.28, and X.29 specifications.
- *STE (signaling terminal exchange)* : Provides packet network interface support to DTEs in other packet networks or between packet exchanges. Uses the X.75 specification.
- *Packet Handler* : Provides a gateway between an X.25 station through an ISDN node to an X.25 network. Uses the X.31 standard.
- *DCE (data circuit-terminating equipment)* : Provides packet network interface support to DTEs with full packet logic capabilities. Uses the X.25 specification. May also use X.32 for an X.25 dial-up port.
- *IWU (internetworking unit)* : Provides gateway functions between X.25 and local area networks. Uses the ISO 8881 specification.[1]

[1] X.25 and Related Protocols — Uyless Black

[2] http://www.ssuet.edu.pk/taimoor/athar/ce-5101/x25/sld043.htm

[3] http://www.ssuet.edu.pk/taimoor/athar/ce-5101/x25/sld044.htm

X.28

PACKET ASSEMBLER/DISASSEMBLER (PAD)

CHARACTER TERMINALS : Simple computer terminals are often referred to as "dumb" terminals, as they have no local intelligence. They are also known as character terminals, since they transmit one character at a time.

When X.25 was originally designed, the goal was connecting remote terminals to mainframe computers. Since, an asynchronous dumb terminal was not smart enough for implementing the entire X.25 functionality, the need for connecting these device to the network arose. A device called packet assembler/disassembler (PAD) was developed to remedy this situation. PADs were developed to buffer data and perform packet assembly / disassembly for communications on an X.25 network, as shown in Figure 2.0(a).

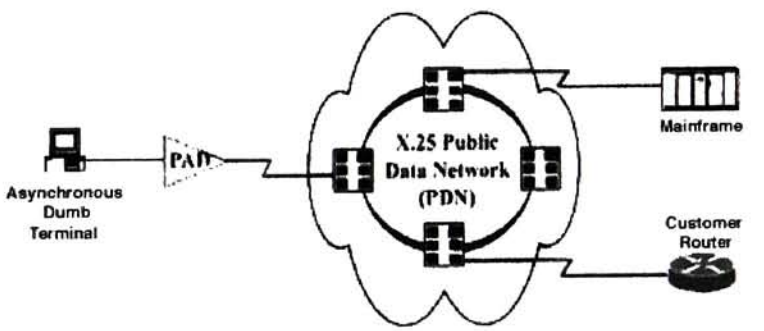


Figure 2.0 (a) : An example of a PAD in an X.25 network.

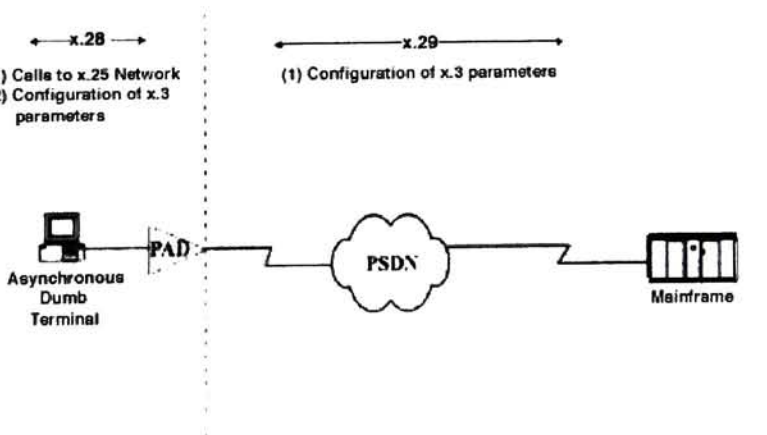


Figure 2.0 (b) : X.28 and X.29.

When a dumb terminal sends a packet to the PAD, the PAD adds the appropriate header and then sends it to the DCE device. Incoming packets have the X.25 information stripped off by the PAD and sent to the appropriate asynchronous dumb terminal. X.3 is

the protocol defining the operation/role of the PAD in support of asynchronous dumb terminals.

There are two other protocols used with a PAD supporting X.3. X.28 protocol specifies the user interface between the asynchronous terminal and the PAD. This enables users to access X.25 networks or set PAD parameters. X.29 is a protocol only defining how to set the X.3 parameters from a remote X.25 host. This could be analogous to teleneting into a remote router to modify its configuration. Figure 2.0(b) shows us the relationship between X.28 and X.29.[1]

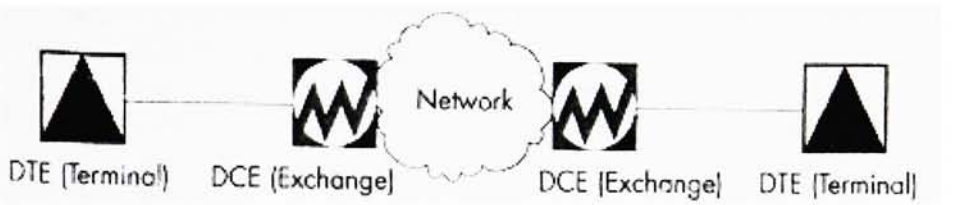


Figure 2.1 : A simple network diagram assuming that the DTE is capable of working in the packet mode

In figure 2.2, we can see another a situation where a character terminal is able to access a packet-switched network using the PAD as an access medium. In this example, the character terminal is transmitting the message, "The quick brown fox..." to the PAD. The PAD assembles the individual character into a packet before transmitting it across the X.25 interface. This PAD also receives data in packets from the far end, disassembles each packet into individual characters before transmitting them to the character terminal.

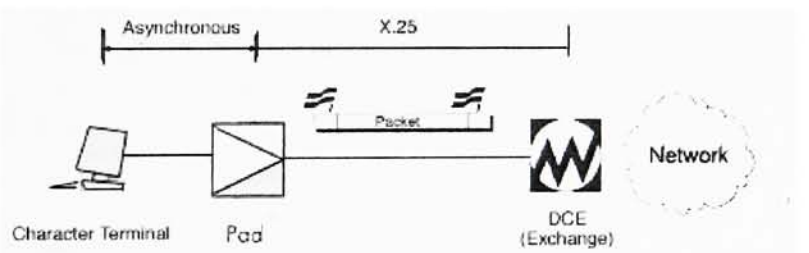


Figure 2.2 : A character terminal can access a packet-switched network by using a packet assembler/disassembler as a protocol converter.

PADs that only serve one character terminal can be bought smaller pads usually have 4, 8, 16, or even terminal connections available, sharing the same X.25 communication link. In figure 2.3, eight terminals sharing the same PAD is shown. Here, the PAD is serving eight dumb terminals simultaneously.

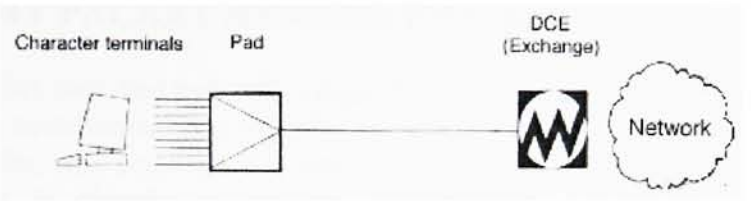


Figure 2.3 : PADs will usually support several dumb terminals, using mutiplexing techniques to allow the terminals to share thhe same X.25 interface

PACKET ASSEMBLER/DISASSEMBLER ARCHITECTURE : A PAD could be a communications computer presenting itself as a PAD. It does not have to be a component such as a box, filled with electronic components. A good example is a production of Tandem "midi-computer" can be connected to the X.25 interface running a program called X.3 PAD providing all the functions required in order to comply with the CCITT recommendation.

It is also possible to buy PADs in the form of small "stand-alone" boxes acting similarly to a conventional protocol converter. These "stand-alone" PADs are examples of the progress made in the recent years, enabling miniaturization and cost-effectiveness of computer components. These PADs are computers in their own right, having a microprocessor, memory, peripheral chips to handle X.25 and character terminal interfaces.

DIAL-UP PACKET ASSEMBLER/DISASSEMBLER

A frequently encountered situation is shown in figure 2.4. Here, even without a dedicated PAD, the user can access the network via a modem, that calls another modem, connected to a PAD on the network. Travellers find this a real boon as they canuse a laptop and access the network.

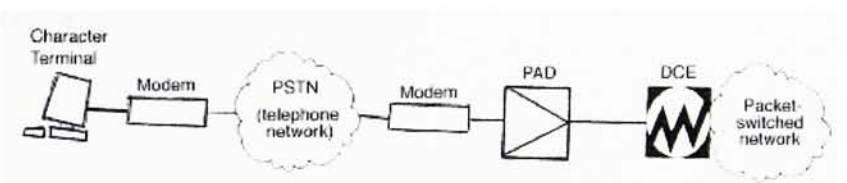


Figure 2.4 : Dial-up access to a network. this service is frequently found on public packet-switched networks.

A character terminal can be a PC operating in terminal mode or a large computer system that acts as the terminal mode.

WHY PACKET ASSEMBLERS/DISASSEMBLERS ARE USED

Packet-switched networks coupled with X.25 recommendations virtually guarantee error-free communications virtually guarantee error-free communications using a vast range of media, e.g., satellites, microwave, fiber optic, and telephone cables. A PAD enables the user to cheaply access this sophisticated network by using inexpensive terminal equipment.

The PAD does the following work :

1. Establishing a link with the packet-switched network.
2. Maintaining the link.
3. Assembling and disassembling packets.
4. Communicating with the character terminal.
5. Handling special control processes for the character terminal.

PACKET ASSEMBLER/DISASSEMBLER STANDARDS—"TRIPLEX" & "IA5"
A character transmitted and received by the PAD must conform to the International Number 5 (IA5) or ASCII — a 7-bit binary code to which a parity bit is added. There has to be a standard in the communications world in some form for a task to be completed. The CCITT has produced PAD standards. In 1977, provisional recommendations were published and the formal release was in 1980. The "Triple X" recommendations that affect PAD are X.3, X.28, and X.29.

RECOMMENDATION X.28

Recommendation X.28 defines the procedures used by a terminal to access the services of a PAD that is attached theoretically to a public data network.

The control procedures used to establish the physical connection to the PAD commands that the user sends to the PAD and the service signals sent by the PAD to the terminal user. If a PAD is accessed via a telephone network by the user as in figure 2.4, the X.28 protocol requires that a network user identification (NUI) code is entered by the user. This is for billing and accounting.

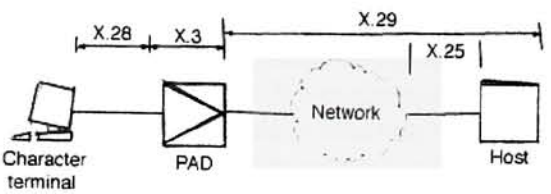


Figure 2.5 : Three recommendations are employed when a PAD is connected to a packet-switched network. These are usually known as the Triple X recommendations.

THE PHYSICAL CONNECTION : In figure 2.6, we see that X.28 specifies V.24 and V.28 (RS-232) for dial-up and X.20 is a leased line exists between the character terminal and the PAD. X.28 defines the protocol that is used for the exchange of characters between the character terminal and the PAD.

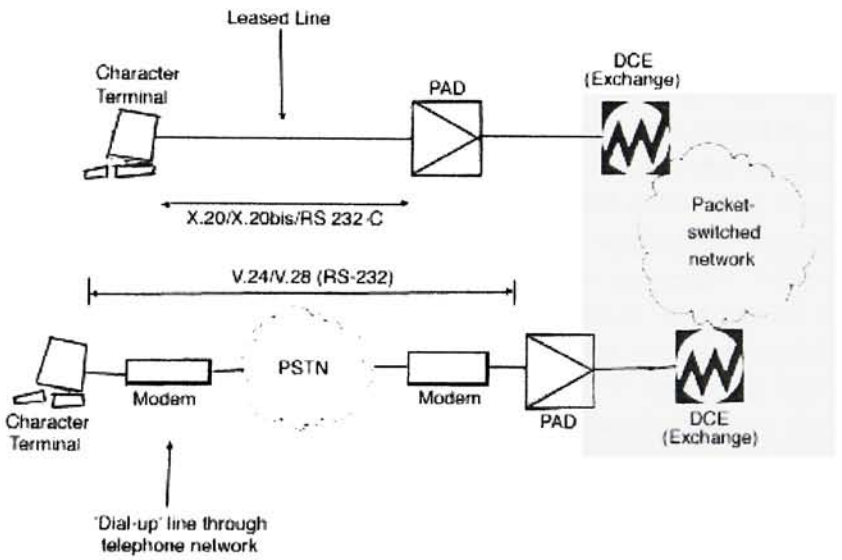


Figure 2.6 : The recommendations for X.28 differentiates between leased line access (top), and 'dial-up' access using a modem (bottom).

INTERFACE STATES

There are three main conditions (or states) that may exist between a PAD and a character terminal. These are PAD waiting, data transfer, and waiting for command.

PAD WAITING : Here the physical connection is established between the PAD and the character terminal. The PAD awaits some call set-up information from the terminal. In

this state, the terminal may set-up and/or read the PAD parameters before any call set-up information is transferred.

There are 22 PAD parameters as shown in the table below. These parameters are stored in tables within the PAD. They are accessed to construct a table of parameters, producing a profile that can be associated with a particular port on a PAD. An electronic mail system can be used for accessing the main computer system of the company. Thus, the profile could be designed to suit particular applications. There are different ways to change parameter values. If the network can determine them, they can be set by the user during subscription time. When a call from a PAD is initiated, change can be made the host computer or by the user of the character terminal while call is being set up.

SL. NO.	PAD PARAMETERS	DESCRIPTION OF PAD PARAMETERS
01.	PAD recall	On receipt of specific character, PAD recall enables escape to PAD command state. When a particular IA5 character is transmitted by the character terminal, the PAD will return to the command state awaiting commands from the character terminal. A typical application — a character wanted the ability to clear a call with a distant user. The default is [CTRL+P] which returns the PAD to the 'command' state. A new command may be entered by the user such as CLEAR or RESET. An alternative character to [CTRL+P] can be transmitted in the code range of 2 through 127. The default here would have a value of (0).
02.	Echo	For echo, the parameter will be set to 0 and 1 for non-echo. It is handy and one of the most frequently used parameters for applications like sppression of the text when a user is typing in his/her name and password when accessing a computer system.
03.	Data-forwarding characters	PAD prefers transmitting large chunks of data like a complete line of text. 'Carriage Return' is a typical character used by this parameter because it denotes the end of a line of text. A PAD manufacturer's manual generally has a table showing options allowing forwarding on (a) every character, (b) any control character, (c) forward after n characters. If a parameter is set to [0], the PAD will forward data at a time interval set by the idle timer.
04.	Idle timer	Here, PAD can buffer for a preset period of time. The idle timer is disabled when set to [0]. Any value between 1 and 255 in units of 0.05 seconds can be used. Use of the highest value is desirable for maximum efficiency. However, this slows down the PAD's response time while working on a distant

		machine with fast software. For the PAD to buffer data to half a second, a typical value could be 10.
05.	PAD to terminal flow control	Data will be received faster than the PAD can process / forward it if the PAD has an intelligent terminal attached (e.g., PC transmitting data directly from disk). By allowing the use of flow control characters, parameter 5, solves this problem, 'Please stop transmission' character is transmitted to the intelligent terminal if the PAD is being 'overrun'. This can be followed by 'Please resume' after the backlog has been cleared. [DC1-X-ON] and [DC3-X-OFF] are two generally used characters here. The PAD can be set to the familiar 'ENQ'/'ACK' sequence and use control signals as 'CTS'.
06.	Suppression of PAD service signals	The PAD stops sending signals back to the character terminal responding to events such as the X.25 call being cleared or reset.
07.	Action on receipt of break signal from character terminal	Here, the break action is the sequence defined for a particular PAD which is used by the host that the PAD is connected to indicating that the host may be considered to be 'hung in a loop'/'stuck in transmit mode'. With the standard PAD is offered by British Telecom's PSS, this break will consist of the link being held in the space condition for more than 100 ms. To break this condition, the action of the PAD will be selected from the parameter list, e.g., if the value is set [8], the PAD will escape to command mode and await commands from the character terminal.
08.	Discard output	Data will be delivered to the character terminal normally when set to [0]. The PAD discards any data destined for the character terminal when set to [1].
09.	Padding after [carriage return]	After a carriage return is transmitted to the character terminal, insertion of padding characters (character [NUL]) is allowed. A delay is thus effectively created which older mechanical devices such as teletypes (teleprinters), enough time to move their heads back to the beginning of a line before the resumption of data transmission.
10.	Line-folding	Data is allowed to be formatted into regular line lengths when it is delivered to the character terminal. While the latter may have only 60 column wide display, it may have been prepared on an 80 column screen during transmission. The value set in line folding (e.g., 60 here) will determine the number of characters to be transmitted before a [Carriage Return] is set to the end of the line.

11.	Binary speed (baud rate)	The speed at which the character terminal is communicating with the PAD indicated by the read-only value. Values for possible terminal speeds are laid down by CCITT, e.g., the value [3] equates to 1200 baud.
12.	Flow control of the PAD by the character terminal	This is the reverse of parameter 5. The character terminal is allowed here to control the rate at which data are sent to it by the PAD.
13.	Line-feed insertion after [carriage return]	Different types of terminals that will encountered in the field is allowed by this parameter. Availability of several values produce the most suitable effect on a user's character terminal are seen.
14.	Padding after [line-feed]	It operates like padding after [carriage return] except that the insertion of padding [NUL] characters after a [Line Feed] has been transmitted.
15.	Editing	This parameter allows the character terminal to edit characters held in a buffer in the PAD and awaiting transmission, when set to [1]. Characters used for editing are defined in parameters 16, 17, and 18.
16.	Character delete character (ASCII/IA5)	Any characters between 1 and 127 may be used except [NUL], e.g., the ASCII [Backspace] character will be used when set to [8]. Before this parameter is effective, parameter 'editing' must be set to [1].
17.	Buffer delete character (ASCII/IA5)	Like 'character delete character', this ASCII character causes the PAD to discard the entire character buffer as generated by the characer terminal so far. This is sometimes called the 'line delete character', as a buffer in the PAD will normally hold one line worth of useful data. A typical value here would be the ASCII code [24] which is the [Cancel] character. This is usually generated by typing [CTRL+X] at the character terminal keyboard.
18.	Line display character (ASCII/IA5)	Here, complete contents of the PAD's buffer are displayed on a new line on the character terminal. After many [Delete] operations have been undertaken, it may be useful to display the state of the buffer. 'Editing' parameter has to be enabled before this parameter is effective. ASCII character is [DC2] is used although any ASCII character (except [NUL]) between 1 and 127 can be used. The generation is brought about by striking the [CTRL+R] keys on the character terminal.
19.	Editing PAD service signals	To define the effect of editing buffered characters with the character delete and buffer delete functions, this parameter is used.
20.	Echo mask of character(s)	If the 'echo' parameter is set to 1 (echo is 'ON'), this parameter will give some control over the selection of

		the characters that are echoed.
21.	Parity treatment	This determines if parity-checking generation is to be invoked — the checking is of little value and in normal conditions is better to be left in the 'OFF' condition.
22.	Page wait	Pagination of data sent to a terminal effectively allowed. If a terminal displays 22 lines, the page wait parameter is set at 22, the PAD sends 22 lines of data, and stops transmission. The PAD will wait until it receives any character from the terminal, whereupon it will deliver another 22 lines of data.

If the physical connection between the devices remain the PAD will revert to this state when a call is complete and cleared.

DATA TRANSFER : A virtual circuit between the PAD and the character terminal has been established in this case. Usually the PAD is invisible to both the character terminal and the distant user that is being called.

WAITING FOR COMMAND : This state is only accessible from the data transfer state. The entry is done so that the character terminal can either alter the PAD parameter settings or clear the call.

PACKET ASSEMBLER/DISASSEMBLER COMMANDS AND SERVICE SIGNALS

It is possible to issue commands to a PAD for performing functions like setting up PAD parameters or clearing a call; these commands are called X.28 commands. The 1984 X.28 recommendation allowed for eight PAD commands, although some equipment suppliers will provide extended commands that are usually designed to make the PAD easier to use. The PAD provides service signals to provide the character terminal with status information. A common signal, e.g., is "OCC", which tells the character terminal is OCCupied or busy. The X.28 commands and their descriptions are given as follows :

SL. NO.	X.28 COMMANDS	DESCRIPTION OF X.28 COMMANDS
1.	STAT	STAT requests status information about virtual circuit that is currently in use.
2.	CLR	CLR will clear the virtual circuit that is currently in use.
3.	PAR?	PAR? is short for 'parameters?', will and cause the PAD to list all the PAD parameters.
4.	SET	The command SET will amend the PAD parameters. For example, the command SET 2:1 changes parameter 2 to 1, thereby enabling 'local echo'.
5.	SET?	This is the same as SET except that the PAD will list the PAD parameters after the SET command has been accepted.

6.	PROF	PROF is short for 'profile' and allows the user to implement one of twenty-two predetermined parameter profiles that are held in the PAD. For example : PROF 1 will ask for profile 1 to be used.
7.	RESET	RESET will reset the current virtual call.
8.	INT	INT causes the PAD to transmit an INTERRUPT packet.

SERVICE SIGNALS : These service signals are sometimes called *X.28 responses*. They are responses in the form of codes that pass status information back to the character terminal from the PAD.[2]

[1] http://www.ccprep.com/NetCerts/DownloadsSC-BC-RAN-X25.pdf
[2] X.25 Made Easy — Nicholas M. Thorpe & Derek Ross (Prentice Hall)

INTERNETWORKING X.25-BASED NETWORKS WITH X.75

Designing of X.25 allows communication of users with each through a single network. Establishing communications for sharing resources / exchanging data may be needed when two users operate on two separate X.25 networks. The designing of X.25 meets the need. Packet exchange within a network can also be connected. For more than ten years, this standard has been in development — the provisional recommendation was published in 1978 and amended in 1980, 1984, and 1988.

The main objective of X.75 is allowing internetworking. A gateway is provided by X.75 for a user to communicate with another user through multiple networks (Figure 3.1). It also connects exchanges within a network. X.75 standard works best when user stations, networks, and packet exchanges use X.25 packets, since X.25 packet headers (created at the user/subnetwork interface) are used by X.75. The end user of X.25 connection never sees X.25.

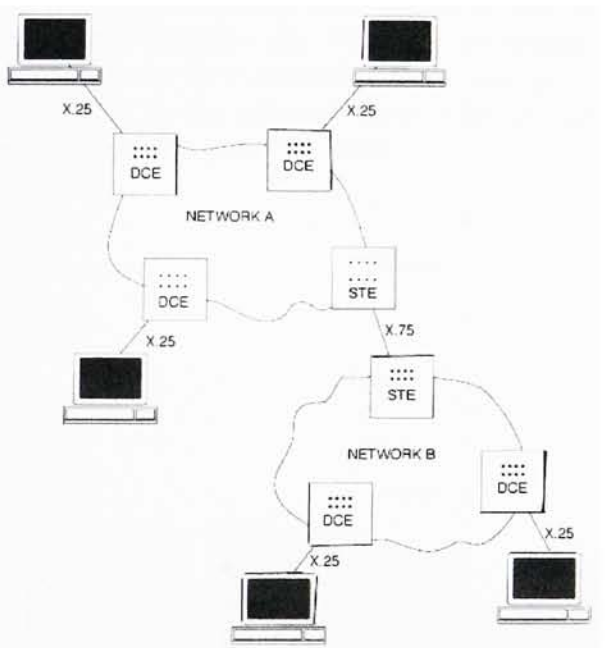


Figure 3.1 : X.75 Gateways

X.75 and X.25 are quite similar; the many features X.75 has are permanent virtual circuits, virtual call circuits, logical channel groups, logical channels, and several of the control packets. The architecture is divided into the physical link and packet levels with X.75 (Multilink Procedures) MLP in the network layer.

The operation of international packet-switched services are defined by X.75. While each terminal operates within its own packet mode data network, how two terminals are connected logically by an international link is described. A slightly different term for the network interface is used by X.75. The term data-circuit terminating equipment (DCE) is used to describeX.25 packet exchange. The X.75 terminology defines this device as

signaling terminal equipment (STE), although the device may the same as that of the X.25.

The physical level, with appropriate V series recommendations (such as V.35) can be implemented like X.25. Performance of signaling at 64 Kbps is X.75's requirement (an optional rate is 48 Kbps). Other link speeds (56 Kbps, 1.544 Mbps, etc.) are X.75's second level uses HDLC subset LAPB and does not support LAP.

X.75 and Multilink Procedures (MLP) : The multilink procedure (MLP) is often used by X.75 link level, as it permits multiple links between STEs. The rules for frame transmission and frame resequencing for delivery to and from the multiple links are established by MLP. Parallel communications channels between STEs appear as a single channel with greater capacity, with multilink operations. More reliability and throughput than could be achieved on a single channel is provided by this arrangement.

At the upper part of the data-link level has the existence of multilink procedures [Figure 3.2]. The X.25 network layer perceives that it is connected to a single link, and LAPB single links operate like they are connected directly to the network layer. MLP is responsible for flow control between layers 2 and 3 and for resequencing the data units for delivery to the network layer. The network layer operates with a perceived higher bandwidth in the data-link layer.

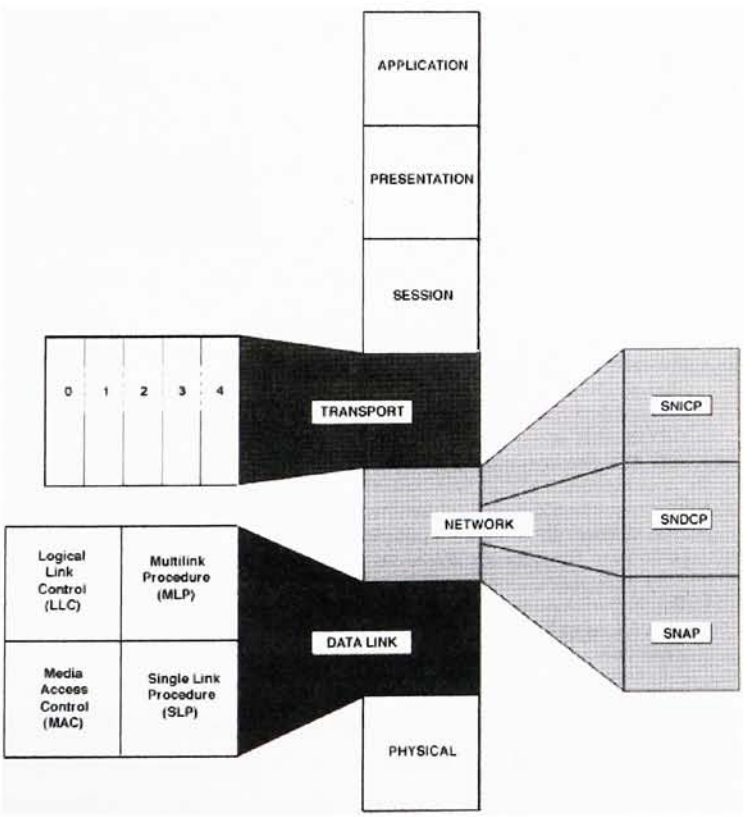


Figure 3.2: The Internetworking Layers

X.75 Packet Types : Because the STE-to-STE communications has no relationship to the "other side of the cloud", X.75 does not use the variety of packet types found in X.25. Since communication is only between two STEs, not between two sets of DCEs/DTEs, there is no other side in X.75. The X.75 protocol uses the following packet types :

(I) *Call setup and clearing* — (i) Call request, (ii) Call connected, (iii) Clear request, and (iv) Clear confirmation.

(II) *Data and interrupt* — (i) Data, (ii) Interrupt, and (iii) Interrupt confirmation.

(III) *Flow control and reset* — (i) Receive ready, (ii) Receive not ready, (iii) Reset, and (iv) Reset confirmation.

(IV) *Restart* — (i) Restart and (ii) Restart confirmation.

The X.75 is almost identical to the X.25 format. The address fields are defined as international data numbers (X.121). The logical channels have significance only for the STE-to-STE interface.

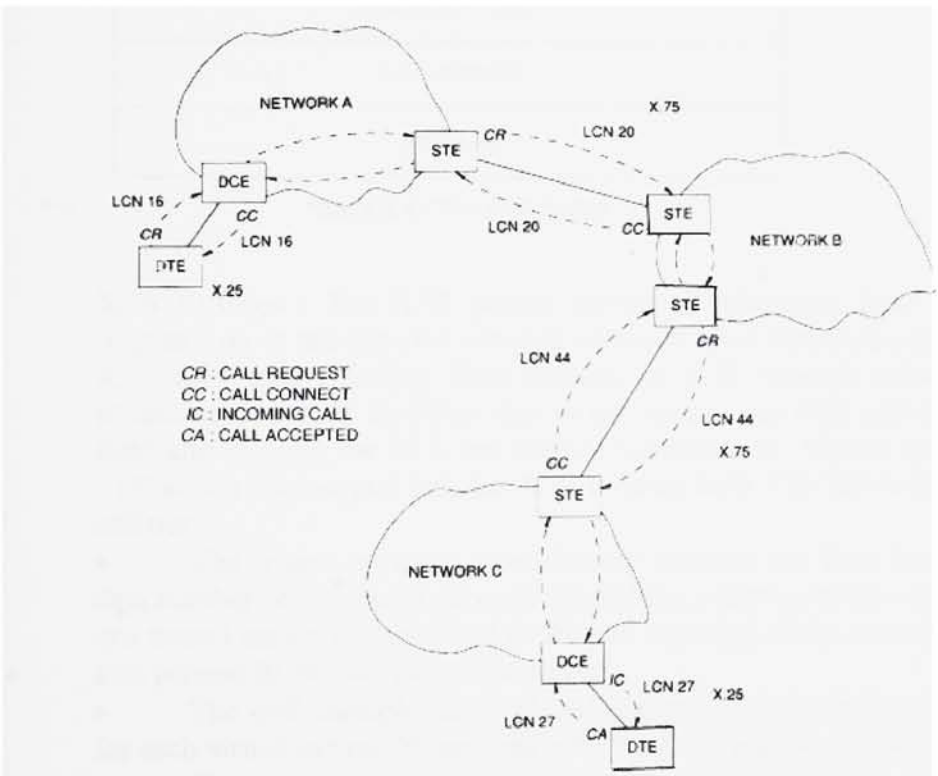


Figure3.3: Internetworking with X.75

In Figure 3.3, we can see the similarities and differences between X.25 and X.75. A call to DTE in Network C is initiates by the DTE in Network A. For each phase of the connection establishment, the call setup packet and logical channel relationships are depicted. X.75 does not use the incoming call and call accepted packets needed by X.25 on the "other side" of the network cloud.

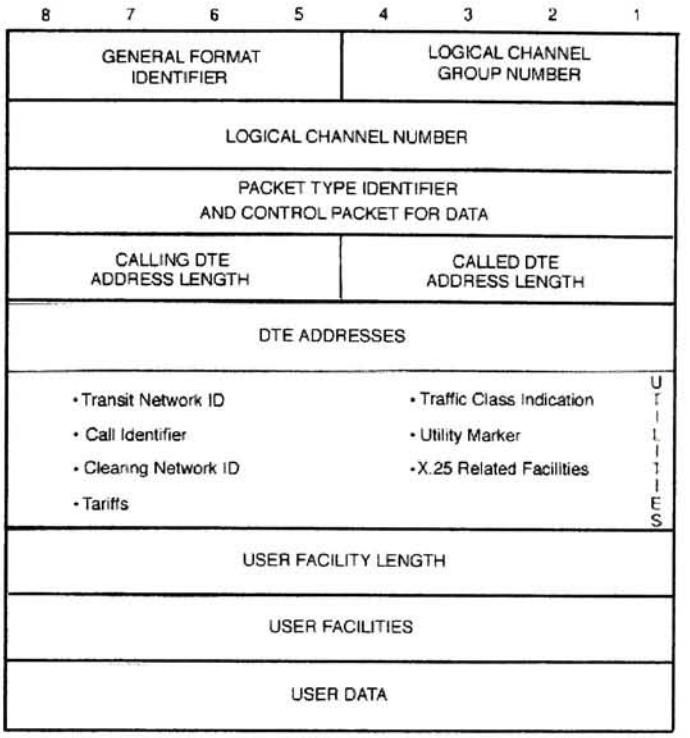


Figure 3.4 : The X.75 Packet

X.75 Utilities : The X.75 packet carries an additional field called network utilities (Figure 3.4). It provides for network administrative functions and signaling. A request in X.25 user packet facility field invokes an X.75 network utility is observed in many situations. The X.25 facilities that do not require any STE action remain in the facilities field and through the STE are relayed transparently. Others user facilities that require STE action are mapped into the X.75 utilities field. The following are descriptions of the utilities :

- The *transit network identification* contains the first four digits of international data number of the transit network controlling a portion of the virtual circuit. If more than one transit network is involved in the call traversal of the networks, this identification is also present in the call connected packet.
- The *call identifier* is an identifying name established by the originating network for each virtual circuit. When used with the DTE address, it uniquely identifies the call.
- The *throughput class indication* specifies the throughput classes applying to the call.
- The *window size indication* identifies the negotiated window size between the STEs.
- The *packet size indication* identifies the negotiated packet size between the STEs.
- The *fast select indication* indicates that a fast select is requested for the call.
- The *closed user group indication* establishes calls between DTEs that are members of an international closed user group. X.75 also supports closed user group with outgoing access indication.

- The *reverse charging indication* allows reverse charging of calls to be established across the networks.
- The *called line address modified notification*, used with hunt groups and call redirections, identifies the specific reason for the called address to be different from the address in the call request packet.
- The *clearing network identification code* provides additional information on the origin of the clear request packet.
- The *traffic class indication* identifies such service information as terminal, fascimile. This utility has not yet been fully defined.
- The *transit delay selection and indication* identifies the transit delay on the virtual circuit in accordance with X.135.
- The *utility marker* separates X.75 utilities from non-X.75 utilities. Its use is subject to bilateral agreements between networks.
- *Tariffs* could be used for billing, but this utility is defined by each network.
- The *network user ID* (NUI) provides supplementary information for billing, accounting, etc..
- The *recognized private operating agencies* (RPOA) is used to designate the transit network.[1]

[1] X.25 and Related Protocols — Uyless Black

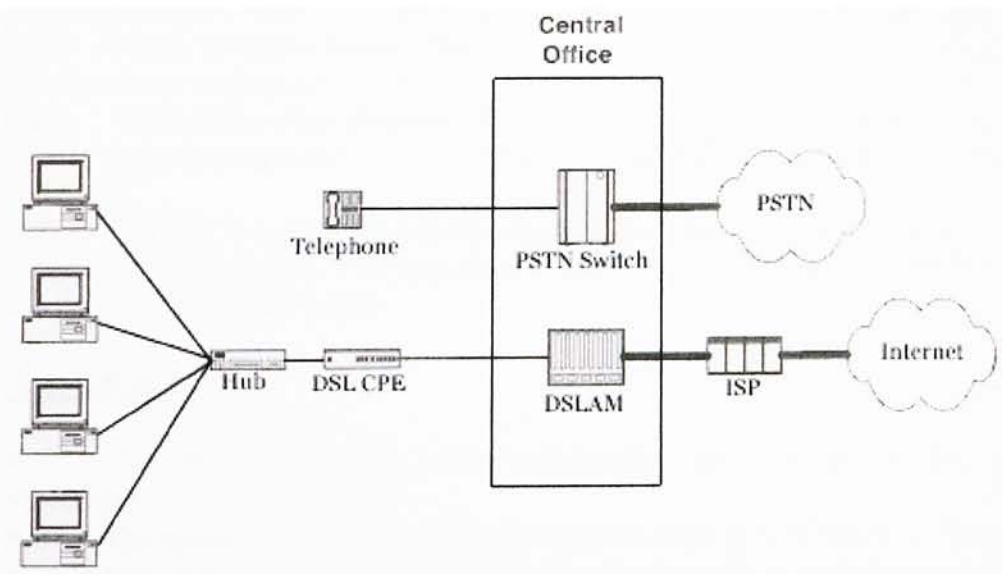
Digital Subscriber Line (DSL)

DSL offers faster Internet connection than the standard dial-up connection. This technology supports the existing two-wire copper telephone wiring to deliver high-speed data services to homes and businesses. It uses existing phone lines, without requiring additional phone lines. This "always-on" Internet access does not hold up the phone line. DSL users are offered speeds ranging from 144 Kbps to 1.5 Mbps. This is 2.5 to 25 times faster than a standard 56 Kbps dial-up modem. DSL can deliver bandwidth-intensive applications like streaming audio/video, online games, application programs, telephone calling, video-conferencing, and other high-bandwidth services.[1]

Transformation of ordinary telephone into high-speed DSL lines is due to the special equipment at each end of the telephone line. In residences and businesses, it is a DSL modem or router that connects to the telephone line and to a computer or Local Area Network (LAN). At the CO (Central Office) servicing this area, the telephone line ends at special DSL-enabling equipment called DSL Access Multiplexers (DSLAMs). The DSLAM can also be installed in a large office or residential building instead of at the CO as an MTU (Multi-Tenant Unit).

The data from the user's PC travels through the DSL modem or router, out to the telephone line, and to the CO. Here, it is routed to the DSLAM and then to the DSL provider's data network to be passed off to the user's ISP.

Some DSL flavors such as SDSL service, require a separate line from the user's voice telephone line. The DSL traffic goes to the DSLAM, and voice communications over a voice telephone line go to the telephone network, as shown in the following figure.



2

There are many flavors of DSL :

(i) ***ADSL (Asymetric Digital Subscriber Line)*** can send data of upto 6.1 Mbps downstream and upto 640 Kbps upstream. This form of DSL will become most familiar to home and small business users. It is called "assymetric" because most of its two-way or duplex bandwidth is devoted to the downstream direction (i.e., the direction from the server to the client), sending data to the user. For upstream (i.e., from the client to the server) or user interaction messages, only a small portion of bandwidth is available.

(ii) ***CDSL (Consumer Digital Subscriber Line)*** sends data of upto 1 Mbps downstream and probably less upstream. The advantage here is that a "splitter" does not need to installed at the user's end.

(iii) G.Lite (also known as DSL Lite, splitterless ADSL, and universal ADSL) is a slower ADSL not requiring splitting of the line at the user's end, but splits it for the user remotely at the telephone CO, saving the cost. G.Lite (officially ITU-T standard and G-992.2), provides a data rate from 1.544 Mbps to 6 Mbps downstream and 128 Kbps to 384 Kbps upstream. G.Lite is expected to become the most widely installed form of DSL.

(iv) HDSL (High-bit rate DSL) is the earliest variation of DSL used for wideband digital transmission withing a corporate site and between the telephone CO and a customer. Its main characteristic is that it is symmetrrical : an equal amount of bandwidth is available in both directions — hence maximum data rate is lower than for ADSL. HDSL can carry as much on a single wire of twisted-pair as can be carried on a T1 line in North America or an E1 line in Europe (2320 Kbps).

(v) IDSL (ISDN DSL) is closer to ISDN data rate and provides a bandwidth of 128 Kbps upstream.

(vi) RADSL (Rate-Adaptive DSL) is a kind of ADSL technology, in which the software is able to determine the rate at which signals can be transmitted.

(vii) SDSL (Symmetric DSL) is the same as HDSL with a single line, carrying 1.544 Mbps (US and Canada) or 2.048 Mbps (Europe) in each direction on a duplex line.

(viii) UDSL (Unidirectional DSL) is a proposal from a European company and is a unidirectional version of HDSL.

(ix) VDSL (Very high data rate DSL) is a developing technology that promises much higher data rates between 51 to 55 Mps over relatively short distances (upto 300 meters in length).

(x) x2/DSL is a planned modem from 3Com and US Robotics supporting 56 Kbps modem communication. It is upgradeable through new software installation to ADSL on availability in the user's area.[1]

Advantages :

- The user can leave the Internet connection open and still use the phone line for voice calls.
- The speed is much higher than the regular modem (1.5 Mbps vs. 56 Kbps).
- DSL does not require new wiring; it makes use of the existing phone line.
- The company offering DSL usually provides the modem as part of the installation.

Disadvantages :

- A DSL connection works more efficiently when the user is closer to the provider's central office.
- The downstream connection is faster than the upstream connection.
- DSL service is not available everywhere.[3]

References :

[1] http://www.everythingdsl.com/whatis/
[2] DSL for Dummies — David Angell (2nd Edition)
[3] http://www.howstuffworks.com/dsl.htm

E1

There are two major standards in the international realm of digital transmissions — one used in North America (T1) and one used in Europe and the rest of the world (E1). Japan has a standard which differs from both, but is rather similar to the North American standard.

E1 Networks

The E1 digital transmission system provides full-duplex transmissions at 2.048 Mbps. One or two of those channels are reserved for framing, based on the frame format. The information bandwidth generally consists of 32 multiplexed 64 Kbps channels for digitized voice. For data, it may be channelized the same as with voice, or may carry from one to several hundred signals on an unchannelized basis.

E1 Signal Characteristics

E1 signals are also bipolar, i.e., alternating signals are of opposite polarity. E1 also uses Pulse Code Modulation (PCM) and Time Division Multiplexing (TDM). E1 uses a time slot, at 488 nanoseconds (ns). This division gives 2,048,000 slots per second. Pulses have one half the duration of the time slot, and indicate a ONE in the binary/digitized transmission. E1 incorporates Alterate Mark Inversion.

Transmission Facilities

Transmissions facilities for E1 signals are the standard twisted pair wire in most cases, with 5 to 6 dB loss per 1,000 feet. Because of the higher speeds of E1 signaling, repeaters on copper links are required more often than every 6,000 feet. E1 signals can also be carried by satellites, microwaves, fiber optics, coaxial cable, etc., just as with T1.

Pulse Density

With E1, there is no specific requirement to maintain a pulse density, because ones density is automatically maintained by High Density Binary 3 (HDB3) coding.

E1 Framing Synchronization

With E1 signaling, data is grouped into frames of 256 bits. Each frame consists of 32 8-bit time slots, and 8,000 frames are transmitted each second ((8,000*256) bits per second = 2,048,000 bits per second = 2.048 megabits per second). This provides for 32 64 kbps channels.

Framing information is carried in time slot 0 (TS0) while signaling information is carried in time slot 16 (TS16). The remaining 30 time slots are for user information. A group of 16 frames is a multiframe.

Framing Formats

Two main framing formats are used in E1 signaling, TS0 and TS16. Time slot 0 or time slot 16 is used in each to provide the framing pattern, which allows the receiving E1 equipment to synchronize on the signal correctly.

TS16 was designed to provide signaling information to a public switched network, where individual 64 kbps time slots can be routed independently through the network.

TS0 has two main forms, one with a 4-bit CRC (Cyclic Redundancy Check)* and one without. Since Frame Synchronization does not require all 8 bits of every TS0 in every frame, the extra bits are used for other functions, such as frame loss alarms, data links to transmit control and status information, etc..[1]

* [**Cyclic Redundancy Check :** A process used to check the integrity of a block of data.][2]

The E1 Hierarchy

The E1 standard also has a hierarchy of data rates as channels from individual E1 circuits can be multiplexed to create various speeds for a transmission facility.

Digital Signal Number	Bit Rate (kbps)	Number of 64k Voice Channels	Transmission Media
DS-0	64	1	Wire Pairs
E1	2048	32	Wire Pairs
E2	8448	132	Wire Pairs, Fiber
E3	34368	537	Coax, Radio, Fiber
E4	139264	2176	Coax, Radio, Fiber
E5	565148	8704	Coax, Fiber

Advantages

- E1 has more channels per circuit, so less wire or fiber needs to be laid to get the same number of channels.
- 32 channels is a binary multiple, so E1 can generally interface with computer equipment better. Since the standards are based on digitization (i.e., one or zero), this is important, as much of the equipment in the circuit is computer-based.
- Since there is a separate time slot for signaling, a single channel runs clear at 64 kbps, vs. the 56 kbps in the US due to robbed signaling bit. Besides, the additional 8 kbps available in the channel, with E1, there are no issues with maintaining pulse density.[1]

Disadvantage

E1 is quite expensive for home and small business users.

References

[1] http://www.2sparrows.org/Sean/rit/t1e1.htm
[2] Newton's Telecom Dictionary — Harry Newton

Cable

The pipeline for the cable broadband consists of coaxial cable and fiber optics, instead of copper phone lines. The client's computer connects to the coaxial television cable with a special modem. Data flows between the client's home/business and a neighborhood node. Data travels at high speeds from the node, to the cable company's "headend", and to the Internet over fiber-optic lines from there. The cable modem is typically installed by the local cable television company and subscribers pay a monthly fee to use it.

Strengths

- A cable connection is "always on", like DSL and speeds fall under the same range, up to 1.5 Mbps.
- The phone line is free, while the Net is being surfed, as the client does not need the phone line to connect to the Internet.
- The client can watch the television while online, without the reception being affected, as the Internet and the television use different frequencies of the cable.

Weaknesses

- Cables used to carry data are shared by multiple users and hence sensitive during heavy traffic. If everyone in the client's neighborhood on the same cable node surfs at the same time, the speed of his/her connection can be affected.
- Some cable systems have one-way cable connections, allowing subscribers only to receive the Internet data. Here, clients still need to use a phone line to send the information over the Net.
- As cable Internet connections use a fixed IP addresses, they are more vulnerable to security breaches.

Reference : http://www.earthlink.net/blink/feb01/cover2.html

Fixed Wireless

(A) Wireless Local Loop

In a telephone network, a Wireless Local Loop (WLL) is a generic term for a high-speed Internet access that uses a wireless link to connect subscribers in fixed locations such as homes or offices to their local exchange as an alternative to conventional copper cable and coax. Using a wireless link shortens the construction period, reducing installation and operating costs. The cost of installing a WLL system for subscriber access lines is now virtually the same as that of copper cable, though it can vary depending on the subscriber line length and local conditions.[1]

Wireless Local Loop Internet access involves the use of inexpensive spread spectrum microwave transceivers known as wireless LAN devices designed for bridging workstations together.[2]

Wireless Local Loop systems use a small, inexpensive microwave antenna that is attached to a radio at the customer premises. The Customer Premises Equipment (CPE) is pointed back to the ISPs Access Point (AP) — typically a tall building or radio tower — to create a Wireless Local Loop (WLL).[3]

Fixed wireless devices generally get their electrical power from the utility mains, unlike mobile wireless or portable wireless which tend to be battery-powered. Even though mobile and portable systems can be used in fixed locations, efficiency and bandwidth are compromised compared with fixed systems. Mobile or portable, battery-powered wireless systems can serve as emergency backups for fixed systems in case of a power blackout or natural disaster. High-end fixed wireless employs broadband modems that bypass the telephone system and offer Internet access hundreds of times faster than twisted-pair hard-wired connections or cell-phone.[4]

Strengths

- Subscribers can be added or moved (to a certain extent) without modifying the infrastructure.[4]
- Broad bandwidth is possible because there are no wires or cables to introduce reactance into the connection (reactance limits bandwidth by preventing signals higher than a certain frequency from efficiently propagating).[4]
- As the number of subscribers increases, the connection cost per subscriber goes down.[4]
- Subscribers in remote areas can be brought into the network quickly, since it is easier to set up wireless towers in these areas than to invest the millions of dollars necessary to bring high-speed cable or telephone lines out to many of these regions.[5]
- Wireless Local Loop does not require satellite feeds, a government licence, or even local phone services.[3]

Weaknesses

- Wireless signals can still experience some interference from buildings or even large trees between a home/office and the antenna, making the technology difficult to use in densely populated city areas.[5]
- Wireless Local Loop is a shared-bandwidth technology — as more people log on in a given neighborhood, the download speeds available to any single person will drop.[5]

(B) Single-Channel Radio Link

Single-Channel Radio Link is a kind of fixed wireless system which provides a bandwidth of 64 Kbps.

The technology for the wireless connection to the Internet is as old as the Net itself. Amateur radio operators began "patching" telephone lines into fixed, mobile, and portable two-way voice radios in the middle of the 20th century. A wireless modem works somewhat like an amateur-radio "phone patch", except that it is much faster.[4]

Radio link uses line-of-sight microwave communication technology. Most of the radio links are digital. The multiplexing and demultiplexing equipment used with the radio link are either PDH (Plesynchronous Digital Hierarchy)* or SDH (Synchronous Digital Hierarchy)** type. At the telephone exchange, V.35*** port is used as the connection between the two ends. The frequency of a typical radio link is 7 GHz.[6]

*[**PDH :** Plesynchronous Digital Hierarchy. Developed to carry digitized voice over twisted pair cabling more efficiently. This evolved into the North American, European, and Japanese Digital Hierarchies where only a discrete set of fixed rates is available, namely, n*DS0 (DS0 is a 64 Kbps rate) and then the next levels in the respective multiplex hierarchies.][7]

[SDH :** Synchronous Digital Hierachy. A set of international fiber-optic transmission standards, planned and developed by CCITT. SDH was based on the North American SONET standards, which are now considered to be a subset of SDH.][7]

***[**V.35 :** ITU-T standard for trunk interface between a network access device and a packet network that defines signaling for data rates greater than 19.2 Kbps. It is an international standard termed "data transmission up to 1.544 Mbps" (i.e., T1). It is typically used for DTE or DCE that interface to a high-speed digital carrier. The physical interface is a 34-pin connector, which can't connect, either physically or electronically, to any other interface without a special converter.][7]

Strengths

- Subscribers can be added or moved (to a certain extent) without modifying the infrastructure.[4]
- As the number of subscribers increases, the connection cost per subscriber goes down.[4]

- Subscribers in remote areas can be brought into the network quickly, since it is easier to set up wireless towers in these areas than to invest the millions of dollars necessary to bring high-speed cable or telephone lines out to many of these regions.[5]
- Single-Channel Radio Link does not require satellite feeds or a government licence.[3]

Weaknesses

- Wireless signals can still experience some interference from buildings or even large trees between a home/office and the antenna, making the technology difficult to use in densely populated city areas.[5]
- Single-Channel Radio Link is a shared-bandwidth technology — as more people log on in a given neighborhood, the download speeds available to any single person will drop.[5]

References

[1] http://www.phsmou.or.jp/newsletter/issue4/WLLsystem.html
[2] http://www.isp-planet.com/fixed_wireless/business/fw_101_p2.html
[3] http://www.isp-planet.com/fixed_wireless/business/fw_101.html
[4] http://searchnetworking.techtarget.com/sDefinition/0,,sid7_gci295716,00.html
[5] http://news.com.com/2100-1033-246597.html?legacy=cnet
[6] Sayed-Ur Rahman (sayed@bttb.net.bd)
[7] Newton's Telecom Dictionary — Harry Newton

Wireless Application Protocol (WAP)

WAP is "short for *Wireless Application Protocol*, a secure specification that allows users users to access information instantly via handheld devices such as mobile phones, pagers, two-way radios, smart phones, and communicators.".

Most wireless networks support WAP like CDPD, CDMA, GSM, PDC, PHS, FLEX, ReFLEX, iDEN, TETRA, DECT, DataTAC, and Mobitex.

All operating systems support WAP — specially engineered for handheld devices are Palm OS, EPOC, Windows CE, FLEXOS, OS/9, and JavaOS.

WAPs use microbrowsers for displaying and accessing the Internet. Microbrowsers are browsers with small file sizes accomodating low memory constraints of handheld devices and low-bandwidth constraints of a low-bandwidth network.[1]

WAP evolved from technologies that were developed by Phone.com, a software company based in Redwood City, California. Cell phones and their networks are not robust enough to handle HyperText Markup Language (HTML) of the Internet. Website publishers use HTML for weaving text and graphics into easy-to-navigate documents. Current cell phone networks have a low bandwidth relying on data much more slowly than fixed-line networks making wireless transmission of Web pictures next to impossible. Cell phones today do not have enough processing power or the display screens for showing complex images.[2]

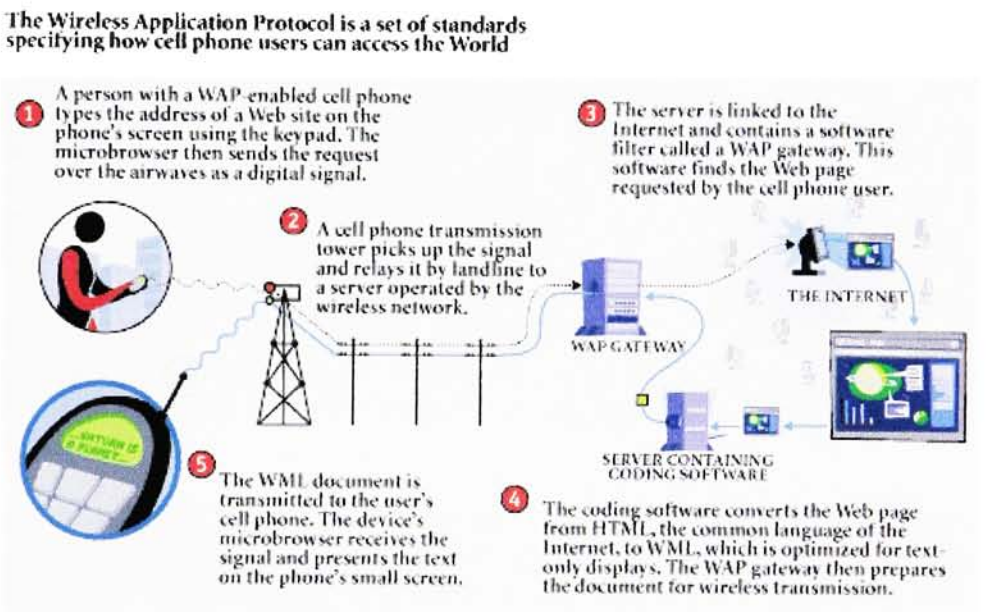
To overcome these problems, Phone.com allied with three cell phone manufacturers — Motorola, Nokia, and Ericsson and devised a standardized language based on HDML (Handheld Devices Markup Language). WAP combined two fast growing network technologies — wireless communications and the Internet. The project objective was creating a common protocol and a representation design that could be utilized by different devices and applications. Another objective was creating a world-wide specification for wireless information exchange that would work between different wireless technologies and everywhere. The WAP architecture succeeds in turning the new generation of mobile phones into media cellulars.

When a request is sent by the WAP browser in a mobile phone (a URL address is used in identifying the requested content), the request is first directed to the WAP gateway of a carrier, an Internet Service Provider or a company (e.g., via data call that is routed through PSTN). The WAP request is interpreted by the WAP gateway, finds the content server specified by the URL address and sends an HTTP request to the content server. The request is handled by the HTTP server, which returns the response. After receiving the content, the WAP gateway encodes and forwards it to the client, where the browser interprets it and displays it to the user.

A WAP gateway is always needed in between to make a protocol conversion, because in the WAP architecture, a WAP phone cannot establish direct contact with a WWW server.

A WAP gateway can be physically located either with a carrier, an Internet Service Provider, or with the company providing the content. When planning WAP services, it is important to understand the architectural differences between these alternatives. [3]

How the WAP user gets on to the Web[4]



When services handle public company or similar information which is less confidential, a simple WAP service can be created quickly and easily by a central office on a WWW server. On the other hand, if a central office wants to secure the confidentiality of its services independently from the carriers, owning and controlling a WAP gateway is essential.

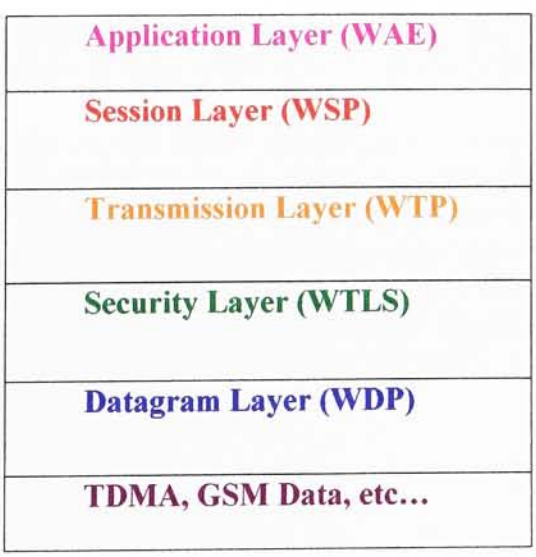
A WAP gateway converts the WAP protocol to conventional Internet protocols like HTTP and SSL. When conversion is made, the ISP's WAP gateway handles information such as credit card data, account data, user names, and passwords without protection and may save them in a log file on the WAP gateway and may compromise confidentiality. In WAP gateway software products, this drawback is an unavoidable characteristic of protocol conversion. When the WAP gateway is under control, these problems can be avoided. A central office providing access to confidential data should own and control the WAP gateway for providing access to confidential data.

If a central office owns its own WAP gateway, owns or rents a dial-up service for its services, the central office is totally independent of carriers. Owning a WAP gateway empowers a central office to integrate it freely with its own information system, offer WAP services to customers of different telecom carriers without being tied down to make separate agreements with different carriers.[3]

WAP Architecture and Protocols

The protocol stack of dedicated layers defined by WAP specializes in specific tasks, embedded in all user devices and WAP gateways. The WAP protocol defines content formats, connection and security protocols and data transfer in wireless networks. The form exhibits new solutions which can be targeted to resolve matters related to e-commerce., content push with wireless devices, e.g., verification of digital signatures, customer identification made with mobile terminals. The WAP specification puts forth numerous prime solutions resolving limitations with present terminals and network technologies as well as give advanced solutions for the future when there will be increased transmission speeds. The WAP protocol stack and those used in WWW have a lot of similarities. The WML language used to create WAP pages are defined as XML (eXtensible Markup Language), which has similarities with HTML. The scripting language used in the WAP sphere, WMLscript, is based on languages like Javascript is used on WWW. WML and WMLscript are adapted to and optimised for wireless environments.

Similarities exist for lower elements of the protocol stack (WSP and WTP). These protocols have an analogy to Internet protocols (HTTP), but conform to the requirements of a wireless environment. The URL address used in the WWW standard is also used in the WAP architecture to identify resources and services.



The WAP architecture

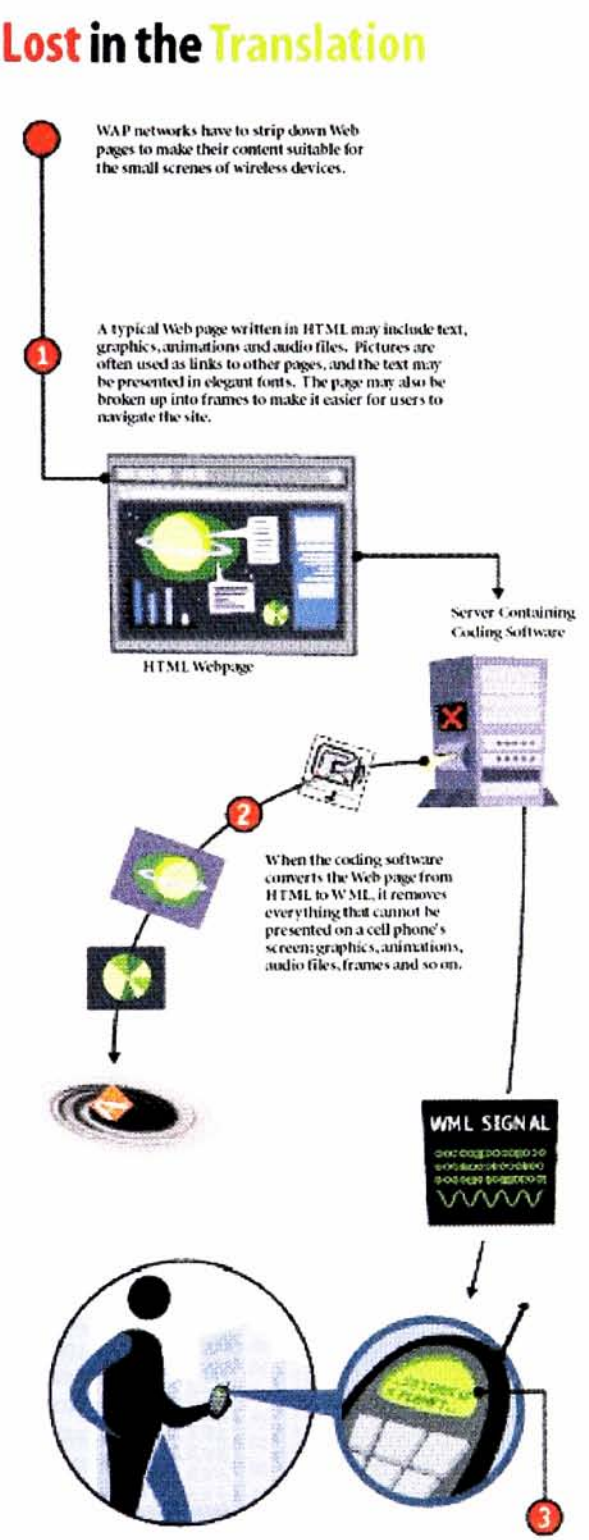
The application layer, Wireless Application Environment (WAE) which hosts the WAP browser environment, occupies the highest level of the WAP architecture. The WML and WMLscript languages, as well as WTA (Wireless Telephony Applications) and WTAI (Wireless Telephony Applications Interface), are part of the application layer's functionality and specify the data format for the mark-up language, script language, images, phone book, and calendar data. This layer also specifies how retrieved content can communicate with other phone functions.

The WSP session layer of the WAP protocol handles the negotiation between communication entities and session management between a WAP device and a gateway. WSP offers an interface for the application layer to two services. The first one works on top of the WTP layer. This is needed for reliable, connection-oriented communication. The second one is necessary for WWW-type connectionless transfer, where the sender does not receive confirmation of a successful transfer. The functionality of the WSP layer includes HTTP/1.1 semantics and functionality (as WSP/HTTP 1.1), session suspension and resumption, and support for data push.

The WTP layer is a light, optimized protocol, offering reliable transaction management to the higher-level layers (if needed, service messages are monitored and resent).

WTLS is an information security protocol based on TLS protocol (Transport Layer Security, which was previously known as SSL, Secure Sockets Layer). WTLS ensures privacy and integrity of transmitted data and authentication of the parties that are communicating. WTLS has also been optimized for a wireless environment, e.g., via optimized handshake and persistent sessions : when a WAP terminal (mobile phone) and a WAP gateway have negotiated a WTLS session, the latter can be utilized for other, subsequential data calls (with the same terminal) without renegotiating another session. Encryption keys should be regularly renewed during the session for maximum security, as part of the WTLS protocol. Authentication procedures for WAP gateways and WAP terminals is also specified by WTLS (WTLS class II and WTLS class III).

The transport layer's role in the WAP architecture is handled by WDP (Wireless Datagram Protocol). This works on top of bearer services offered by various wireless networks. Because of WDP protocol's role of providing a common interface to the upper layer protocols (Security, Transmission, and Session layers), the upper layers can operate independently of the wireless network technologies. Thus, the WAP applications being developed for current wireless networks can be used in the future with the evolution of underlying network technology (the introduction of faster wireless technologies will make WAP more user-friendly).[3]



Disadvantage of using WAP[5]

References :

[1] http://www.webopedia.com/TERM/W/WAP.html
[2] http://www.sciam.com/2000/1000issue/1000bannan.html
[3] Inside WAP : programming applications with WML and WMLScript
[4] http://www.sciam.com/2000/1000issue/1000bannanbox1.html
[5] http://www.sciam.com/2000/1000issue/1000bannanbox2.html

Global System for Mobile Communication (GSM)

GSM is short for Global System for Mobile Communications. It is one of the leading digital systems using narrowband TDMA — allowing eight simultaneous calls on the same radio frequency. GSM has become the *de-facto* standard in Europe and Asia.[1]

The development of GSM started in the early 1980s. It was viewed as the mainstay of plans for the infrastructure of Europe's mobile communication of the 1990s. At present, GSM and its DCS 1800 and PCS 1900 versions have spread beyond Western Europe with networks installed across all continents.

By 1986, it had become clear that analogue cellular networks would run out of capacity by the early 1990s. Hence, directives were issued for two blocks of frequencies in the 900 MHz band to be reserved for a pan-European service to be opened in 1991. As excellent progress was being achieved with the development of agreed standards, a decision was taken to adopt a digital rather than analogue system.

The digital system would offer improved spectrum efficiency, better quality transmission and services enhancing features including security. The use of Very Large Scale Integration (VLSI) technology would be permitted leading to smaller, cheaper mobiles, including handheld terminals. Lastly, digital approach would complement the development of the Integrated Services Network (ISDN) with which GSM would have to interface.[2]

The GSM Association today is the world's leading wireless industry representative body consisting of more than 600 second and third generation wireless network operators and key manufacturers and suppliers to the wireless inustry. Today's GSM accounts for approximately 70 percent of total digital wireless market.

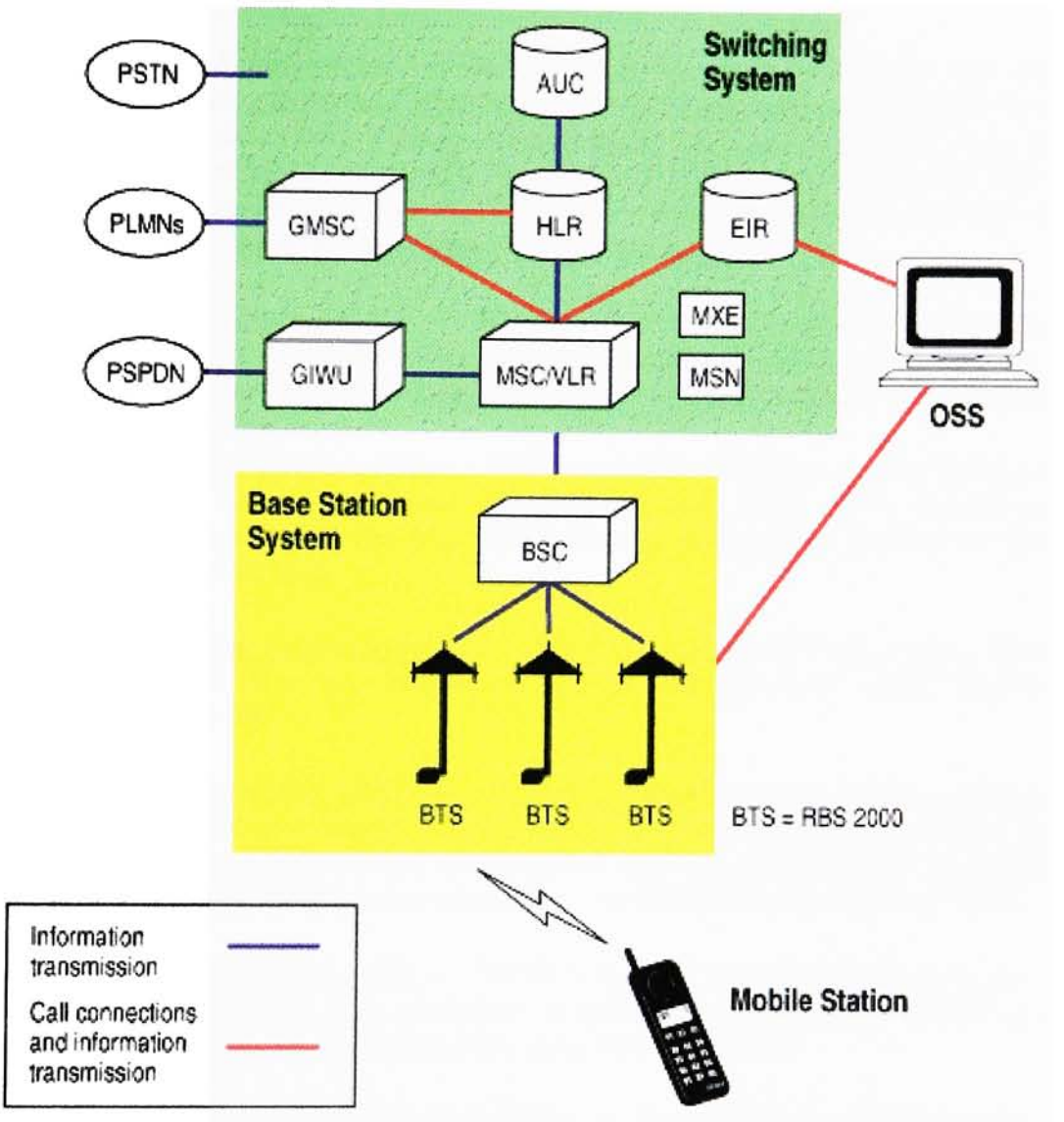
The GSM Association with it global reach offers a full range of business and technical service to its members and is driving forward its vision of a seamless, limitless world of wireless communication.

The GSM family of wireless communications is a living and evolving family offering an expanded feature-rich "family" of voice and data enabling services. Today's GSM family consists of today's GSM, General Packet Radio Services (GPRS), Enhanced Data rates for GSM Evolution (EDGE), and third generation GSM services (3GSM).[3]

GSM NETWORK

GSM does not give requirements, but recommendations. The GSM specifications does not address the hardware, but defines in details the functions and interface requirements. The reason behind this is to limit the designers as little as possible, yet make it possible for the operators to buy equipments from different suppliers. The GSM network is divided into three major systems : The Switching System (SS), the Base Station System (BSS), and the Operation Support System (OSS).

The basic GSM network elements are shown in the diagram below :



The Switching System (SS) — This system is responsible for performing call processing and subscriber-related functions. The follwing functional units come under this system.

Home Location Register (HLR) — The HLR is a database used for storing and managing of subscriptions. It is considered to be the most important database, since it stores permanent data about subscribers, their service profiles, location information, and activity status. Upon buying a subscription from one of the PCS operators, he/she is registered in HLR of that operator.

Mobile Services Switching Center (MSC) — The MSC performs telephony switching functions of the systems. Calls to and from other telephone and data systems are

controlled by MSC. Other functions that are also performed by MSC are toll ticket-ing, network interfacing, common channel signaling, etc..

Visitor Locator Register (VLR) — The VLR is always integrated with the MSC and it is a database containing temporary information about subscribers needed by MSC in order to service visiting subscribers. When a mobile station roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. If the mobile station later makes a call, the VLR will have the information needed for call setup without the need for interrogating the HLR each time.

Authentication Center (AUC) — This unit provides authentication and encryption parameters, which verify the user's identity and ensures confidentiality of each call. It also protects network operators from various types of fraud in today's cellular world.

Equipment Identity Register (EIR) — This is a database containing information about the identity of the mobile equipment that prevents calls from stolen, unauthorized, or defective mobile stations. The AUC and EIR are implemented as stand-alone nodes or a combined AUC/EIR node.

The Base Station System (BSS) — The BSS consists of Base Station Controllers (BSCs) and the Base Transceiver Stations (BTSs). All radio-related functions are performed in the BSS.

Base Station Controller (BSC) — The BSC provides all the control functions and physical links between the MSC and the BTS. This high-capacity switch provides functions such as handover, cell configuration data and control Radio Frequency (RF) power levels in base base transceiver stations. An MSC serves a number of BSCs.

Base Transceiver Station (BTS) — The BTS handles the radio interface to the mobile station. The BTS is the radio equipment (transceivers and antennas) needed to service each cell in the network. BTS groups are controlled by a BSC.

The Operation and Support System (OSS) — The operations and maintenance center (OMC) is connected to all equipments in the switching system and the BSC. The implementation of OMC is called the Operation and Support System (OSS). From the OSS, which is the functional entity, the network operator monitors and controls the system from the OSS. The OSS offers the customer cost-effective support for centralized, regional, and local operational and maintenance activities required for a GSM network. Providing a network overview, supporting the maintenance activities of different operation and maintenance organizations is the important function of OSS.

ADDITIONAL FUNTIONAL ELEMENTS

Message Center (MXE) — The MXE is a node providing integrated voice, fax, and data messaging. The MXE specifically handles short message service, call broadcast, voice mail, fax mail, e-mail, and notofication.

Mobile Service Node (MSN) — This node handles the mobile intelligent network (IN) services.

Gateway Mobile Services Switching Center (GMSC) — A gateway is a node that is used to interconnect two networks. When the gateway is implemented in an MSC, the latter is then referred to as the GMSC.

GSM Internetworking Unit (GIWU) — The GIWU consists of hardware and software providing an interface to various networks for data communications. Through the GIWU, users can alternate between speech and data during the same call. The GIWU hardware equipment is physically located at the MSC/VLR.[4]

FEATURES OF GSM

Quality

Sound quality is sharp and clear with digital. Static, background sounds and crossed-line conversations are eliminated. Compared to analogue, there are few dropouts and quality is more like that of a fixed telephone.

Security

Conversation in the digital network is safe and secure in comparison to analogue. User authentication prohibits unauthorised access, distribution of encryption key guarantees privacy of the callee/caller identification restrictions that can prevent the delivery of the calling user's number to the receiver.

Convenience

The user can get twice the talk time from each battery charge compared to analogue. More calls can be handled at any one time, thus reducing congestion in areas where population is dense and the usage is high.

Roaming

The user can use his/her mobile phone and number in countries around the world where GSM network is operated. Alternatively, the user can take his/her SIM card and use another GSM phone. The user's home carrier has to have a roaming agreement in place and has to be notified before leaving so that the user's mobile can be activated in that country. The user just has to switch on the phone at his/her destination and will be able to automatically log into the network. In some countries, the user's old SIM can be used. However, in some countries, the user will need to get a loan SIM from his/her carrier before going there. This will give the user a new number whilst in that country, but the user can set up a diversion to the number, if necessary.

GSM Phase 1 features

- Call Forwarding
- All Calls
- No Answer
- Engaged
- Unreachable
- Call Barring
- Outgoing — Bar certain outgoing calls (e.g., ISD).
- Incoming — Bar certain incoming calls (Useful if in another country).
- Global roaming — The user can visit any other country with GSM and a roaming agreement and use his/her phone and existing number.

GSM Phase 2 features

- SMS (Short Message Service) allows the user to send text messages to and from phones.
- Multi Party Calling — The user can talk to five other parties at the same time.
- Call Holding — Place a call on Hold.
- Call Waiting — Notifies the user of another call whilst on a call.
- Mobile Data Services allows handsets to communicate with computers.
- Mobile Fax Service allows handsets to send, retrieve and receive faxes.
- Calling Line Identity Service — This facility allows the user to see the telephone number of the incoming caller on our handset before answering.
- Advice of Charge allows the user to keep track of call costs.
- Cell Broadcast allows the user to subscribe to local news channels.
- Mobile Terminating Fax — The user is issued with another number with which he/she receives faxes that he/she can then download to the nearest fax machine.

GSM Phase 2 + features

- Available by 1998
- Upgrade and improvements to existing services
- Majority of the upgrade concerns data transmission, including bearer services and packet switched data at 64 kbps and above
- DECT access to GSM
- PMR/Public Access Mobile Radio (PAMR)-like capabilities
- GSM in the local loop
- Virtual Private Networks
- Packet Radio
- SIM enhancements
- Premium rate services (e.g., Stock prices sent to the user's phone)

GSM 96 features

Services of GSM 96 are : TS11 (basic speech), TS12 (emergency calls/112), SMS MT, Call forwarding/Call barring services and data/fax. Then there are E96 services, services to be implemented for roamers before end 1996. The only service in this section is ODB Phase 2. (ODB = Operator Determined Barring). E97 is SMS MO (Short Message/Mobile Originated). The list for E98 is longer. One reason is to put pressure on suppliers. Services included are CAMEL (to support PNP as a start), SOR, USSD, HSCSD and GPRS.[5]

STRENGTHS OF GSM

- GSM is already used worldwide with over 450 million subscribers.
- GSM is mature, having started in the mid-80s. This maturity means a more stable network with robust features.
- GSM's maturity means engineers cut their teeth on the technology, creating an unconscious preference.
- The availability of Subscriber Identity Modules, which are smart cards that provide secure data encryption giving GSM m-commerce advantages.[6]

WEAKNESSES OF GSM

- High cost,
- Unreliable connections,
- Restricted bandwidth, and
- Exposure to loss of confidentiality and integrity.[7]

REFERENCES

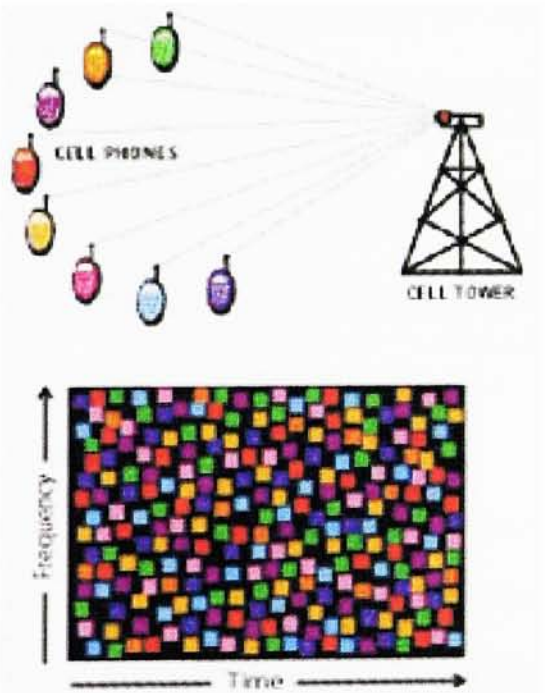
[1] http://www.webopedia.com/TERM/G/GSM.html
[2] http://www.mobileworld.org/gsm_about_01.html
[3] http://www.gsmworld.com/index.html
[4] http://www.iec.org/online/tutorials/gsm/topic03.html
[5] http://www.mobileworld.org/gsm_about_04.html
[6] http://www.mcommercetimes.com/Technology/95
[7] http://www.brownsbox.com/gsm.htm

Code Division Multiple Access (CDMA)

CDMA (Code Division Multiple Access) is a radically modern concept in wireless communications. CDMA is a form of spread-spectrum as well as a family of digital communication techniques that has been used in military applications for many years. Its history goes back to the early days of World War II.

The use of CDMA for civilian mobile radio applications were proposed theoretically in the late 1940's, but practical application in the civilian marketplace took place nearly 40 years later.

Because of two evolutionary developments, commercial applications became possible — Availability of very low cost, high density digital integrated circuits, which help in reducing the size, weight, and cost of the subscriber stations to an acceptably low level. Realizaton that optimal multiple access communication require that all user stations regulate their transitter powers to the lowest, capable of achieving adequate signal.[1]



CDMA is a digital technique enabling cell phone users to share a frequency channel. Each wireless signal is split into many "chips" of data, each of which is tagged with the cell phone user's code. The chips are spread over a band of frequencies during transmission, then reassembled at the receiving end.[2]

CDMA's "spread spectrum" technology means that it spreads the information contained in a signal of interest over a much greater bandwidth than the original signal. A CDMA call starts with a standard rate of 9600 bits per second (9.6 kilobits per second). This then

spreads to a transmitted rate of about 1.23 megabits per second. Spreading means that digital codes are applied to the data bits associated with users in a call. These data bits are transmitted with all other signals of other users in that call. Upon receipt of the signal, the codes are removed from the desired signal, separating the users, and returning the call to a rate of 9600 bits per second.[3]

CDMA is often described by many with a language analogy, e.g., if we imagine different people sitting in a room and conversing with each other in different languages. A person can discern the language or languages known to him/her from others. Although all sounds (signals) are received by that person's ear, his/her ability to filter out the superfluous conversations is analogous to a CDMA receiver examining the relevant code in the signals and filtering out those that are not pertnent.[4]

CDMA is altering the face of cellular and PCS (Personal Communications Service) communication by :

- Dramatically improving the telephone traffic capacity,
- Dramatically improving the voice quality and eliminating the audible effects of multipath fading,
- Reducing the incidence of dropped calls due to handoff failures,
- Providing reliable transport mechanism for data communications, such as facsimile and Internet traffic,
- Reducing the number of sites needed to support any given amount of traffic,
- Simplifying site selection,
- Reducing deployment and operating costs because fewer cell sites are needed,
- Reducing average transmitted power,
- Reducing interference to other electronic devices, and
- Reducing potential health risks.[1]

Strengths

- Increased cellular communications security.
- Simultaneous conversations.
- Increased efficiency, meaning that the carrier can serve more subscribers.
- Smaller phones.
- Low power requirements and little cell-to-cell coordination needed by operators.
- Extended reach — beneficial to rural users situated far from cells.

Weaknesses

- Due to its proprietary nature, all of CDMA's flaws are not known to the engineering community.
- CDMA is relatively new, and the network is not as mature as GSM.
- CDMA cannot offer international roaming.[5]

REFERENCES

[1] http://www.cdg.org/tech/a_ross/Intro.asp
[2] http://www.sciam.com/2000/1000issue/1000harveybox2.html
[3] http://www.cdg.org/tech/about_cdma.asp
[4] Emerging Communications Technologies (Second Edition) — Uyless Black
[5] http://www.mcommercetimes.com/Technology/95

Satellite Wireless

Currently, the only way to send and receive Internet data via satellite is by having a company install a VSAT which costs $10,000.00 or more for a setup. A VSAT is a satellite dish primarily used in WANs (Wide Area Networks), but it can also be used to access the Internet.[1]

Satellite Wireless works pretty much like satellite television does — a small satellite dish is attached to a residence or business (about 24 inches to 36 inches) to send and receive signals to and from a satellite in stationary orbit 22,000 miles above the earth. The satellite relays data between the client and his/her Internet Service Provider, which has a direct connection to the Internet. There is a special modem connected to the client's computer which deciphers and encodes his/her incoming and outgoing transmissions to and from the satellite.[2]

Strengths

- Its "always on" (like other broadband connection) and does not tie up the phone line.
- It is seven times faster than a 56 Kbps dial-up connection.[2]
- Companies and households located in remote areas of the world or in poor communications networks can place small VSAT antennas on their roofs and bypass the country's PTT.
- VSATs require less space and less power, making them ideal for corporate voice and data networks.[3]

[PTT : Post, Telephone, and Telegraph administration. The PTT's, usually controlled by their governments, provide telephone and telecommunication services in most foreign countries.][4]

Weaknesses

- The size and price of VSAT takes it beyond the reach of most households and businesses.[1]
- Since, signals cover so much distance between the client, the satellite, and the ISP, there is slight delay in transmissions (1/4 of a second or less).[2]
- "Rain fade" occurs during severe storms. A wall of rain is so dense that the satellite signal has problems in reaching the satellite dish and this proves to be a problem to the new, upcoming satellite-based Internet technologies.
- From the latest available information, clients of satellite Internet services may need some type of terrestrial Internet connection as a back-up option so that they can maintain an Internet connection during severe weather.[1]

REFERENCES

[1]http://www.smartcomputing.com/editorial/article.asp?article=articles%2Farchive%2Fg0807%2F09g07%2F09g07%2E.asp

[2] http://www.earthlink.net/blink/feb01/cover3.html

[3] Introduction to Telecommunications — M. A. Rosengrant

[4] Newton's Telecom Dictionary — Harry Newton