e-Gov@Gujarat - An *e-Governance* Bulletin from GUJARAT INFORMATICS LTD.

This issue covers technical details on WLL *Technologies*

Vol. 1 l No. 10
September 2003

Gyan Ganga

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WLL Technologies

Courtesy:

Shri Anupam Bhatnagar

(Consultant)

Editorial Team

- Neeta Shah
- Amrish Panchal

Gyan Ganga Project

"A project to connect the rural areas of Gujarat using Wireless in Local Loop (WLL) technology"

The Government of Gujarat has taken considerable initiative in digitization of public domain information (e-Governance) and delivery of IT services through G2C and C2G initiatives. The Department of Science & Technology (DST) spearheads such efforts and is actively & independently supported by Gujarat Informatics Ltd. (GIL), the nodal agency for IT promotion and implementation in the state.

Background

The project is envisaged to connect the rural areas using Wireless in Local Loop (WLL) technology in the state of Gujarat.

The Government of Gujarat has taken considerable initiative in digitization of public domain information (e-Governance) and delivery of IT services through G2C and C2G initiatives. The Department of Science & Technology (DST) spearheads such efforts and is actively & independently supported by Gujarat Informatics Ltd. (GIL), the nodal agency for IT promotion and implementation in the state.

Gujarat is already the leading state in creating IT infrastructure in the state with a strong focus on the deployment of such infrastructure for Government functioning. The Gujarat State Wide area Network is already the largest IP-based network in the Asia- Pacific region and connects the state headquarters upto the Taluka headquarters. The need has been identified to take further the reach of the electronic medium up to the doorstep of the citizen residing in the villages. Such last mile connectivity will truly foster the process of eGovernance and will assist in abolishing the digital divide and bring the rural citizen closer to his Government. Economic & cheap technology, which will make rural connectivity feasible and sustainable has been developed by Prof. Ashok Jhunjhunwala and the research group (TeNet) at IIT, Madras in the form of the CorDECT technology, using the concept of Wireless in Local Loop.

It is planned to take full advantage of this indigenously developed technology by putting together a self-sustainable model with private participation. Gujarat Informatics Ltd, on behalf of the Government of Gujarat, proposes to tie-up with the IIT, Madras promoted company, n-Logue Communications to implement the project to establish rural connectivity using CorDECT technology across the Gujarat state.

Objectives

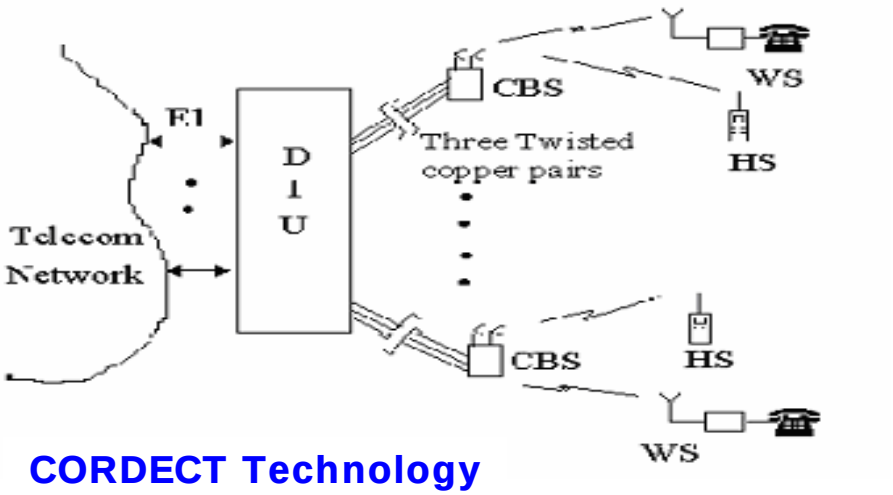
The objectives of this promising project are as follows:

- ✓ Utilize IT to increase the efficiency and productivity of the existing infrastructure and local enterprise by setting up a state-of-the-art computer communication networks
- ✓ Provide agricultural, medical, and educational information to villagers at Facilitation Booths in their villages
- ✓ Provide communication facilities at the booths to link villagers to the local intranets
- ✓ Bring the world's knowledge at the doorstep of villagers through the Internet
- ✓ Provide distance education to both primary and higher educational institutes
- ✓ Establish a Geographical Information System (GIS) of the surrounding villages leading to greater transparency in administration especially in matters related to land.

Technology

corDECT is India's very own Wireless Local Loop technology, jointly developed by Analog Devices Inc., Midas Communication Technologies (P) Ltd. and TeNeT group, IIT Madras.

Based on the Digital Enhanced Cordless Telecommunications standard specified by the European Telecommunications Standards Institute (ETSI), corDECT provides cost-effective, **simultaneous** high-quality voice and data connectivity in both urban and rural areas.



CORDECT Technology

WLL Technologies

This revolutionary new technology provides voice communication using 32 Kbps ADPCM, and Internet connectivity at 35/70 Kbps.

Background

India is a large country where we find 70% of the population living in the rural areas.

The rural region is a vast consumer base which has not yet been tapped , it is a region were technological development has wider scope as part of the Rural eGovernance. The scope is for such technological development which is cost effective and can provide a effectve rural connectivity. In Gujarat there are 25 Districts and a total of 1600 village,

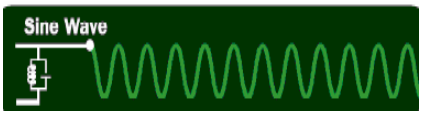
Therefore connecting each corner of the rural region is still not possible using a leased connectivity as there has to be capacity building and infrastructure support to do . Which is costly and . reaching each corner in a rural region is a high cost input .

What are option available that connects each corner of a rural region and be an effective part of the eGovernance and cost effective solution , the solution is simple wireless technology " No New Wire " free from hurdles of leased circuits a transmission via air via radio waves . Wireless networking technologies take the concept of "no new wires" one step further. In a wireless network, all of the computers in your network broadcast their information to one another using radio signals. This can make networking extremely easy, especially if you have computers in one area (e.g. Home or Office). It also makes it a whole lot simpler to move computers around in the area without much of disturbance. For example, a laptop with a wireless network card is completely portable throughout the house! In wireless networking, a peer-to-peer (or point-to-point) wireless

network means that each computer can communicate directly with every other computer on the network. But some wireless networks are client/ server. They have an access point, which is a wired controller that receives and transmits data to the wireless adapters installed in each computer wireless-Ethernet specification, known as IEEE 802.11, designated two ways of communicating between devices and allowed for speeds up to 2 Mbps. Both communication methods, direct-sequence spread spectrum (DSSS) and frequency-hopping spread spectrum (FHSS), use the frequency-shift keying (FSK) technology based on spread-spectrum radio waves in the 2.4-gigahertz (GHz) range. Spread spectrum simply means that data is sent in small pieces over a number of the discrete frequencies available for use at any time in the specified range. Devices using direct-sequence spread spectrum (DSSS) communicate by splitting each byte of data into several parts and sending them concurrently on different frequencies. DSSS uses a lot of the available bandwidth, about 22 megahertz (MHz). Devices using frequency-hopping spread spectrum (FHSS) send a short burst of data, shift frequencies (hop) and then send another short burst. Since the FHSS devices that are communicating agree on which frequencies to hop to, and use each frequency for a brief period of time (less than 400 milliseconds) before moving on, several independent FHSS networks can exist in the same physical area without interfering with each other. Also, due to FCC restrictions, as well as the fact that FHSS devices generally send data on just two to four frequencies simultaneously, they only use 1 MHz or less of the available bandwidth. Because they use any given frequency for such a short time, FHSS devices are less prone to interference than DSSS devices. But DSSS is capable of much greater speed than FHSS since these devices can send a lot more data at the same time. Currently, FHSS-based devices are easier and cheaper to produce, which has led the HomeRF group to adopt FHSS as the method of communication.

All radios today, however, use continuous sine waves to transmit information (audio, video, data). The reason that we use continuous sine waves today is because there are so many All radios today, however, use continuous sine waves to transmit information (audio, video, data).

The reason that we use continuous sine waves today is because there are so many different people and devices that want to use radio waves at the same time. If you had some way to see them, you would find that there are literally thousands of different radio waves (in the form of sine waves) around you right now -- TV broadcasts, AM and FM radio broadcasts, police and fire radios, satellite TV transmissions, cell phone conversations, GPS signals, and so on. It is amazing how many uses there are for radio waves today). Each different radio signal uses a different sine wave frequency, and that is how they are all separated.



In our country in respect to wide connectivity we find GSM and CDMA and our own indigenous developed Technology CORDECT IIT madras . Let us examine the technology for purpose Rural connectivity.

GSM

From the beginning, the planners of GSM wanted ISDN compatibility in terms of the services offered and the control signaling used.

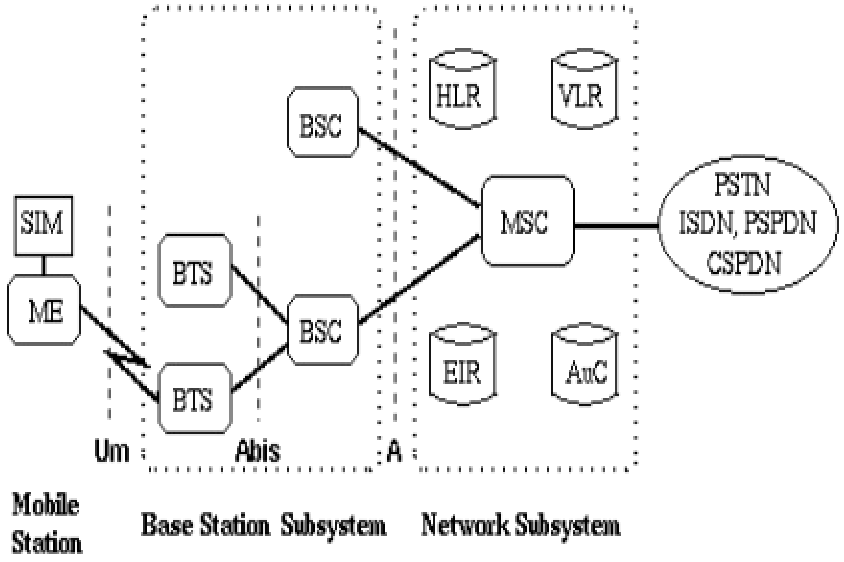
However, radio transmission limitations, in terms of bandwidth and cost, do not allow the standard ISDN B-channel bit rate of 64 kbps to be practically achieved. Using the ITU-T definitions, telecommunication services can be divided into bearer services, teleservices, and supplementary services. The most basic teleservice supported by GSM is telephony. As with all other communications, speech is digitally encoded and transmitted through the GSM network as a digital stream. There is also an emergency service, where the nearest emergency-service provider is notified by dialing three digits (similar to 911). A variety of data services is offered. GSM users can send and receive data, at rates up to 9600 bps, to users on POTS (Plain Old Telephone Service), ISDN, Packet Switched Public Data Networks, and Circuit Switched Public Data Networks using a variety of access methods and protocols, such as X.25 or X.32. Since GSM is a digital network, a modem is not required between the user and GSM network, although an audio modem is required inside the GSM network to interwork with POTS.

Architecture of the GSM network

A GSM network is composed of several functional entities, whose functions and interfaces are specified.

The GSM network can be divided into three broad parts. The Mobile Station is carried by the subscriber. The Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the

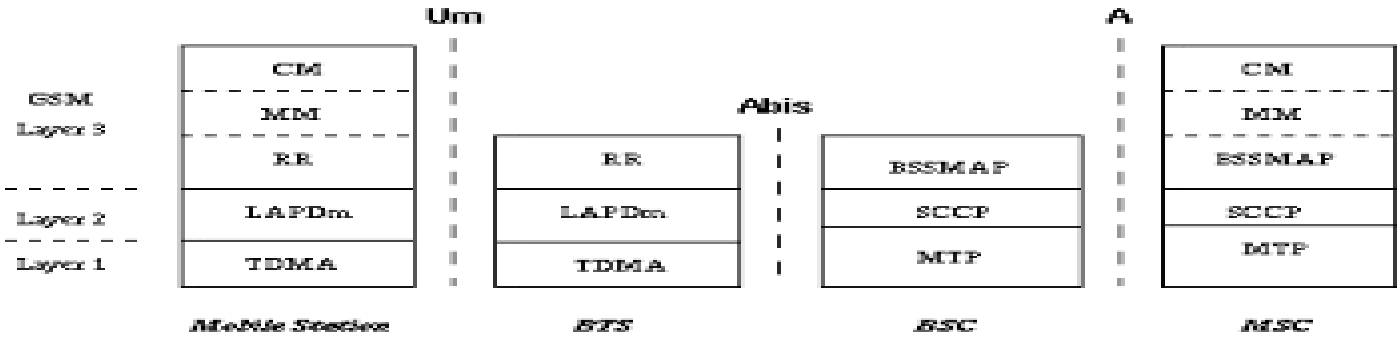
main part of which is the Mobile services Switching Center (MSC), performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. Not shown is the Operations and Maintenance Center, which oversees the proper operation and setup of the network. The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link The Base Station Subsystem communicates with the Mobile services Switching Center across the A interface.



SIM Subscriber Identity Module
ME Mobile Equipment
BTS Base Transceiver Station
BSC Base Station Controller
HLR Home Location Register
VLR Visitor Location Register
MSC Mobile services Switching Center
EIR Equipment Identity Register
AuC Authentication Center

General architecture of a GSM network

Ensuring the transmission of voice or data of a given quality over the radio link is only part of the function of a cellular mobile network. A GSM mobile can seamlessly roam nationally and internationally, which requires that registration, authentication, call routing and location updating functions exist and are standardized in GSM networks. In addition, the fact that the geographical area covered by the network is divided into cells necessitates the implementation of a handover mechanism. These functions are performed by the Network Subsystem, mainly using the Mobile Application Part (MAP) built on top of the Signalling System No. 7 protocol.



Signaling protocol structure in GSM

The signaling protocol in GSM is structured into three general layers, depending on the interface, which uses the channel structures discussed above over the air interface. Layer 2 is the data link layer. Across the Um interface, the data link layer is a modified version of the LAPD protocol used in ISDN, called LAPDm. Across the A interface, the Message Transfer Part layer 2 of Signaling System Number 7 is used. Layer 3 of the GSM signaling protocol is itself divided into 3 sub layers.

Radio Resources Management

Controls the setup, maintenance, and termination of radio and fixed channels, including handovers.

Mobility Management

Manages the location updating and registration procedures, as well as security and authentication.

Connection Management

Handles general call control, similar to CCITT Recommendation, and manages Supplementary Services and the Short Message Service.

GSM *cost per line (Rs.)*

ITEM: Rural + urban 4000K Tender
INFRA STRUCTURE: 6,000
HAND SET mobile: 5,000
LINES per 100 SQ. KMS: 2,000

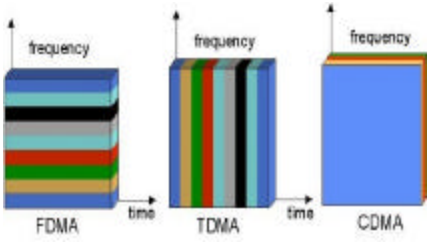
ITEM: Rural + urban 10000K Tender
INFRA STRUCTURE: *4*,500
HAND SET mobile: *2*,500
LINES per 100 SQ. KMS: *4*,000

CDMA

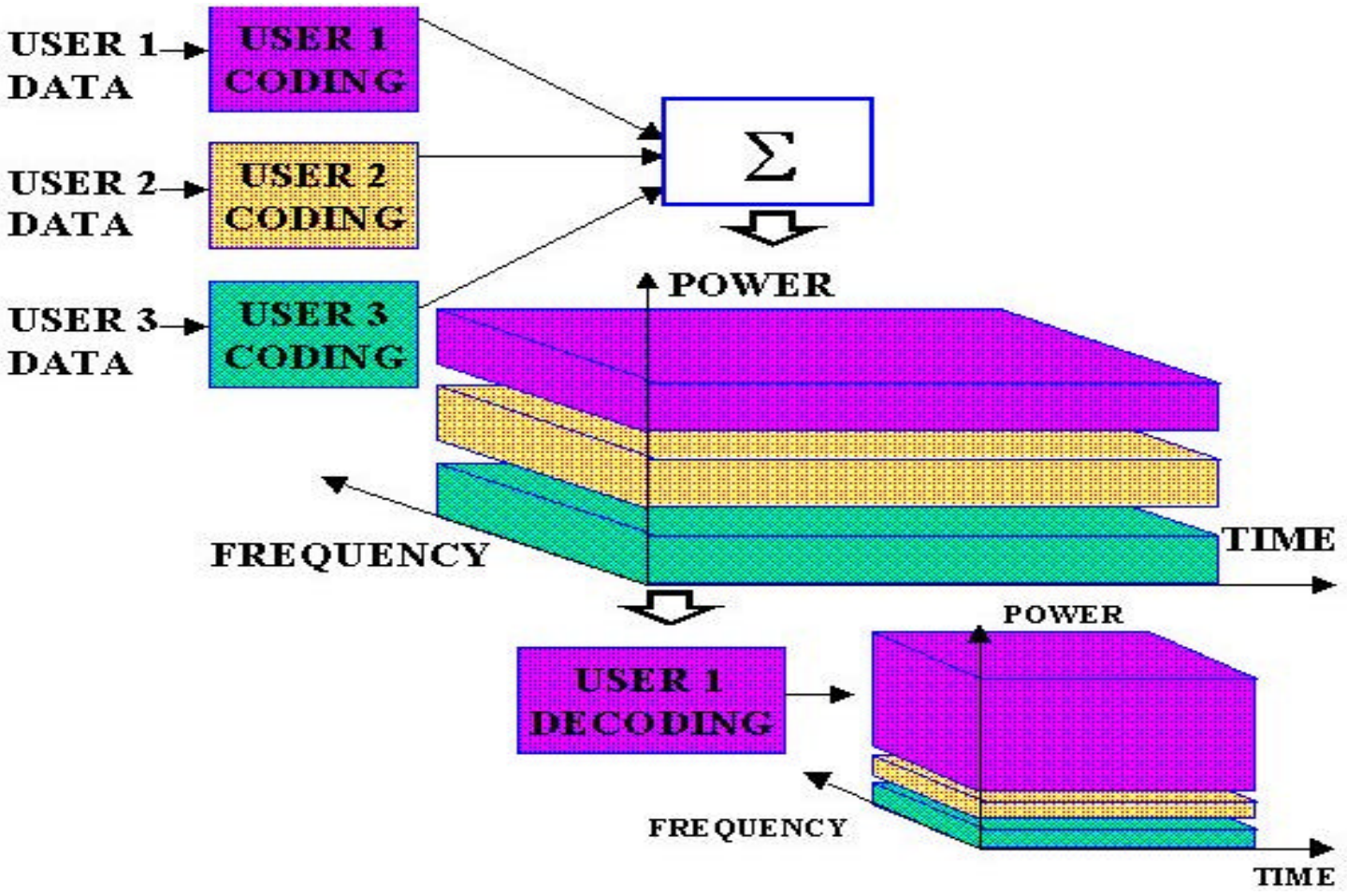
For radio systems there are two resources, frequency and time

Division by frequency, so that each pair of communicators is allocated part of the spectrum for all of the time, results in Frequency Division Multiple Access (FDMA). Division by time, so that each pair of communicators is allocated all (or at least a large part) of the spectrum for part of the time results in Time Division Multiple Access (TDMA).

In Code Division Multiple Access (CDMA), every communicator will be allocated the entire spectrum all of the time. CDMA uses codes to identify connections.



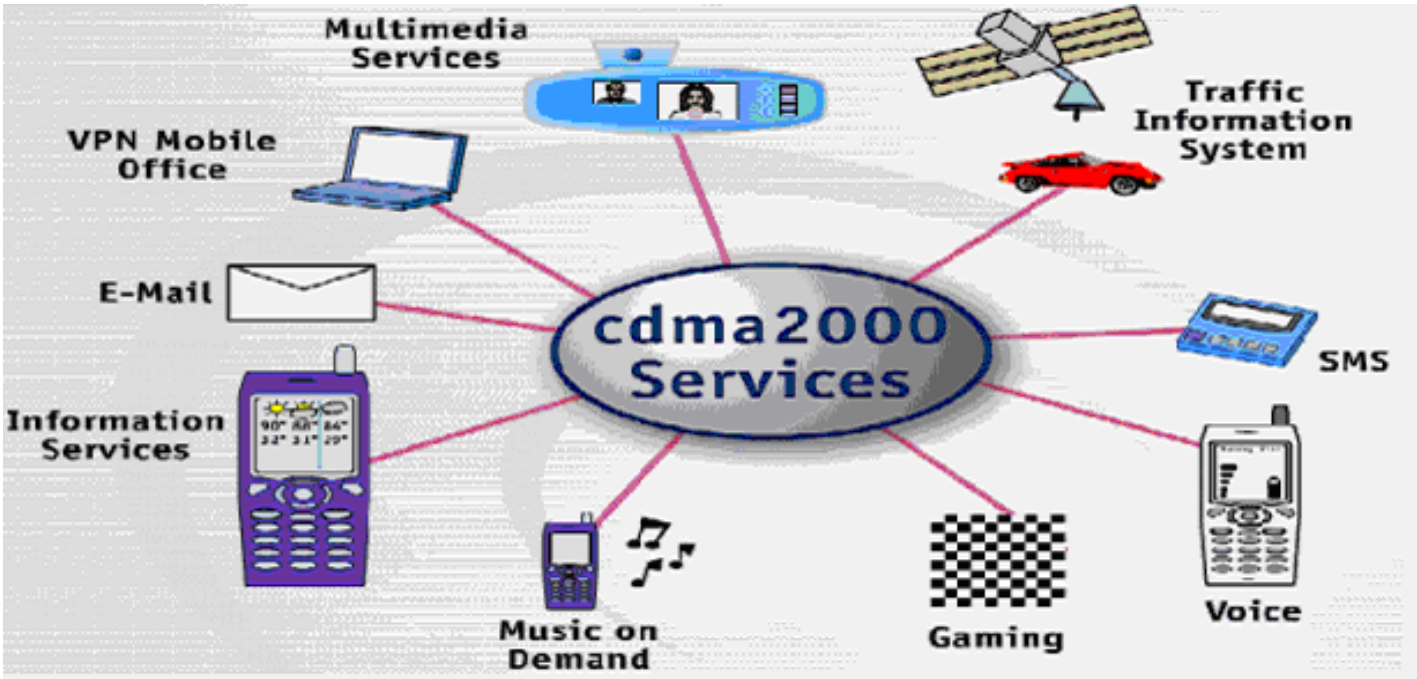
CDMA uses unique spreading codes to spread the base band data before transmission. The signal is transmitted in a channel, which is below noise level. The receiver then uses a correlator to dispread the wanted signal, which is passed through a narrow band pass filter. Unwanted signals will not be dispread and will not pass through the filter. Codes take the form of a carefully designed one/zero sequence produced at a much higher rate than that of the base band data. The rate of a



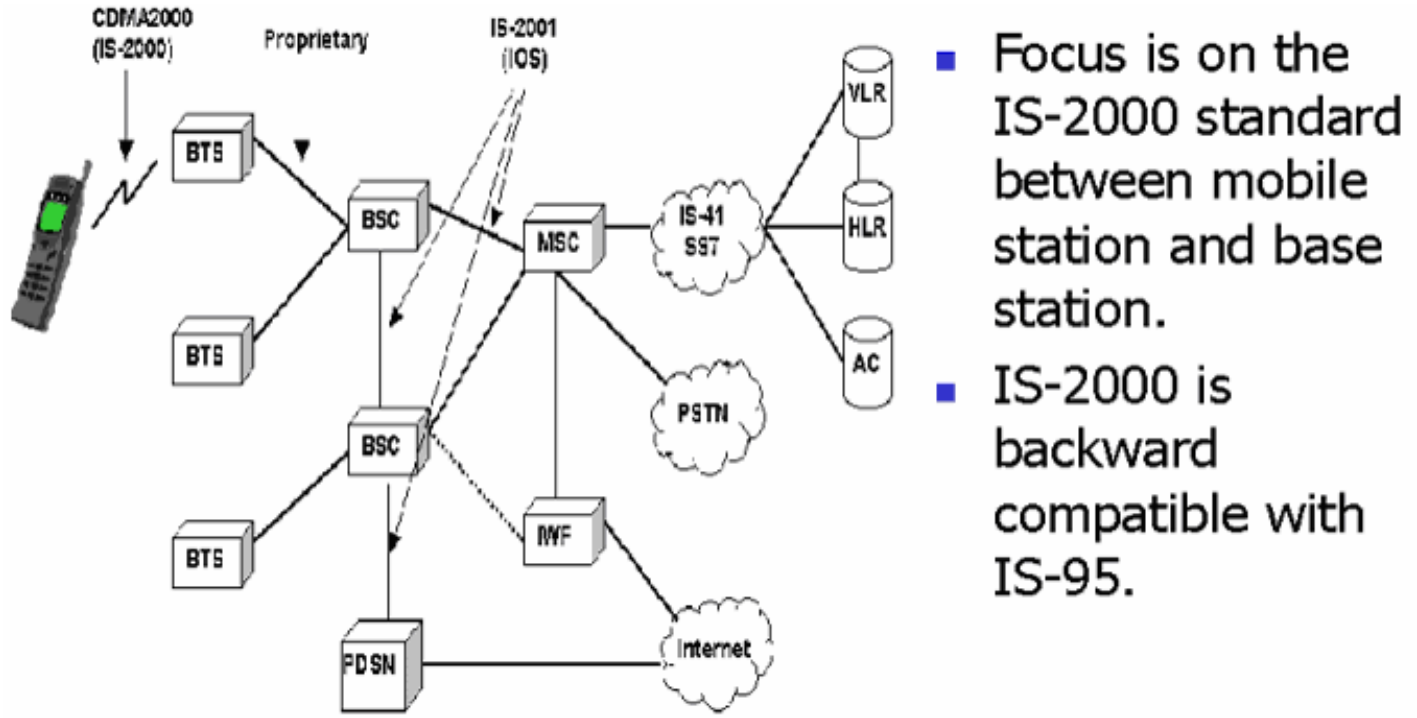
CDMA codes are not required to provide call security, but create a uniqueness to enable call identification. Codes should not correlate to other codes or time shifted version of itself. Spreading codes are noise like pseudo-random codes, channel codes are designed for maximum separation from each other and cell identification codes are balanced not to correlate to other codes of itself.

One of the main advantages of CDMA systems is the capability of using signals that arrive in the receivers with different time delays. This phenomenon is called multipath. FDMA and TDMA, which are narrow band systems, cannot discriminate between the multipath arrivals, and resort to equalization to mitigate the negative effects of multipath. Due to its wide bandwidth and rake receivers, CDMA uses the multipath signals and combines them to make an even stronger signal at the receivers. CDMA subscriber units use rake receivers. This is essentially a set of several receivers. One of the receivers (fingers) constantly searches for different multipaths and feeds the information to the other three fingers. Each finger then demodulates the signal corresponding to a strong

multipath. The results are then combined together to make the signal stronger.

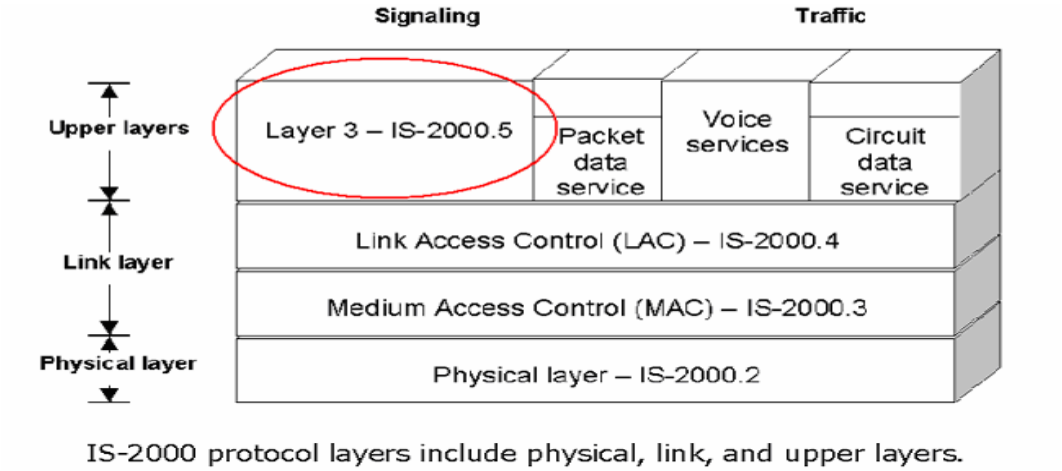


A wide range of data and enhanced services are provided by CDMA2000.



- Focus is on the IS-2000 standard between mobile station and base station.
- IS-2000 is backward compatible with IS-95.

CDMA2000 network components



IS-2000 protocol layers include physical, link, and upper layers.

GSM Vs CDMA

The Basics GSM: The Global System for Mobile Communications (GSM) divides the users by frequency channels and time slots. The available spectrum (4.4 MHz – 6.2 MHz in India) is first split 200 kHz channels, which are then chopped sequentially into time slices. Users of the channel take turns in their allotted time slots in a round robin fashion; thus only one person is using the channel but he uses it for very short bursts (about 577 micro seconds). Further to optimize the frequency usage and cover the large areas, the total available channels (22 for 4.4 MHz) are split into 7 reusable groups. To avoid interference at the boundaries of cells, no adjacent cell shares the same frequency channels. CDMA: Code Division Multiple Access (CDMA) on the other hand, lets everyone transmit at the same time. CDMA works by assigning unique codes to all speech bits and the encrypted signals are dispersed over a wide frequency spectrum (1.25 MHz). The signals are picked out by the receiver's equipment that is tuned/programmed to identify that code. In contrast to GSM, same frequency channels are used in each cell

The GSM calls for heavy capital investment in the form of costly base stations with negligible operating cost. All the cost we pay them is their capital cost.

CDMA *cost per line (Rs.)*

ITEM	*INFRA STRUCTURE*	*HAND SET*		*LINES per 100 SQ. KMS.*
		Fixed	*Mobile*	
Rural Tender 600K (2000)	17,500	12,500	-	25
Urban Tender 56K (2000)	11,500	12,500	12,000	50
500K Tender (2001)	8,500	9,500	6,500	100
Projected V5.2 (2002)	5,000	8,500	5,000	200

CORDECT Technology

The Traditional local loop used to connect each telephone subscriber to the nearest exchange which was expensive and not reliable .Wireless local loop system eliminates the copper wires and provide a cost effective solution CORDECT is one such WLL system based on the Dect (Digital Enhanced Cordless telecommunication) standard. Which provides toll quality ,voice and data capabilities below the cost of wired local loop.

For purpose of high density subscriber micro- cell and dynamic channel selection (DCS) is used.

Wireless technology can provide a cost effective solution to te local loop problems . The wireless service facilitates easy expansion of the network and at the same time installation is easy. One such wireless system is the CORDECT wireless system developed by Telnet Group of the IIT Madars .

The CORDECT system consists of four sub systems which are:

- ✓ Dect Interface Unit (DIU) which performs system control and interface to the public switched telephone network (PSTN)
- ✓ Compact Base Station (CBS) which provides wirless access to the subscriber in a area on a 12 simultaneous channel.
- ✓ WallSet (WS) Wireless fixed terminal adopter that can be connected to any standard Telephone, Modem or Fax machine.
- ✓ Handset (HS) Portable telephone set for voice.

The DIU consist of an OMC (Operation and maintenance Control) .The OMC is a Personal Computer (PC) which provide a used interface to the operator for performing system operation, maintenance, remote fault monitoring, subscriber registration and billing.

How CORDECT Works

Employing Multi-Carrier Time Division Multiple Access (MC-TDMA), a technique in which the frequency can change from one time slot to another, DECT defines a wireless communication standard between a Fixed Part (FP) and a Portable Part (PP). Communication takes place using Gaussian Frequency Shift Keying (GMSK) Modulation.

This new system uses a frame of 10 msec in which 24 time slots are defined. Communication between FP and PP is time-division duplex in which 12 time slots are used for a one way

transmission. In a 20 MHz frequency spectrum, 10 carriers are defined. Thus, for communication from PP to FP, 10 carriers can be used in each of the 12 time slots, amounting to 120 channels

In DECT, no channel is permanently assigned to any FP or PP. Which means, any PP can select any of the 120 channels to communicate with a FP using the Dynamic Channel Selection (DCS) algorithm? The algorithm requires the PP to measure Receive Signal Strength (RSSI) on all the 120 channels. It locks to the FP providing the strongest signal and then maintains a RSSI table for all other channels. When a PP tries to establish a connection, it chooses the channel providing lowest interference. Even while a communication process is taking place, the RSSI table is periodically updated and if a channel with less interference than the current one is found, a seamless handover to the new channel takes place.

ETSI has specified the 1880 - 1935 MHz band for DECT. Normally any 20 MHz band out of this spectrum can be chosen for operation. Each DECT channel can carry 32 kbps of payload, and the voice coding employed in DECT is 32 kbps.

The CORDECT subscriber terminal, called Wallset, provides an RJ-11 telephone port and an RJ-232 serial port for simultaneous internet access using a PC. The Internet access speed is 35/70 Kbps. The CORDECT system has been designed such that it can be easily integrated with the existing network. The system interfaces to the network on E1 (2.048 Mbps) lines as per ITU-T G703 standard. In one of the configurations, the CORDECT system acts like a switch along with the wireless local loop. The numbering plan is flexible so that it can be modified as per the requirements. The tones, announcements, metering, charging, switching, routing and special services are provided by the `switch part' of the CORDECT system. Alternatively, CORDECT can also be configured as an Access Network connected to a main exchange using ITU-T specified access protocol V5.2.A transparent version with two-wire analog interface to any exchange is also available for quick rollout.

CORDECT has been designed to be a modular system. While the basic unit provides service to up to 1000 subscribers, multiple CORDECT systems can be connected together using a transit switch. The system has been designed in such a way that the initial investment for the Fixed Part is low. Further, since this scheme does not require frequency planning, the installations need not be coordinated. Coupled with the low cost, it thus makes CORDECT one of the most versatile Wireless in Local Loop systems available today.

After successful field trials by the Department of Telecommunications (DoT) at several sites in India, and by Telebras, the Brazilian counterpart of DoT, at Sau Paulo, Brazil, the technology has now been licensed to a few companies in India, Singapore, Tunisia and Brazil.The system has been deployed in Mumbai and Delhi. Systems are operational in Madagascar, Figi, Kenya, Tunisia, Argentina and Nigeria. The CORDECT system is poised to change the every million of people connect to the world.

CRITERIA	IS-95 (Qualcomm's CDMA)	DECT (IIT-M's CORDECT)
Overview	IS-95 GSM, IS-54, IS-136 are mobile communication standards to provide medium quality voice (8 kbps/13kbps) communication for people on the move in a macro-cell (3 km- 20 km).The calling rate is assumed to be low and data communication is an exception.	DECT, PHS and PACS are standards to provide phones at offices and homes. They provide high-quality voice (32kbps/64 kbps) communication for people at homes and operate on a microcell (100m-3 km). The calling ratye is assumed to be high (as high as 20% during busy hours) and fax/data communication is routine.
Multiple access	IS-95 uses Code Division Multiple Access, a pioneering technique in digital communication. Based on the spectrum technologies developed in the Sixties and used extensively by the defence, CDMA exploits multipath propagation to time diversity * and provides a high rouse of spectrum (almost rouse in every cell).	DECT uses Multi-Carrier-Time Division Multiple Access with Dynamic Channel Selection, a pioneering technique evolved in wireless operation without any frequency planning. It provides frequency system efficiency several times more than Fixed Channel Allocation Techniques used by the other systems.
Modulation	Office QPSK	QPSK (BT-0.5)
Voice bit-rate	8 kbps or 13 kbps vocoder quality	32 kbps toll quality
Voice band data/fax	None	9.6 kbps
Data communication/fax	9.6 kbps **	28.8 kbps (single slot) 64.0 kbps (double slot) 552 kbps (multiple slot)
N-ISDN support	No	Yes
Asymmetric data link	No	Yes

No. of channels in the 20 MHz spectrum	146 (8 kbps with VAD) 320 *** (8 kbps with VAD) 128 (13 kbps with VAD) 200 (13 kbps with VAD)	120
Multiple operators on the same frequency band	No	Yes
Receiver threshold	105 dBM (under normal system)	86 dBM, 90 dBM
LOS Range (approx)	25 km	5 km 10 km in CORDECT 25 km in Relay Base Station
Range for portable HS (approx)	1-3 km	200-500m
Mobility	100 km/hour	5 km/hour
Base station size	2 m	0.05 m
Interface to PSTN	E1 with R2-MF, V 5.2	E1 with R2-MF or V 5.2
Total cost per line	Rs. 40,000 - 50,000	Rs 10,000 - 15,000

Conclusion

When we are looking at making rural connectivity, the technology has to be affordable and catering to the India environment connectivity demand. The India rural environment is not as sophisticated as that of Europe and America. Here if we therefore provide a sophisticated technology like for rural connectivity will not serve the interest CORDECT which understand our rural environment and has the proven capabilities will serve as a backbone for rural connectivity. There are number of issue which needs to be addressed in rural connectivity toward eGovernance with respect to wirless connectivity.

MoU between Gujarat Informatics Ltd. On behalf of Govt. of Gujarat and n-Logue Pvt. Ltd. for GYAN GANGA (Rural Connectivity) Project

"A memorandum of understanding was signed between Gujarat Informatics Limited, Department of Science & Technology, Government and n-Logue Communications Pvt Ltd, TeNet Group, promoted by IIT, Chennai in the presence of Hon'ble CM Shri Narendra Modi for establishing Rural Connectivity under the Gyanganga Project"

An Apex Body headed by Secretary, Science & Technology, GoG and Prof Ashok Jhunjhunwala, IIT Chennai has been formed for coordination and monitoring of Rural Connectivity Project.

State Government

1. A grant of Rs 2.25 crores has been sanctioned by the State Govt to set up 15 Access Centres at the rate of Rs. 15 lac per Access Center Hub.
2. 15 locations will be identified for implementation of this project based on state government's priority as well as commercial and operational viability.
3. APEX body will be coordinating and monitoring the implementation of this project.
4. A transparent procedure will be followed for appointment of Local Service Providers.
5. Information related to education will be provided by State Government.
6. The secondary and higher secondary schools of the state will be computerized and connectivity will also be provided to them through this project. These schools will be provided with a Wireless Antenna and Receiving System.
7. State Government with the help of its different departments and agencies will provide information related to Agriculture, Medical and Social Welfare Schemes at village level.
8. State Government will do the necessary to provide land on lease after considering the location of tower for implementation of this project at District & Taluka level.
9. State Government will do the needful for making loans available through Local Service Provider/ Kiosk Operator Bank/ Other Financial Institutes/ Other Government Schemes.

n-Logue Communications Pvt. Ltd.

10. n-Logue, Chennai will open its office in the state.
11. n-Logue will decide the Local Service Provider at District/Taluka Level. The Local Service Provider will carry out daily administration of the Access Center Hub.
12. n-Logue will provide Internet connectivity to the villages (Data, Voice and Video).
13. n-Logue will be responsible for providing Software, Connectivity, Hardware and any other facility required to Local Service Provider.
14. n-Logue will obtain permission from BSNL for providing Telephony Services.
15. n-Logue will also provide training to Kiosk operators for implementation of this project.

Few snaps of the great event

Web Corner

Collector - Ahmedabad
www.collectorahmedabad.gujarat.gov.in

Collector - Vadodara
www.collectorvadodara.gujarat.gov.in

Collector - Surat
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Contact Address:
Gujarat Informatics Ltd.
Block No. 1, 8th Floor,
Udyog Bhavan,
Gandhinagar – 382017
Phone: 079 – 3256022
Fax: 079 – 3238925