

Second Generation cellular systems - Subscribers have handsets at outdoor locations as well. They cover few hundreds of meter with a specific base station. If user is outside the range of base station, the call may disconnect.

* OVERVIEW OF GENERATIONS OF CELLULAR SYSTEMS -

Cellular telephone system provides wireless connection to the PSTN for users located within the range.

The generations of cellular systems as followed:

- 1) 1G : Analog Cellular Networks - Able to transfer calls from one site to next during a conversation as the user is moving.
- 2) 2G : Digital Networks - Use GSM Standard, Digital transmission instead of analog, fast phone to network signaling, less battery consumption, clear voice because of digital coding, reduced noise.
- 3) 2.5G (GPRS) - GPRS provide high data rate from 56 kbit/s to 115 kbit/s. Used for Wireless Application Protocol (WAP) access, Multimedia Messaging & Internet.
- 4) 2.75G (EDGE) - Extended version of GSM. Data rates upto 384 kbit/s.
- 5) 3G : High Speed IP Data Networks - Use packet switching instead of circuit switching for data transmission. Speeds upto 1.8, 3.6, 7.2 & 14.0 Mbit/s.

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6) 4G & Growth of Mobile Broadband: Extension of 3G technology with more bandwidth & services. High quality audio/video streaming. Voice calls in 4G are treated like any other type of streaming audio media via VoIP.

4G ~~area~~ is available in 2 standards \rightarrow WiMAX & LTE.

4GLTE \rightarrow 100 Mbit/s download & 50Mbit/s upload.

WiMAX \rightarrow 128 Mbit/s download & 56Mbit/s upload.

In this voice switching is packet as well whereas

in 1G, 2G, 3G voice switching was Circuit based switching

	Standards	Technology	SMS	Voice Switching	Data Switching
1G	AMPS, TACS	Analog	No	Ckt	Ckt
2G	GSM, CDMA, GPRS, EDGE	Digital	Yes	Ckt	Ckt
3G	UTMS, HSPDA	Digital	Yes	Ckt	Packet
4G	LTE, WiMax (IEEE 802.16)	Digital	Yes	Packet	Packet

* COMPARISON OF COMMON WIRELESS COMMUNICATION SYSTEM-

Service	Coverage Range	Regd. Infra Structure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote Control	Low	Low	Low	Low	Infrared Transmitter	
Garage door Opn	Low	Low	Low	Low	< 100MHz	11

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MOBILE COMPUTING

- * Refer Page: ③ & ④ from Wireless Communication.
- * Review of generation of Mobile Services

* OVERVIEW OF WIRELESS TELEPHONY

Wireless telephony is the provision of telephone services to phones which may move around freely rather than stay fixed in one location.

The mobile phones connect to a base station & satellite phones are connected to orbiting satellites. Both networks are interconnected to PSTN so that any phone in the world can be dialed.

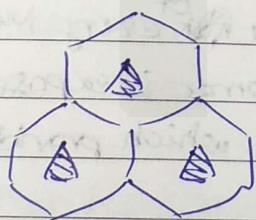
* THE CELLULAR CONCEPT -

(area covered)

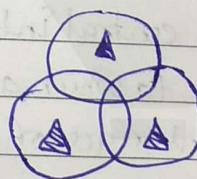
Cell: The coverage area of mobile base station.

So, for every cell there is a base station.

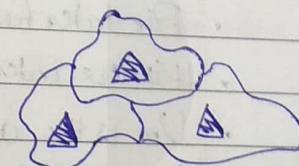
Cell
Fundamentals :



Theoretical Coverage



Ideal Coverage



Real Coverage

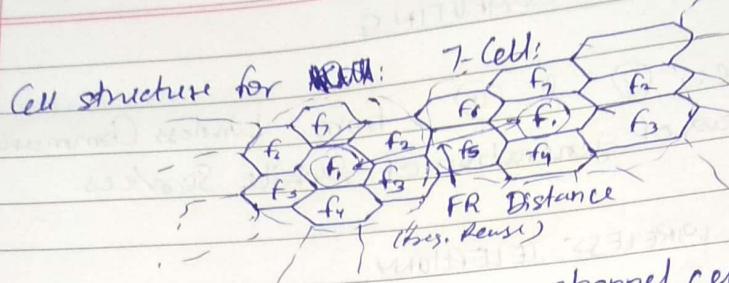
Frequency Reuse Concept: Frequency Reuse Distance is maintained between two same frequencies of clusters.

Cluster may be made up of 3, 4, 7, 9, 12, 13, 16 etc. cells. But most commonly used are 7-cell & 4-cell clusters to cover an area.

In simpler words, Frequency reuse implies that in a given coverage area, there are several cells that use same set of frequencies.

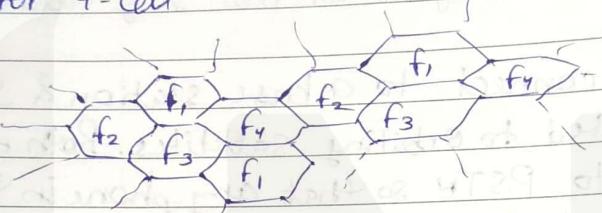
These channels are also called Co-channel cells & interference b/w signals from these channels is called Co-channel Interference.

Cell structure for ~~Health~~:



f_1-f_1 , f_2-f_2 , ..., f_n-f_1 are co-channel cells.

for 4-cell



Advantages of cell structures: High number of users

Less Power Needed

Base Station deals with interference locally

* GSM AIR INTERFACE -

- Air Interface is central interface ~~of~~ every Mobile System.
 - It is the interface to which a customer is exposed.
 - Um is the air interface of GSM which provides physical link b/w mobile & network.
 - GSM utilizes a combination of FDMA & TDMA on Air Interface that results in 2-D structure.

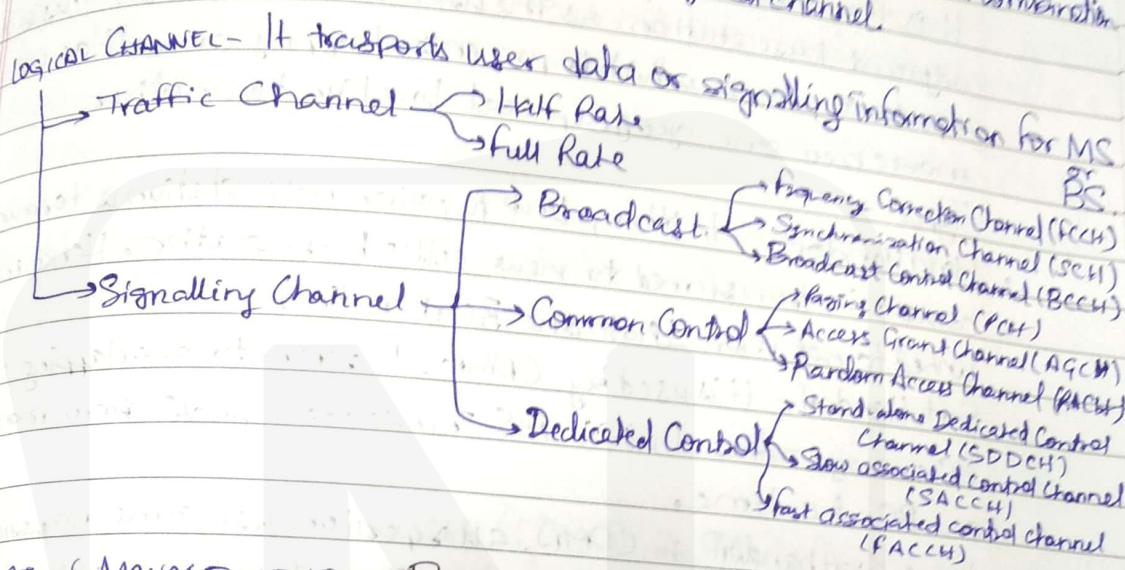
* CHANNEL STRUCTURE :

Channels: Used in air interface

→ Physical Channel - Medium over which information is carried

→ Logical Channel - Information carried over physical channel.

Physical CHANNEL - When MS & BTS communicate, they do so on Radio Frequency (RF) carriers within a given time slot. This combination of time slot & carrier frequency forms physical channel.



locally

* **LOCATION MANAGEMENT** - Page 15 WIRELESS COMMUNICATION

* HLR-VLR:

- **Home Location Register (HLR)** - It is mobile operator database which includes details of subscribers such as phone number, current network location, billing details, number status. These details are accessible by MSC & VLR.
- **Visiting Location Register (VLR)** - It supports roaming functions for users outside coverage area of their own HLR. It contains same data as HLR with updates in network location. VLR can locate in which network + the number is currently roaming.

The main difference b/w them is that HLR has permanent data while VLR changes data all the time & is temporary.

* MOBILITY MANAGEMENT - (LOCATION MANAGEMENT)

It is one of the major functions of GSM network that allows mobile phones to work. The aim of mobility management is to track where subscribers are & thus, allowing the calls, SMS & other services to be delivered to them.

- Location update procedure - It allows mobile device to inform the cellular network when it moves from one location area to the next.
- TMSI - The Temporary Mobile Service Identity is the identity that is sent between the mobile & the network. TMSI is randomly assigned by VLR to every mobile in the area, the moment it is switched on. This number is local to a location area, hence it is updated each time mobile moves to a new geographical area.
- Roaming - It is ability for a cellular customer to make & receive voice calls, send/receive data or access other services when travelling outside geographical coverage area or home network by means of using a visited network.

* HANDOFFS-

It is the transition for a user from one base station to adjacent base station as the user moves around. This is an important process which prevents dropping of call as user moves from one geographical location to another.

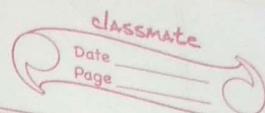
Types-

- Hard Handoff - In this, link to prior base station is terminated as user is transferred to new cell's base station. Hence, mobile is linked to not more than one BS at a time.
- Soft Handoff - It is used by CDMA. It refers to overlapping of BS coverage zones. In this, MS transceive signals from more than one BS at a time.

Hence, soft handoff in CDMA, all repeaters use same frequency channel for each mobile set. Each set's identity is based on a code.

Types of GSM Handover - because of

- Intra-BTS Handover - It occurs due to interference. In this, mobile remains attached to same BTS but changes channel.
- Inter-BTS Intra BSC Handover - It occurs when mobile moves out of coverage area of one BTS but controlled by same BSC. In this, BSC assigns new channel & slot to mobile before releasing old BTS.
- InterBSC Handover - When mobile moves out of range of BSC, handover is performed not only from one BTS to another but one BSC to another as well. This handover is controlled by MSC.
- Inter MSC Handover - It occurs when changing b/w networks. In this, Two MSC involve to control the handover.



CHANNEL ALLOCATION -

- * H deals with allocation of channels to calls in cellular network. Types:
 - 1) Fixed Channel Allocation: FCA system allocate specific channel to specific cells. It is static & can't be changed. FCA system allocate channel in a way which maximize frequency use.
 - 2) Dynamic Channel Allocation: In DCA system, there is no relationship b/w channel & cells. Whenever a channel is needed by a cell, the channel is allocated such that frequency requirements cannot be violated.
 - 3) Hybrid Channel Allocation: It includes all systems that are hybrids of fixed & dynamic channel allocation schemes.

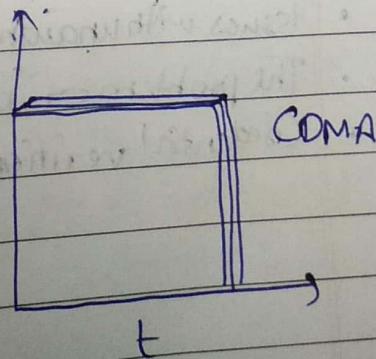
* CDMA -

Code Division Multiple Access (CDMA) is digital wireless technology that uses spread spectrum techniques. It provides channel access to multiple users simultaneously. Only one channel carries transmission from all users simultaneously.

Each bit in ~~radio~~ signal is replaced by code to create high bandwidth signal. Codes are different for different users.

Advantages: Dropouts in CDMA occur only if MS is atleast twice as far from the base station.

Disadvantages: Lacks international roaming, changing handset is not easy as the network information is stored in phone unlike GSM which stores information in SIM card.



* GPRS-

General Packet Radio Service (GPRS) is packet based wireless communication service that provides high data rates. It is based on Global System for Mobile (GSM) Communication as it implements packet switch network domain along with circuit switched domain of GSM.

It costs less than circuit switched services.

It supports Wireless Application Protocol (WAP), SMS, MMS etc. GPRS uses GSM network nodes such as MSC/VLR, HLR & BSS. New network nodes for packet data are:

- 1) Serving GPRS Support Node (SGSN) - It is responsible for authentication of GPRS mobiles, registration of mobiles in network, mobility mgmt.
- 2) Gateway GPRS Support Node (GGSN) - It acts as interface & router to external networks. It contains routing information for GPRS mobiles.

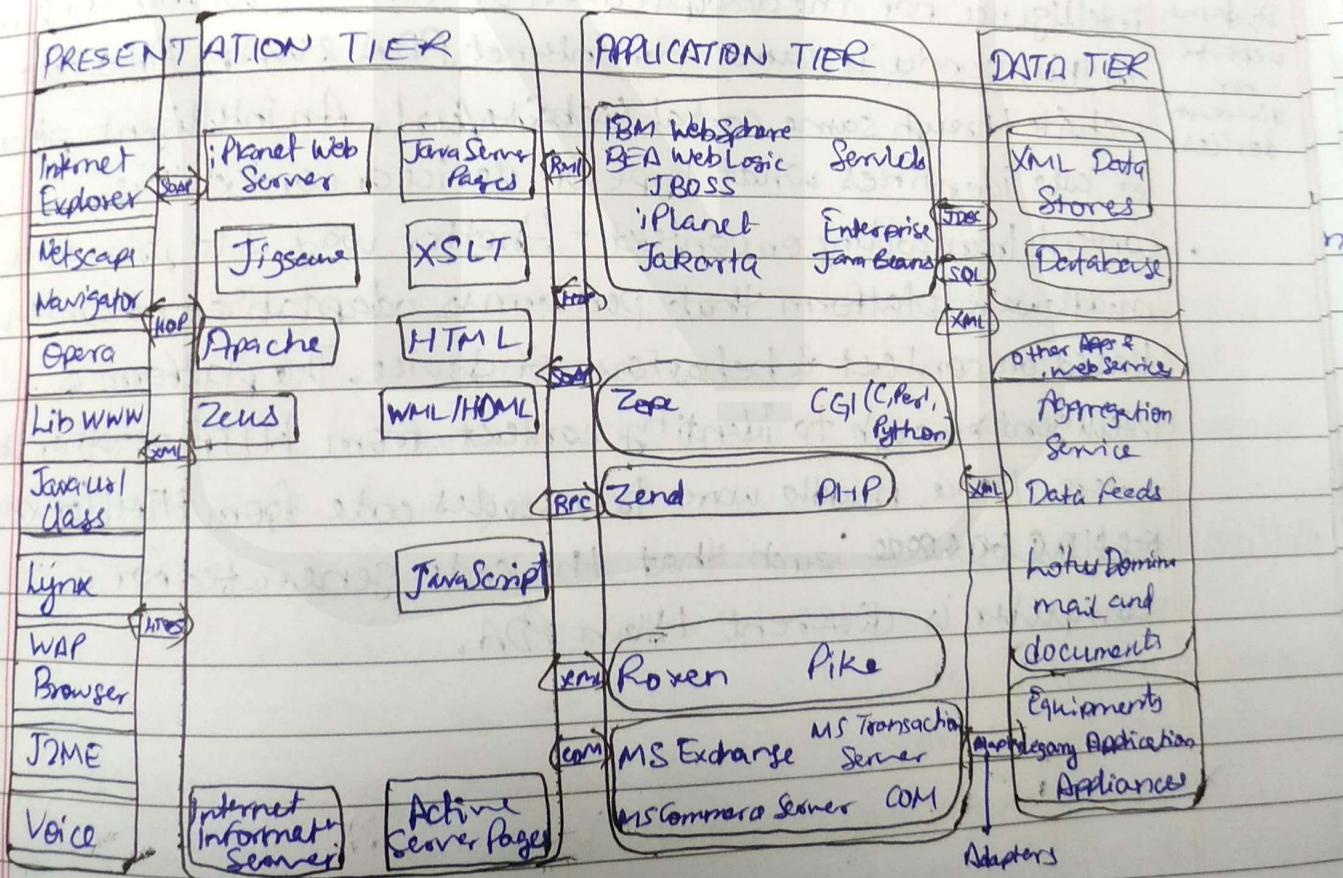
Unit-I : Ch-2

* ISSUES IN MOBILE COMPUTING-

- Due to its nomadic nature, it's not easy to monitor proper usage.
- Hacking, piracy, malicious destruction, fraud are some of the problems experienced by Mobile Computing.
- Issues with unauthorized access to data & information by hackers.
- The problem of identity theft is very difficult to eradicate.
- Credential verification is also a big problem in mobile computing.

* THREE TIER ARCHITECTURE FOR MOBILE COMPUTING

- PRESENTATION (TIER-1) : This is the user facing system in first tier. These applications run on client device & offer user interface. This tier is responsible for presenting information to the end user.
- APPLICATION (TIER-2) : It performs the processing of user input, obtaining data & making decisions. This layer transcode data for rendering in presentation tier. These functions are implemented using middleware software which is in between OS & User facing software. It includes JAVA, JSP, .NET, PHP etc.
- DATA (TIER-3) : It is used to store data needed by application & act as repository, both temporary & permanent data. Data can be stored in any form of database. Database middle ware run between application program & database.





* DESIGN CONSIDERATIONS

Mobile computing environment needs to be content independent as well as context sensitive. "Context" means information that helps determine state of an object.

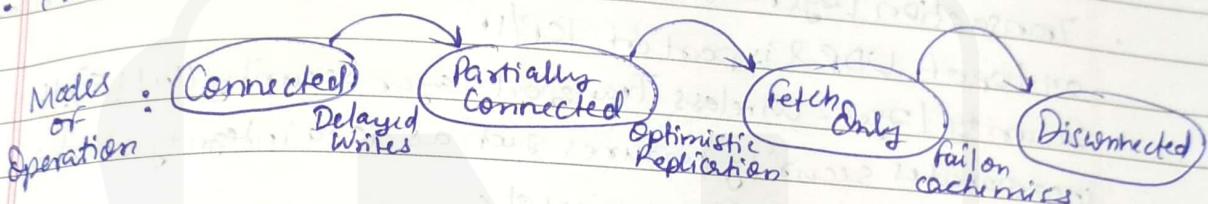
Object can be a person, a device, a place, a physical or computational object.

There are many ways in which context can be adapted:

- Content with context awareness - Build each application with context awareness. There are different services for different website for different device client context (devices). For example, the websites are designed in different way for laptops, mobiles and PDAs etc. i.e., display & UI is different in each of them. (^{www.site.com/wap/}_{palmtop/}^{internet/})
- Content switch on context - Another way is to provide intelligence for the adaptation of content within the service. In this, service is same for Internet, PDA & WAP. All access website through same portal ~~website url~~. An intelligent piece of code identifies what type of device or context it is.
- Content transcoding on context - Another way is to provide a middleware platform that performs adaptation of content based on context & behaviour of device. The platform is intelligent enough to identify context from HTTP or other parameters. Hence, middle ware translates code from HTML (or XML) ~~to HTML code~~ such that the code generated for a computer is different than PDA.

* MOBILE FILE SYSTEMS-

- Mobile File Systems ~~allow~~ allow mobile users to run applications that access shared files over a mobile network.
 - Applications behave same regardless of where user is located.
 - Adaptability is the main goal of Mobile File Systems.
- Characteristics of Mobile File Systems-
- Provide location transparency
 - Provide cache consistency.
 - Provide scalability.



Coda Distributed File System is used in which files are grouped into volumes which are replicated on Coda Servers.

* MOBILE DATABASES-

Mobile Database is a database that is transportable, portable & physically detached from corporate database server but has capability to communicate with those servers from remote sites allowing sharing of data.

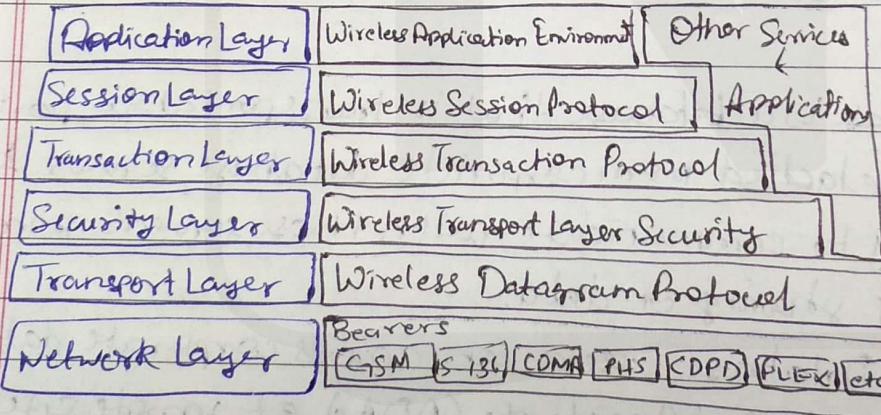
With Mobile Database, users can access corporate data on their laptop, Personal Digital Assistants (PDAs) at remote sites.

Corporate database server & DBMS in mobile database environment deals with storing corporate data & providing corporate applications. Two main issues with mobile database are management of mobile database & communication between mobile & corporate database.

Examples of Mobile Database: SQL Server Express (Microsoft), DB2 Everywhere (IBM), Oracle (Oracle)

* WAP ARCHITECTURE AND PROTOCOL STACK

- Wireless Application Protocol is designed in a layered fashion so that it can be extensible, flexible & scalable. WAP protocol stack is divided into 5 layers -
- Application Layer - Wireless Application Environment (WAE) It contains device specifications, WML, WMLScript.
 - Session Layer - Wireless Session Protocol (WSP). Provide fast connection suspension & reconnection
 - Transaction Layer - Wireless Transaction Protocol (WTP). It runs on top of UDP & is part of TCP/IP.
 - Security Layer - Wireless Transport Layer Security (WTLS). It incorporates security features such as data integrity checks, privacy, authentication services etc.
 - Transport Layer - Wireless Datagram Protocol (WDP): It presents consistent data format to higher layers of WAP protocol stack.



BLUE PEN - WAP Layered Architecture

BLACK PEN - WAP Protocol Stack

* DATAGRAM PROTOCOL -

Wireless Datagram Protocol, short for WDP. Datagram Protocol, defines the movement of information between source & destination over wireless IP network.

It provides interface to upper layers of protocol stack.

WDP performs 3 basic tasks: Port Addressing, Segmentation of datagrams & Reassembly of packets at receiving end.

WDP does not confirm data gram delivery, resend lost packets or correct errors during transmission.

* WIRELESS TRANSPORT LAYER SECURITY -

- It is a security protocol which is a part of WAP protocol stack.
- WTLS is based on industry standard Transport Layer Security (TLS).
- It provides transport layer security between a WAP client & WAP Gateway/Proxy.
- WTLS goals are data integrity, privacy, authentication, Dos protection.
- It is specifically designed for wireless environments which is needed to authenticate client & server so that wireless transactions between them remain secure.
- WTLS is used to encrypt the connection.

For example, user making transaction with bank over a wireless device needs to know that the connection is secure. Hence, WTLS is needed as mobile networks do not provide complete end-to-end security.

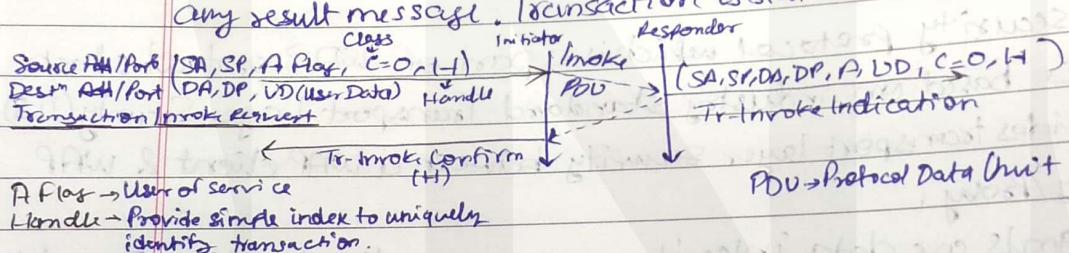
* WIRELESS TRANSACTION PROTOCOL-

WTP is a standard used in mobile telephony. It is a layer of WAP that is intended to bring Internet access to mobile phones.

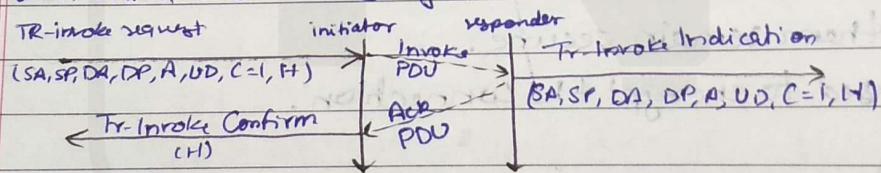
- WTP runs on top of UDP & performs many of the same tasks as TCP optimized for wireless devices.
- Each transaction has unique identifiers, acknowledgements, duplicates removal & retransmission.
- WTP has no security mechanisms.

Types of classes in WTP -

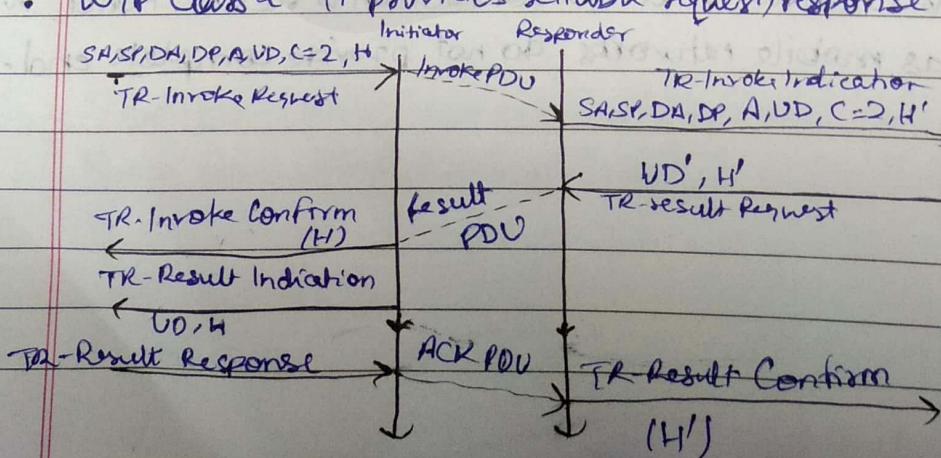
- WTP Class 0 - It provides unreliable message transfer without any result message. Transaction is stateless & can't be aborted.



- WTP Class 1 - It offers reliable transaction service but without a result message.



- WTP Class 2 - It provides reliable request/response transaction.



* WIRELESS SESSION PROTOCOL -

- WSP is open standard for maintaining high level session.
- Wireless session is normal Web browsing session that starts when user connects to one url & ends when user leaves that url.
- It provides shared state between client & server used to optimize content transfer.
- WSP has following features for content exchange b/w client & server.
- Session Management : Sessions can be established from client to server & may be long lived. Sessions can be released in orderly manner.
- Content Encoding : Binary encoding of the content it transfers.
- Capability Negotiation : Client & servers agree upon a common protocol functionality during session establishment.

There are 2 types of WSPs -

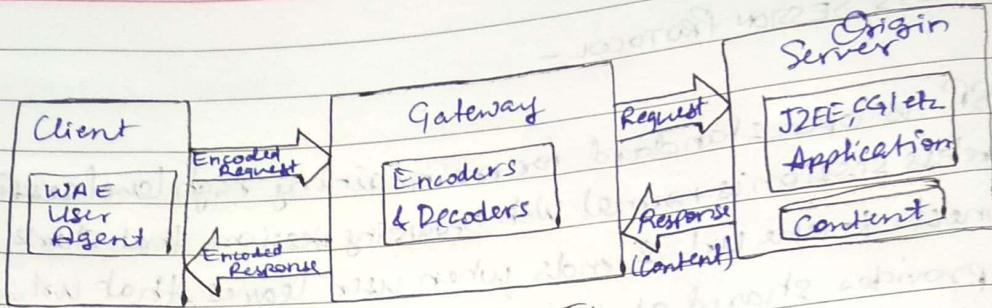
- 1) Connectionless WSP (CL-WSP) : Offers unreliable transport of WSP primitives, both pull (request & response) & push (single message) transfer.
- 2) Connection-oriented WSP (CO-WSP) : It enhances HTTP 1.1's performance & offers same services as CL-WSP extended with session management, larger data transfer (segmentation & reassembly) & reliable data transport (acknowledgement mechanism).

* WAP APPLICATION ENVIRONMENT -

Primary objective of WAP application environment is to provide an interoperable environment to build services in wireless space.

Content is transported using standard protocols in WWW domain & optimized HTTP-like protocol in wireless domain.

WAE architecture allows all content & services to be hosted on standard Web Servers.



WAE LOGICAL MODEL

Major elements of WAE model include:

- 1) User Agent: The browser or a client program.
- 2) Content Generators: These are applications on origin server that extract standard content in response to requests from user agents.
- 3) Standard Content Encoding: It allows WAE user agent to navigate web content.
- 4) Wireless Telephony Applications (WTA): Extensions for calls, telephony feature control.

* APPLICATIONS OF WAP -

- Accessing the internet from mobile devices.
- Games can be played from mobile devices over wireless devices.
- Online banking via mobile phones.
- Browsing weather & traffic alerts.
- Email, voicemail on mobile devices.
- Location based services like mapping vehicle location information.

Unit-2: Ch-1

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* WIRELESS LAN OVERVIEW -

A wireless local area network (WLAN) is a wireless computer network that links two or more devices using wireless communication within a limited area such as home, school, office etc.

This enables users to move around within a local coverage area & still be connected to the network.

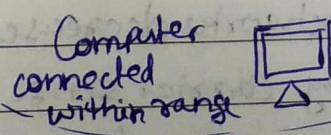
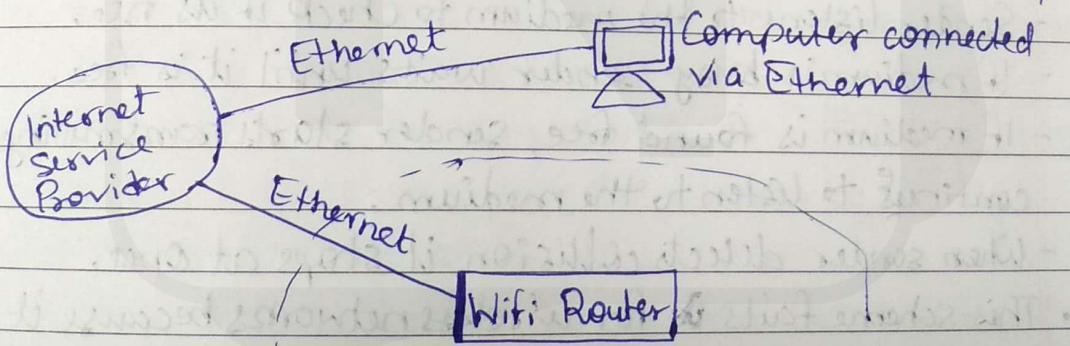
They are also called "Wi-Fi".

Advantages:

- 1) People can access network whenever they want & aren't limited by length of cable.
- 2) Setting up of WLAN is done with Wireless Router.
- 3) Router can handle more than one connections at same time.

Disadvantages:

- 1) WLAN use radio waves. Hence; special care is needed for encryption.
- 2) Reliability issues are there due to interference from other devices.
- 3) Router has fixed range. To extend range, more routers are required.



WLAN ARCHITECTURE

* IEEE 802.11 -

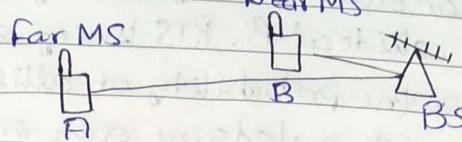
It is the name for series of protocols used for wireless networking. They are called as WLAN, Wireless LAN or Wi-Fi. They allow computers to communicate with each other without using cables.

- It was first Wi-Fi standard.
- It was made in 1997.
- It delivers speed of 1-2 Mbps.
- IEEE 802.11 introduced forward error correction.
- It specified 3 physical layer technologies - Diffused Infrared, Frequency Hopping Spread Spectrum, Direct Sequence Spread Spectrum.

* MOTIVATION FOR SPECIALIZED MAC

- One of the most popular MAC (Medium Access Control) schemes for wired network is Carrier Sense Multiple Access with Collision Detection (CSMA/CD). In this scheme CSMA/CD =
 - Sender listens to the medium to check if its free.
 - If medium is busy, sender waits until it is free.
 - If medium is found free, sender starts transmitting data & continues to listen to the medium.
 - When sender detects collision, it stops at once.
- This scheme fails for wireless networks because it is interested only in collisions that can occur in receivers & not in sender.
- Signal in wireless networks decreases as it travels larger distances.
- A sender may apply carrier sense & detect medium as idle & start transmitting over medium that result in collision. This problem is called Hidden Terminal Problem.
- Same can happen during collision detection i.e., sender ~~standard~~ detects no collision & assumes data has been transmitted without errors whereas collision could've damaged the data at the receiver.
- Therefore we can't use CSMA/CD of MAC for wireless networks.

* NEAR FAR TERMINALS-



A & B, both are sending signals with same transmission power.
Signal strength decreases proportional to square of distance.
Hence, BS is unable to receive A's transmission.

This is the near far problem in CDMA. All signals must arrive at receiver at same strength otherwise the communication quality will be severely degraded.

Precise power control is needed to receive all senders with same strength at the receiver.

* MULTIPLE ACCESS WITH COLLISION AVOIDANCE (MACA)-

MACA is a simple scheme that solves hidden terminal problem.

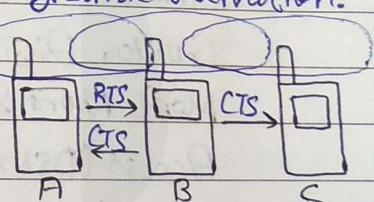
It uses random access Aloha Scheme but with dynamic reservation.

In this case, A & C both want to send to B,

A has already started transmission, but

it is hidden for C, so C also starts transmission

Hence collision occurs at B.



With MACA, A doesn't start transmission at once but sends Request to Send (RTS) first. B receives RTS that contains name of sender & receiver & length of future transmission. RTS is not heard by C & B triggers acknowledgement called Clear To Sent CTS. This CTS is heard by C & medium is reserved by A for duration of transmission. Hence, C is not allowed to send anything for the duration indicated in CTS. Hence, collision can't occur at B & hidden terminal problem is solved.

Still, collision can occur during sending RTS. Both A & B could send RTS that collide at B. RTS is very small as compared to data transmission so the probability of collision is much lower. B resolves this by acknowledging only one station at a time.

* POLLING SCHEME -

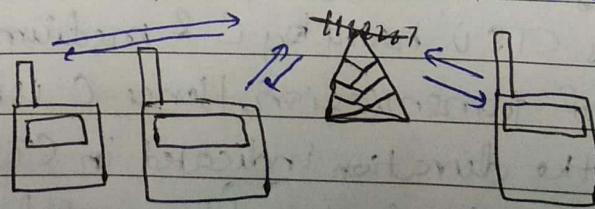
Polling schemes are used when one station wants to be heard by others. Polling is strictly centralized scheme with one master & several slave stations. The master can poll slaves according to many schemes: round robin (only efficient if traffic patterns are similar overall stations), randomly, according to reservation etc. The master can also establish list of stations wishing to transmit during contention phase. After this phase, the station polls each station on the list.

* INHIBIT SENSE MULTIPLE Access -

This scheme is used for packet data transmission service. Cellular Digital Packet Data (CDPD) in the AMPS (Advanced Mobile Phone System) is also known as Digital Sense Multiple Access (DSMA). Here, the BS only signals a busy medium via a busy tone on downlink. After busy tone stops, accessing uplink is not coordinated any further.

The BS acknowledges successful transmission, a MS detects collision only via missing positive acknowledgement.

In case of collisions, retransmission mechanisms are implemented



ISMA using Busy Tone

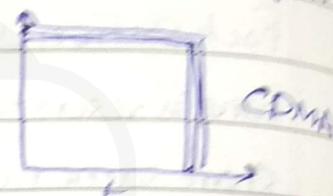
* SPREAD SPECTRUM -

Spread spectrum is a form of wireless communication in which frequency of transmitted signal is deliberately varied. This results in much greater bandwidth than the signal would have if its frequency were not varied.

Forms of spread spectrum:

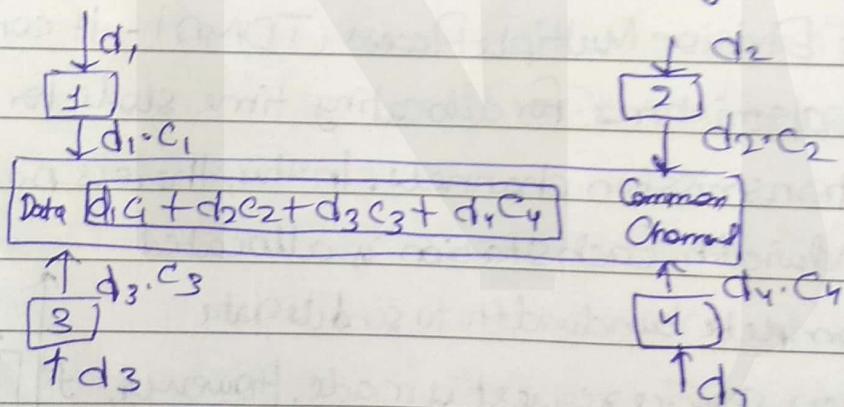
- i) Direct Sequence Spread Spectrum (DSSS) - It is spread spectrum modulation technique used to reduce overall signal interference. In direct sequence spread spectrum, stream of information to be transmitted is divided into small pieces each of which is allocated to a frequency channel. A data signal at point of transmission is combined with higher data rate bit sequence (also known as chipping code) that divides data according to spreading ratio. The redundant chipping code helps signal resist interference & also enables original data to be recovered if data bits are damaged during transmission.
- ii) Frequency Hopping Spread Spectrum (FHSS) - FHSS transmission is the repeated switching of frequencies during radio transmission to reduce interference. It is useful for countering eavesdropping or to obstruct jamming of telecommunications.
In FHSS, the transmitter hops between available narrowband frequencies in a pseudo-random sequence known to both sender & receiver. A short burst of data is transmitted on current narrowband channel, then transmitter & receiver tune to next frequency in the sequence for next burst of data. In most systems, transmitter will hop to new frequency more than twice per second.

- Code Division Multiple Access (CDMA) - Also called Direct Sequence Multiple Access (DSMA), it is a digital multiple access system which provides channel access to multiple users simultaneously. Primary feature is that only one channel carries transmission from all users simultaneously. Each bit in the signal is replaced by a code to create high bandwidth signal. Codes are different for different users.



Code assigned must satisfy two basic requirements.

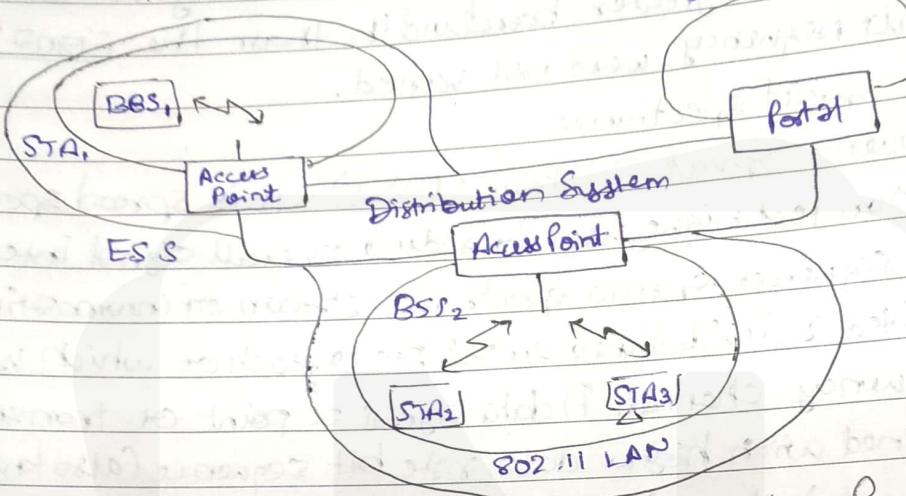
- If code multiplied with itself, the result should give high value, i.e., codes should have a good autocorrelation
- If code is multiplied with another code, result should give zero or low value i.e. codes should be orthogonal to other codes



Technique	TDMA	FDMA	CDMA
Principle	Segment time into time slots (disjoint)	Segment frequency into disjoint subbands	Orthogonal coding
Active Terminals	All active for short periods of time on some frequencies.	Every terminal has its own frequency	All terminals communicate at same place & same time
Techniques for Separation	Synchronization	Filtering in frequency domain	Code plus special receivers.
Signed	in time domain		
Advantages	Digital, flexible	Simple, Robust	Flexible, less planning required.
Disadv.	Synchronisation Difficult	Inflexible	Complex Receivers

- * CODE Division Multiple Access - Done Previously.
Also check WC Notes Page

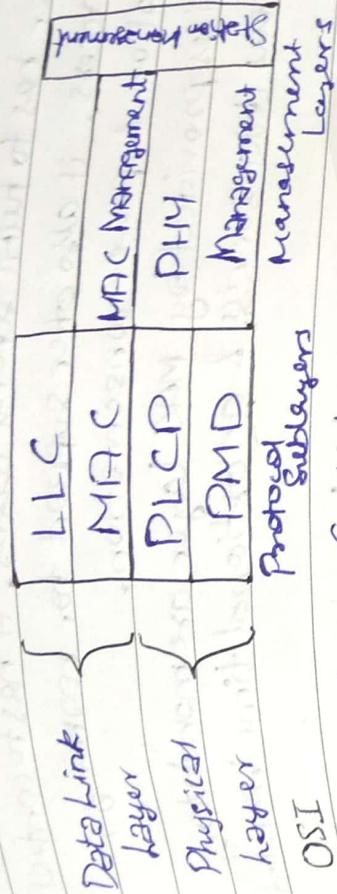
- * LAN SYSTEM ARCHITECTURE



Components of architecture & wireless Part

- Several nodes called stations (STA_i) are connected to access points.
- Stations & AP within same radio coverage form Basic service set (BSS_i).
- BSS₁ & BSS₂ are connected via a distribution system.
- Distribution System connects BSS_i via AP to form single network & extends wireless coverage area. This network is called Extended Service Set (ESS) & has its own identifier, ESSID.
- ESSID is name of the network & is used to separate different networks.

* LAN Protocol Architecture -



LLC - Logical Link Control ; MAC - Media Access Control

PLCP - Physical Layer Convergence Protocol

PMD - Physical Medium Dependent Sublayer

- MAC - It handles medium access, fragmentation of user data, encryption.

• PLCP - It provides carrier sense signal called clear channel assessment & provides Service Access Point (SAP).

- PMD - It handles modulation & encoding / decoding of signals.
- MAC Management - It supports association & deassociation of a station to an access point & roaming between different access points.
- PHY Management - It includes channel tuning & maintenance.
- Station Management - Interacts with both management layers & responsible for additional higher layer functions (ex: control of bridging & interaction with distribution system in case of an access point).

* MAC LAYER AND MANAGEMENT-

- MAC layer has to fulfil several tasks. It has to control medium access, it also offer support for roaming, authentication & power conservation.
 - Basic services provided by MAC layer are mandatory asynchronous data service & an optional time-bounded service.
 - Asynchronous service supports broadcast, multicast & packet exchange is based on 'best-effort' model i.e., no delay bounds can be given for transmission.
 - MAC layer covers three functional areas: Reliable data delivery, Access control & security.
 - Three basic access mechanisms: mandatory basic method, based on CSMA/CA; optional method to avoid hidden terminal problem; a contention-free polling method for time bounded service.
- First two methods are summarized as Distributed Coordination Function. Third method is called Point Coordination Function.
- DCF offers asynchronous service while PCF offers both asynchronous & time bounded service.
 - MAC mechanisms are also called Distributed Coordination Wireless Medium Access Control (DWMAC).
 - To ensure smooth functioning of delays, DCF includes self of delays. A single delay is known as Inter frame Space (IFS).
 - Short IFS: The shortest IFS, used for immediate (SIFS) response actions. (Shortest Waiting Time)
 - Point Coordination Function IFS: A mid-length IFS, used by PIFS centralized controller in PCF scheme.
 - Distributed Coordination Function IFS: The longest IFS used as a longest waiting time between DIFS & SIFS.
 - minimum delays for asynchronous frames.

* HIPERLAN -

High Performance Radio LAN (HIPER) is a WLAN standard. It is European alternative for IEEE 802.11 standards. It is defined by European Telecommunications Standards Institute (ETSI). In ETSI, standards are defined by BRAN project (Broadband Radio Access Networks).

Motivation for HIPER LAN -

- Massive growth in wireless & mobile communications.
- Demands for high internet speed access.
- Emergence of multimedia applications.

HIPERLAN standard family has four different versions -

- HIPERBLAN/1 : Bit Rate - 20Mbps, 50m Range, Frequency Range - 5GHz
- HIPERLAN/2 : Bit Rate - 50Mbps, Frequency Range - 5GHz
- HIPERACCESS : Bit Rate - 25 Mbps, Frequency Range - 11 to 66GHz
- HIPERLINK : Bit Rate - 155Mbps, Short range - Point-to-Point technology.

Unit-II : Ch-2

* IEEE 802.15

It is a working group of Institute of Electrical & Electronics Engineers (IEEE) standard committee which specifies Wireless Personal Area Network (WPAN) standards.

Bluetooth is well known & widely used specification that defines parameters for wireless communication among digital devices.

The specification also allows for connection to the internet.

These WPAN networks are designed for inexpensively connecting low power devices located within 1m to 100m of each other.

The IEEE 802.15 working group proposes two general categories :

- TG4 (low rate : data speed of 20kbps to 250kbps)
- TG3 (high rate : data speed of 11Mbps to 55Mbps)

* BLUETOOTH USER SCENARIOS -

- Three in one phone : In office, your phone functions as intercom (no telephony charge); At home, it is used as cordless phone (fixed line charge). On the move, it functions as mobile phone (cellular charge).
- Headset : Connect headset to your PC through bluetooth. Mostly used in cars.
- Cordless Desktop : Connect your desktop/laptop to printer, scanner, keyboard, mouse.
- Internet Bridge : Use mobile device or laptop to surf internet by connecting through bluetooth & sharing internet.
- File Sharing : Share files between devices using Bluetooth.

* PTM AND MAC LAYER : Done previously.

* WPABX : Wireless Private Automatic Branch Exchange.

These systems integrate wireless telephones with a PBX switching system. Wireless PBX telephones communicate through wired base stations to WPBX switching system. Most WPBX system have automatic switching call transfer that allows wireless handsets to transfer their calls to other base stations as they move through WPBX radio coverage area.

WPABX system's work force is highly mobile in a relatively small area.

A WPABX radio system allows for voice or data communications on either an analog or digital radio channel.

* IrDA: Infrared Data Association

It is an industry sponsored organisation to create international standards for hardware & software used in infrared communication links.

In this radio transmission, a focused ray of light in the infrared frequency spectrum is modulated with information & sent from transmitter to a receiver over relatively short distance.

Infrared Radiation (IR) is same technology used to control a TV set with remote control.

Infrared data communication plays an important role in wireless data communication in devices like laptops, PDAs, digital cameras, phones etc. Other uses include -

- Sending document from notebook computer to printer.
- Coordinating schedules & telephone books b/w your devices.

* ZigBee: It is a low-cost, low-power, wireless network standard used to create personal area network.

Zigbee chips are integrated with radios or microcontrollers that have flash memory b/w 60-256 kB.

ZigBee network layer supports both star & tree networks & mesh networking. It is built on Physical & MAC Layer defined in 802.15.

Zigbee includes four key components : network layer, application layer, Zigbee Device Objects (ZDOs) & manufacturer defined application objects which allows for customization & favors for integration.

Applications include wireless light switches, traffic management systems, home energy monitors etc.



* **RFID:** Radio Frequency Identification technology which can store data to identify an object, animal or person.

- + A form of wireless communication that uses reflection from motion.
- + also tracks tags attached to objects. The tag contains electronic circuitry stored information.
- + In RFID system consists of 3 components: a scanner, reader, known as RFID tag which contains certain commands like the reader, known as RFID tag which consists of a microchip, memory & antenna.
- + RFID system consists of different functions:
 - reading or interrogating data in tag.
 - communicating data in the tag with host computer.
 - updating & sending customized data into the tag.

* **WIMAX:** Worldwide Interoperability for Microwave Access

- + It is a family of wireless communication standards based on IEEE 802.16 standard.
- + Wimax operates similar to WiFi but at higher speeds & over greater distances for greater number of users.
- + can provide same even in areas that are difficult to wired infrastructure.
- + uses unlicensed frequency bands for now, it aims at providing 1Gbps for fixed stations & 15Mbps capacity in a 3km cell coverage area.