ANNAIWOMEN'SCOLLEGE

(Arts&Science)

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Course Material

PaperName: MOBILE COMPUTING

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UNIT-1

The communication device moves (with or without a user). Many mechanisms in thenetwork and inside the device have to make sure that communication is still possible while thedevice is moving. A typical example for systems supporting device portability is the mobilephone system, where the system itself hands the device from one radio transmitter (also calleda base station) to the next if the signal becomes too weak. Most of the scenarios described inthisbookcontainbothusermobilityanddeviceportabilityatthesametime.

Acommunicationdevicecanthusexhibitoneofthefollowingcharacteristics:

● **Fixed and wired:** This configuration describes the typical desktop computer in an office.Neither weight nor power consumption of the devices allow for mobile usage. The devices usefixed networksfor performancereasons.

● **Mobileandwired**: Many of today's laptops fall into this category; users carry the laptopfrom one hotel to the next, reconnecting to the company's network via the telephone networkandamodem.

● **Fixed and wireless**: This mode is used for installing networks, e.g., in his- torical buildings toavoid damage by installing wires, or at trade shows to ensure fast network setup. Anotherexampleisbridgingthelastmiletoacustomerbyanewoperatorthathasnowiredinfrastructu reanddoesnotwanttoleaselinesfromacompetitor.

● **Mobile and wireless**: This is the most interesting case. No cable restricts the user, who canroambetween different wireless networks.Most technol-ogiesdiscussed in this bookdealwith this type of device and the networks supporting them. Today's most successful exampleforthiscategory isGSMwithmorethan800 millionusers.

APPLICATIONS:

Although many applications can benefit from wireless networks mobile communications,particular application environments seem to be predestined for their use.

- **Vehicles:**

  Today's cars already comprise some, but tomorrow's cars will comprise many wirelesscommunication systems and mobility aware applications. Music, news, road conditions,weatherreports,andotherbroadcastinformationarereceivedviadigitaladiobroa dcasting (DAB) with 1.5 Mbit/s. For personal communica- tion, a universal mobiletelecommunicationssystem(UMTS)phonemightbeavailableofferingvoiceanddatac onnectivity with 384 kbit/s. For remote areas, satellite communication can be used,while the current position of the car is determined via the global positioning system(GPS).

- **Emergencies:**

  Justimaginethepossibilitiesofanambulancewithahigh-qualitywirelessconnection to a hospital. Vital information about injured persons can be sent to thehospital from the scene of the accident. All the necessary steps for this particular type ofaccidentcanbepreparedandspecialistscanbeconsultedforanearlydiagnosis.Wireless networks are the only means of communication in the case of natural disasterssuch as hurricanes or earthquakes. In the worst cases, only decentralized, wireless ad-hocnetworkssurvive.

- **Business:**

  A travelling salesman today needs instant access to the company's database: toensurethatfilesonhisorherlaptopreflectthecurrentsituation,toenablethecompany to keep track of all activities of their travelling employees, to keep databasesconsistent etc. With wireless access, the laptop can be turned into a true mobile office,butefficientandpowerfulsynchronizationmechanismsareneededtoensuredataconsistency.

- **Replacementofwirednetworks:**

  In some cases, wirelessnetworks can also be used toreplace wired networks,e.g.,remotesensors,fortradeshows,orinhistoricbuildings.Duetoeconomicreasons,itisoftenimpossibletowireremotesensorsforweatherforecasts,earthquakedetection,ortoprovideenvironmentalinformation.Wirelessconnections,e.g.,viasatellite,canhelpinthissituation.

- **CreditCardVerification**:

  At Point of Sale (POS) terminals in shops and supermarkets, when customersuse credit cards for transactions, the intercommunication required between the bankcentral computer and the POS terminal, in order to effect verification of the card usage,can take place quickly and securely over cellular channels using a mobile computer unit.Thiscanspeedupthetransactionprocessandrelievecongestionatthe POSterminals.

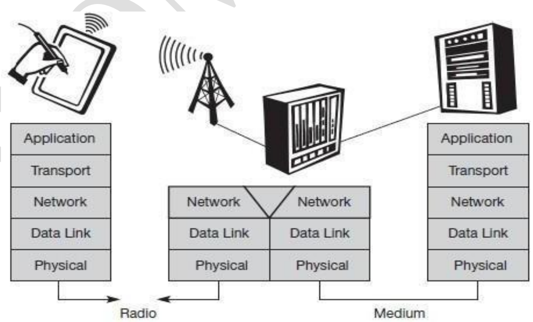
- **ReplacementofWiredNetworks**:

  wireless networks can also be used to replace wired networks, e.g., remotesensors, for tradeshows, or in historic buildings.Duetoeconomic reasons, it is oftenimpossibletowireremotesensorsforweatherforecasts,earthquakedetection,orto provide environmental information. Wireless connections, e.g., via satellite, can help inthissituation.Otherexamplesforwirelessnetworksarecomputers,sensors,orinformation displays in historical buildings, where excess cabling may destroy valuablewallsorfloors.

- **Infotainment**: wirelessnetworkscanprovideup-to-dateinformationatanyappropriatelocation.Thetravelguidemight tell yousomething aboutthehistory of abuilding(knowingviaGPS,contacttoalocalbasestation,ortriangulationwhereyouare)down loading information about a concert in the building at the same evening via a localwirelessnetwork.Anothergrowingfieldofwirelessnetworkapplicationsliesinentertain ment and games to enable, e.g., ad-hoc gamingnetworksas soon as peoplemeetto playtogether.

ASIMPLIFIEDREFERENCEMODEL:

Thefigureshowsthe**protocolstack**implementedinthesystemaccordingtothereference model. **End-systems**, such as the PDA and computer in the example, need a fullprotocol stack comprising the application layer, transport layer, network layer, datalink layer,and physical layer. Applications on the end-systems communicate with each other using thelowerlayerservices.**Intermediatesystems**,suchastheinterworkingunit,donotnecessarily



needallofthelayers.

Physicallayer:

Thisisthelowestlayerinacommunicationsystemandisresponsibleforthe conversion of a stream of bits into signals that can be transmitted on the sender side. Thephysical layer of the receiver then transforms the signals back into a bit stream. For wirelesscommunication, the physical layer is responsible for frequency selection, generation of thecarrierfrequency,signaldetection(althoughheavyinterferencemaydisturbthesignal), modulation ofdata onto a carrier frequency and (depending on the transmission scheme)encryption.

Datalinklayer:

Themaintasksofthislayerincludeaccessingthemedium,multiplexingofdifferentdata streams, correctionoftransmission errors, and synchronization (i.e., detectionof a data frame). Altogether, the data linklayer is responsible for a reliable point-to-pointconnection between two devices or a point-to-multipoint connection between one sender andseveralreceivers.

Networklayer:

Thisthirdlayerisresponsibleforroutingpacketsthroughanetworkorestablishingaconnectionbetweentwoentitiesovermanyotherintermediatesystems.Important functions are addressing, routing, device location, and handover between differentnetworks.

Transportlayer:

This layer isusedinthereferencemodelto establishanend-to-end connection

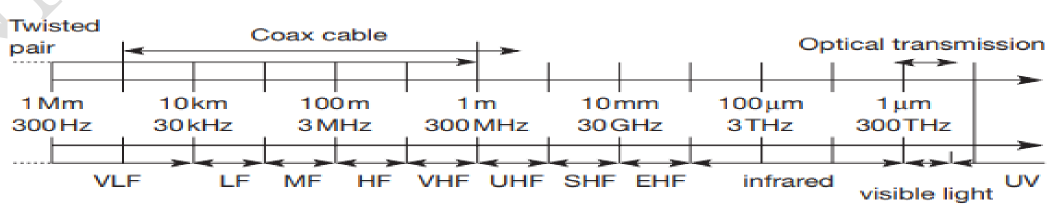
Applicationlayer:

Finally, the applications (complemented by additional layers that can supportapplications) are situatedontop of alltransmissionorientedlayers. Functions are servicelocation, support for multimedia applications, adaptive applications that can handle the largevariations in transmission characteristics, and wireless access to the world-wideweb using aportabledevice.

WIRELESSTRANSMISSION:

FREQUENCIESFORRADIOTRANSMISSION:

Radiotransmissioncantakeplaceusingmanydifferentfrequencybands.Eachfrequency band exhibits certain advantages and disadvantages. Figure gives a rough overviewofthefrequencyspectrumthatcanbeusedfordatatransmission.Thefigureshowsfrequencies starting at 300 Hz and going up to over 300 THz. Directly coupled to the frequencyisthewavelengthλviatheequation:λ=c/f.



where c ≅ 3·108 m/s (the speed of light in vacuum) and f the frequency. For traditional wirednetworks, frequencies of up to several hundred kHz are used for distances up to some km withtwisted pair copper wires, while frequencies of several hundred MHz are used with coaxialcable (new coding schemes work with several hundred MHz even with twisted pair copperwires over distances of some 100 m). Fiber optics are used for frequency ranges of severalhundred THz, but here one typically refers to the wavelength which is, e.g., 1500 nm, 1350 nmetc.(infrared).

Radio transmission starts at several kHz, the very low frequency (VLF) range.These are very long waves. Waves in the low frequency (LF) range are used by submarines,because they can penetrate water and can follow the earth's surface. Some radio stations stillusethesefrequencies,e.g.,between148.5kHzand283.5kHzinGermany.Themediumfrequency(MF) andhigh frequency (HF) ranges are typical for transmissionof hundredsofradio stations either as amplitude modulation (AM) between 520 kHz and 1605.5 kHz, as shortwave (SW) between 5.9 MHz and 26.1 MHz, or as frequency modulation (FM) between 87.5MHzand108MHz.Thefrequencieslimitingtheserangesaretypicallyfixedbynationalregulation and, vary from country to country. Shortwaves aretypically used for(amateur)radio transmission around the world, enabled by reflection at the ionosphere. Transmit powerisupto500kW –whichisquitehighcomparedto the1Wofamobilephone.

Aswemovetohigherfrequencies,theTVstationsfollow.Conventionalanalog TV is transmitted in ranges of 174–230 MHz and 470–790 MHz using the very highfrequency (VHF) and ultra high frequency (UHF) bands. In this range, digital audio broadcasting(DAB) takes place as well (223–230 MHz and 1452–1472 MHz) and digital TV is planned orcurrently being installed (470– 862 MHz), reusing some of the old frequencies for analog TV.UHF is also used for mobile phones with analog technology (450–465 MHz), the digital GSM(890–960MHz, 1710–1880MHz), digitalcordlesstelephonesfollowingtheDECTstandard(1880–1900 MHz), 3G cellular systems following the UMTS standard (1900–1980 MHz, 2020–2025 MHz, 2110–2190 MHz) and many more. VHF and especially UHF allow for small antennasandrelativelyreliableconnectionsformobiletelephony.

SIGNALS:

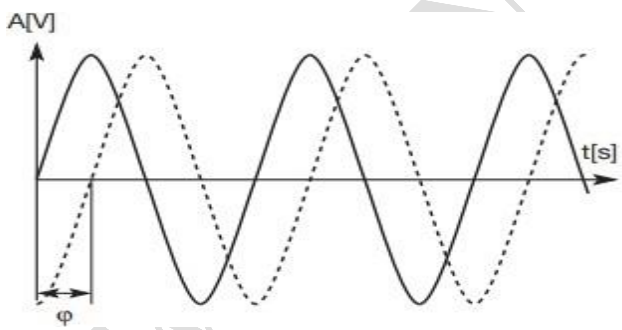
Signals are the physical representation of data. Users of a communicationsystem can only exchange data through the transmission of signals. Layer 1 of the ISO/OSI basicreference model is responsible for the conversion of data, i.e., bits, into signals and vice versa(Halsall, 1996),(Stallings,1997and2002).

Signals are functions of time and location. Signal parameters represent thedata values. The most interesting types of signals for radio transmission are periodic signals,especially sine waves as carriers. (The process of mapping of data onto a carrier is explained insection2.6.)The generalfunctionof asine waveis:g(t) =Atsin(2πftt+ϕt).

Signal parameters are the amplitude A, the frequency f, and the phase shift ϕ.The amplitude as a factor of the function g may also change over time, thus At , (see section2.6.1). The frequency f expresses the periodicity of the signal with the period T = 1/f. (Inequations, ω is frequently used instead of 2πf.) The frequency f may also change over time,thus ft , (see section 2.6.2). Finally, the phase shift determines the shift of the signal relative tothe same signal without a shift. An example for shifting a function is shown in Figure. Thisshows a sine function without a phase shift and the same function, i.e., same amplitude andfrequency, with a phase shift ϕ. Section 2.6.3 shows how shifting the phase can be used torepresentdata.

Sine waves are of special interest, as it is possible to construct every periodicsignalgbyusingonlysineandcosinefunctionsaccordingtoafundamentalequationofFourier:

$$g(t) = \frac{1}{2}c + \sum_{n=1}^{\infty} a_n \sin(2\pi nft) + \sum_{n=1}^{\infty} b_n \cos(2\pi nft)$$

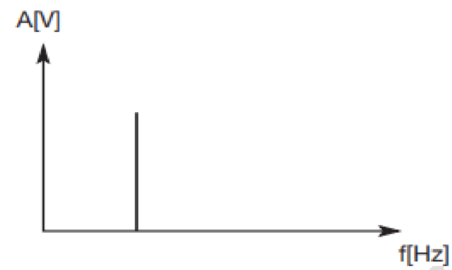


Time domain representation of a signal

Inthisequationtheparametercdeterminesthe DirectCurrent(DC)component of the signal, the coefficients an and bn are the amplitudes of the nth sine andcosine function. The equation shows that an infinite number of sine and cosine functions isneeded to construct arbitrary periodic functions. However, the frequencies of these functions(theso-called harmonics)increase with agrowing parametern and areamultipleofthefundamental frequency f. The bandwidth of any medium, air, cable, transmitter etc. is limitedand, there is an upper limit for the frequencies. In reality therefore, it is enough to consider alimitednumberofsineandcosinefunctionstoconstructperiodic,functions–allreal transmitting systems exhibit these bandwidth limits and can never transmit arbitrary periodicfunctions. It is sufficient for us to know that we can think of transmitted signals as composed ofone or many sine functions. The following illustrations always represent the example of onesinefunction,i.e.,thecaseofasinglefrequency.

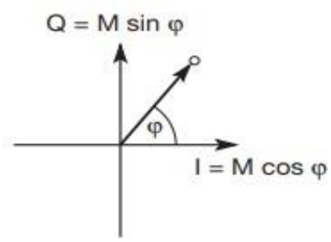
Representations in the time domain are problematic if a signal consists ofmanydifferentfrequencies(astheFourierequationindicates).Inthiscase,abetterrepresentation ofasignalisthefrequencydomain (seeFigure).

Frequency domain representation of a signal



AthirdwaytorepresentsignalsisthephasedomainshowninFigure.Thisrepresentation, also called phase state or signal constellation diagram, shows the amplitude Mof a signal and its phase ϕ in polar coordinates. (The length of the vector represents theamplitude, the angle the phase shift.) The x-axis represents a phase of 0 and is also called In-Phase(I).A phaseshiftof90°orπ/2wouldbeapointon they-axis,calledQuadrature(Q).

Figure
Phase domain representation of a signal



ANTENNAS:

Asthenamewirelessalreadyindicates,thiscommunicationmodeinvolves 'getting rid' of wires and transmitting signals through space without guidance. We do not needany 'medium' (such as an ether) for the transport of electromagnetic waves. Somehow, wehave to couple the energy from the transmitter to the out side world and, in reverse, from theoutsideworldtothereceiver.Thisisexactlywhatantennasdo.Antennascoupleelectromagnetic energy to and from space to and from a wire or coaxial cable (or any otherappropriate conductor). A theoretical reference antenna is the isotropic radiator, a point inspace radiating equal power in all directions, i.e., all points with equal power are located on aspherewiththeantennaasitscenter.Theradiationpatternissymmetricinalldirections(see Figure,atwodimensionalcross-sectionoftherealthree-dimensional pattern).

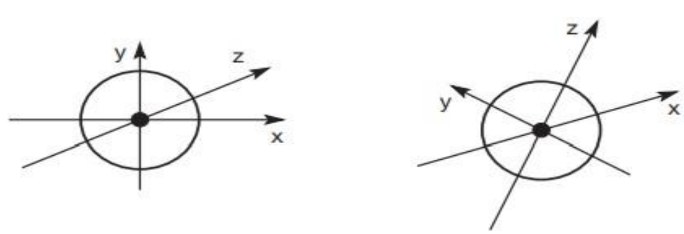
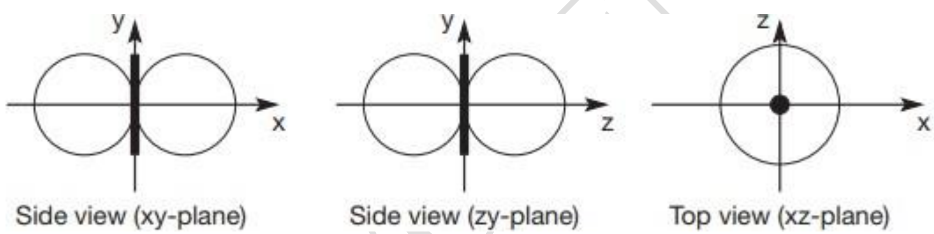


Figure
Radiation pattern of an isotropic radiator

However, such an antenna does not exist in reality. Real antennas all exhibitdirective effects,i.e., theintensityof radiationisnotthesamein alldirectionsfromtheantenna. The simplest real antenna is a thin, center-fed dipole, also called Hertzian dipole, asshown in Figure (right-hand side). The dipole consists of two collinear conductors of equallength, separated by a small feeding gap. The length of the dipole is not arbitrary, but, forexample, half the wavelength λ of the signal to transmit results in a very efficient radiation ofthe energy. If mounted on the roof of a car, the length of λ/4 is efficient. This is also known asMarconi antenna.

Figure
Simple antennas

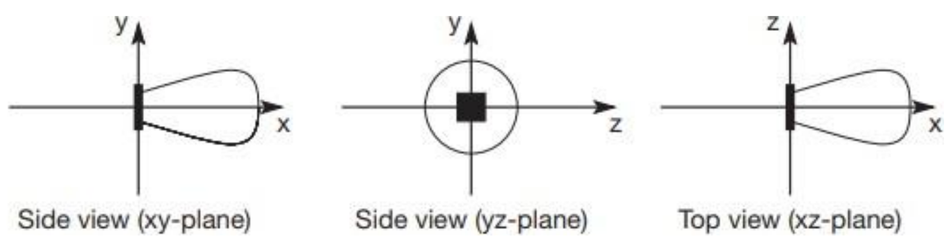
A λ/2 dipole has a uniform or omni-directional radiation pattern in one planeand a figure eight pattern in the other two planes as shown in Figure . This type of antenna canonly overcome environmental challenges by boosting the power level of the signal. Challengescouldbemountains, valleys,buildingsetc.



Radiation pattern of a simple dipole

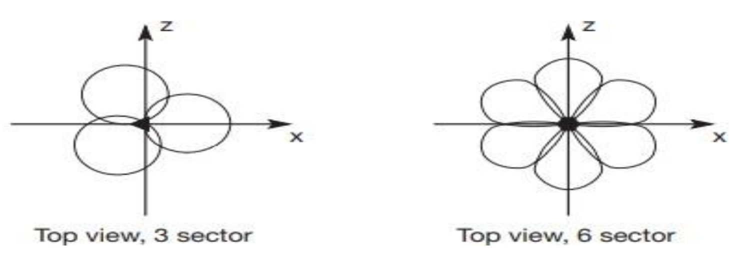
Figureshowstheradiationpatternofadirectionalantennawiththemainlobeinthedirectionofthex-axis.Aspecialexampleofdirectionalantennasis constituted bysatellitedishes.

Radiation pattern of a directed antenna



A cell can be sectorized into, for example, three or six sectors, thus enabling frequency reuse asexplainedinpreviousfig.NextFigureshowstheradiationpatternsofthesesectorizedantennas.

Radiation patterns of sectorized antennas



SIGNALPROPAGATION:

Like wired networks, wireless communication networks also have senders andreceiversofsignals.However,inconnectionwithsignalpropagation,thesetwonetworksexhibit considerable differences. In wireless networks, the signal has no wire to determine thedirection of propagation, whereas signals in wired networks only travel along the wire (whichcan be twisted pair copper wires, a coax cable, but also a fiber etc.). As long as the wire is notinterrupted or damaged, it typically exhibits the same characteristics at each point. One canprecisely determine the behavior of a signal travelling along this wire, e.g., received powerdepending on the length. For wireless transmission, this predictable behavior is only valid in avacuum, i.e., without matter between the sender and the receiver. The situation would be asfollows(Figure).

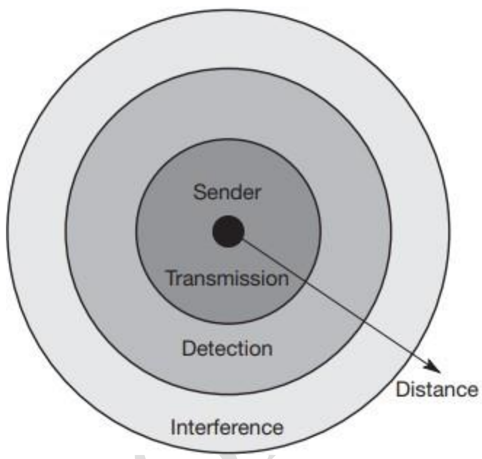


Figure
Ranges for transmission, detection, and interference of signals

Transmission range: Within a certain radius of the sender transmission is possible, i.e., areceiver receives the signals with an error rate low enough to be able to communicateandcanalsoactassender.

- **Detection range**: Within a second radius, detection of the transmission is possible, i.e.,the transmitted power is large enough to differ from background noise. However, theerrorrateistoohightoestablishcommunication.
- **Interference range**: Within a third even larger radius, the sender may interfere withother transmission by adding to the background noise. A receiver will not be able todetectthesignals, butthesignalsmaydisturb othersignals.

This simple and ideal scheme led to the notion of cells around a transmitter.However, real life does not happen in a vacuum, radio transmission has to contend with ouratmosphere,mountains,buildings,movingsendersandreceiversetc.Inreality,thethreecircles referred to above will be bizarrely-shaped polygons with their shape being time andfrequency dependent.

Radio waves can exhibit three fundamental propagation behaviors dependingontheirfrequency:

- **Ground wave(<2MHZ):**Waves with low frequencies follow the earth's surface and canpropagate long distances. These waves are used for, e.g., submarine communication orAMradio.
- **Skywave (2–30 MHz):** Many internationalbroadcasts and amateur radio use theseshort waves that are reflected2 at the ionosphere. This way the waves can bounce backandforthbetweentheionosphereandtheearth's surface,travellingaroundtheworld.
- **Line-of-sight (>30 MHz):** Mobile phone systems, satellite systems, cordless telephonesetc. use even higher frequencies. The emitted waves follow a (more or less) straight lineof sight.

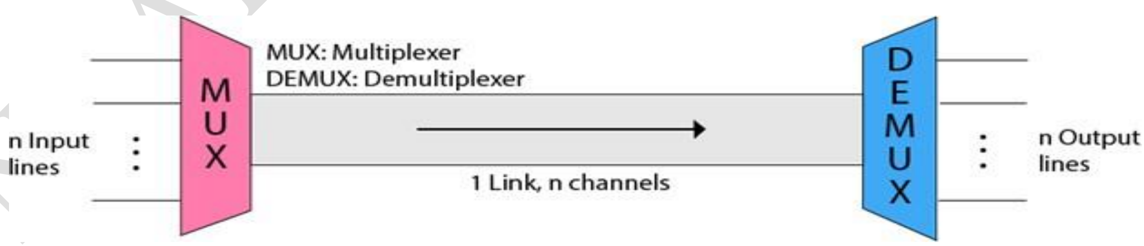
<u>MULTIPLEXING:</u>

Multiplexing is a technique used to combine and send the multiple data streams over asinglemedium.Theprocessof combining the datastreamsis known asmultiplexingandhardwareusedfor multiplexing isknownasamultiplexer.

Multiplexing is achieved by using a device called Multiplexer (**MUX**) that combines ninput lines to generate a single output line. Multiplexing follows many-to-one, i.e., n input linesand oneoutputline.

Demultiplexing is achieved by using a device called Demultiplexer (**DEMUX**) available atthe receiving end. DEMUX separates a signal into its component signals (one input and noutputs).Therefore,wecan saythatdemultiplexing followstheone-to-many approach.

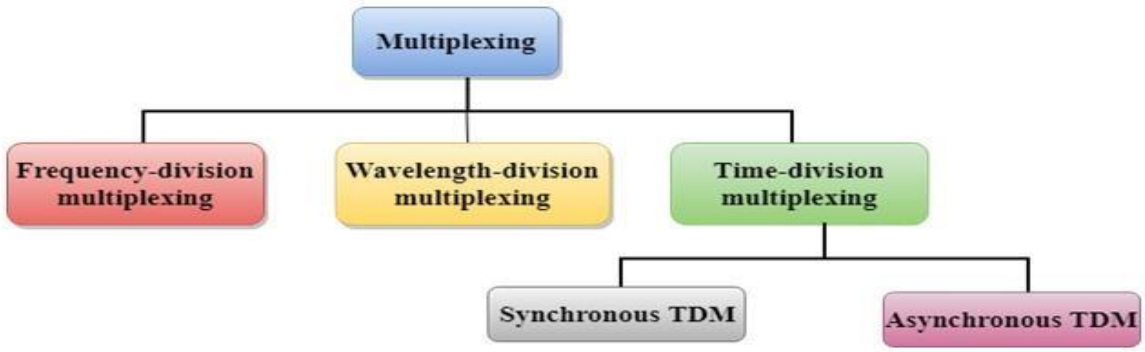
CONCEPTOFMULTIPLEXING:



- The 'n' input lines are transmitted through a multiplexer and multiplexer combines thesignalstoformacompositesignal.
- The composite signal is passed through a Demultiplexer and demultiplexer separates asignaltocomponentsignalsandtransfersthemtotheirrespectivedestinations.

MULTIPLEXINGTECHNIQUES:

Multiplexingtechniquescanbeclassifiedas:

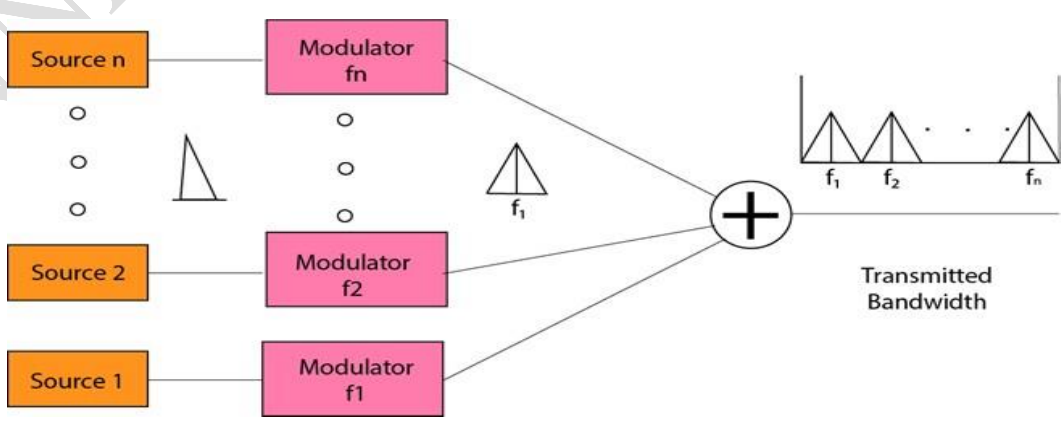


FREQUENCY-DIVISIONMULTIPLEXING(FDM):

- Itisan analogtechnique.
- **Frequency Division Multiplexing** is a technique in which the available bandwidth of asingletransmission mediumissubdividedinto severalchannels.
- In the above diagram, a single transmission medium is subdivided into several frequencychannels, and each frequency channel is given to differentdevices.Device1hasafrequencychannelofrangefrom1to 5.
- The input signals are translated into frequency bands by using modulation techniques,andtheyare combined byamultiplexertoformacompositesignal.

ThemainaimoftheFDMistosubdividetheavailablebandwidthintodifferentfrequencychannelsandallocatethemtodifferentdevices.

- Usingthemodulationtechnique,theinputsignalsaretransmittedintofrequencybandsandthencombinedtoformacompositesignal.
- Thecarrierswhichareusedformodulatingthesignalsareknownas**sub-carriers**.Theyarerepresentedasf1,f2..fn.
- **FDM**is mainlyusedinradiobroadcasts andTVnetworks.



AdvantagesOfFDM:

- FDMisusedforanalogsignals.
- FDMprocessisverysimpleandeasymodulation.
- ALargenumberofsignalscanbesent throughanFDM simultaneously.
- Itdoesnotrequireanysynchronizationbetweensenderandreceiver.

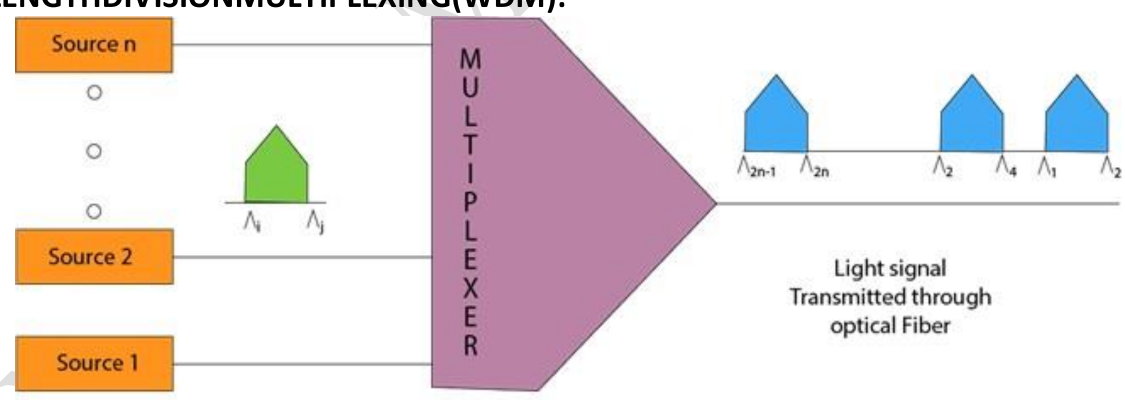
DisadvantagesOfFDM:

- FDMtechniqueisusedonlywhen low-speedchannelsarerequired.
- Itsufferstheproblemofcrosstalk.
- ALargenumberofmodulatorsarerequired.
- Itrequiresahighbandwidthchannel.

ApplicationsOfFDM:

- FDMis commonlyusedinTVnetworks.
- It is used in FM and AM broadcasting. Each FM radio station has different frequencies,andtheyaremultiplexedtoformacompositesignal.Themultiplexedsignalistran smitted inthe air.

WAVELENGTHDIVISIONMULTIPLEXING(WDM):

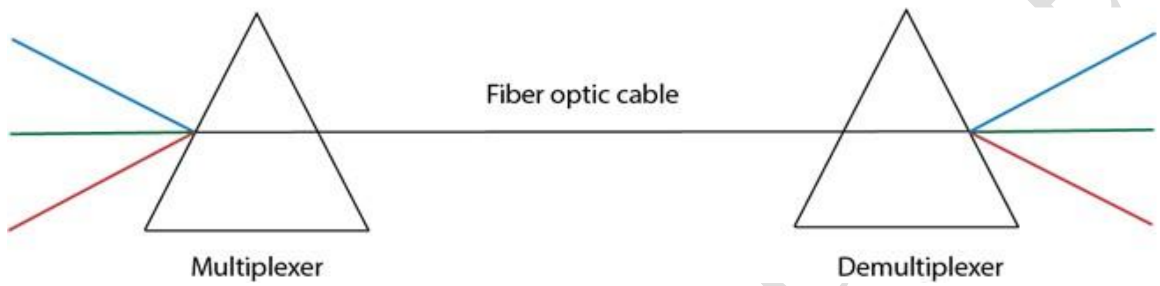


WDM Transmitter

- WavelengthDivisionMultiplexingissameasFDMexceptthattheopticalsignalsaretransmitte dthroughthefibreopticcable.
- WDMisused onfibreopticstoincreasethecapacityofasinglefibre.
- Itisusedto utilizethehigh dataratecapabilityof fibreopticcable.
- Itisan analogmultiplexingtechnique.
- Opticalsignalsfromdifferentsourcearecombinedtoformawiderbandoflightwiththehelpof

multiplexer.

- Atthereceivingend,demultiplexerseparatesthesignalstotransmitthem totheirrespectivedestinations.
- MultiplexingandDemultiplexingcanbeachievedbyusingaprism.
- Prism canperformaroleofmultiplexerby combiningthevariousopticalsignalstoformacompositesignal,andthecompositesignalistransmittedthrougha fibreopticalcable.
- Prismalsoperformsareverse operation,i.e.,demultiplexingthesignal.



TIMEDIVISIONMULTIPLEXING:

- Itisa digitaltechnique.
- In Frequency Division Multiplexing Technique, all signals operate at the same time withdifferentfrequency,butincaseofTimeDivisionMultiplexingtechnique,allsignalsoperateatthe samefrequencywithdifferenttime.

In **TimeDivisionMultiplexingtechnique**,thetotaltimeavailableinthechannelisdistributed among different users. Therefore, each user is allocated with different timeintervalknownasaTimeslotatwhichdataistobetransmittedbythe sender.

- Ausertakescontrolofthechannelforafixedamount oftime.
- InTimeDivisionMultiplexingtechnique,dataisnottransmittedsimultaneouslyratherthedata istransmittedone-by-one.
- InTDM,thesignalistransmittedintheformofframes.Framescontainacycleoftimeslotsinwhicheachframecontainsoneormoreslotsdedicatedtoeachuser.
- Itcanbeusedtomultiplexbothdigitalandanalogsignalsbutmainlyusedtomultiplexdigital signals.

MODULATION:

Modulation is the process of converting data into radio waves by adding information toan electronic or optical carrier signal. A carrier signal is one with a steady waveform --constantheight, or amplitude, and frequency. Information can be added to the carrier by varying itsamplitude, frequency, phase, polarization--foropticalsignals--andevenquantum-levelphenomenalike spin.

Modulationisusuallyappliedtoelectromagneticsignals:radiowaves,lasers/opticsandcomputernet works.Modulation can evenbeappliedtoadirectcurrent--whichcanbetreated as a degenerate carrier wave with a fixed amplitude and frequency of 0 Hz -- mainly byturning it on and off, as in Morse codetelegraphy or a digital current loop interface. The specialcase of no carrier-- a response messageindicating an attached device is no longer connectedtoaremotesystem--iscalledbaseband modulation.

Modulation can also be applied to a low-frequency alternating current -- 50-60 Hz -- as withpowerlinenetworking.

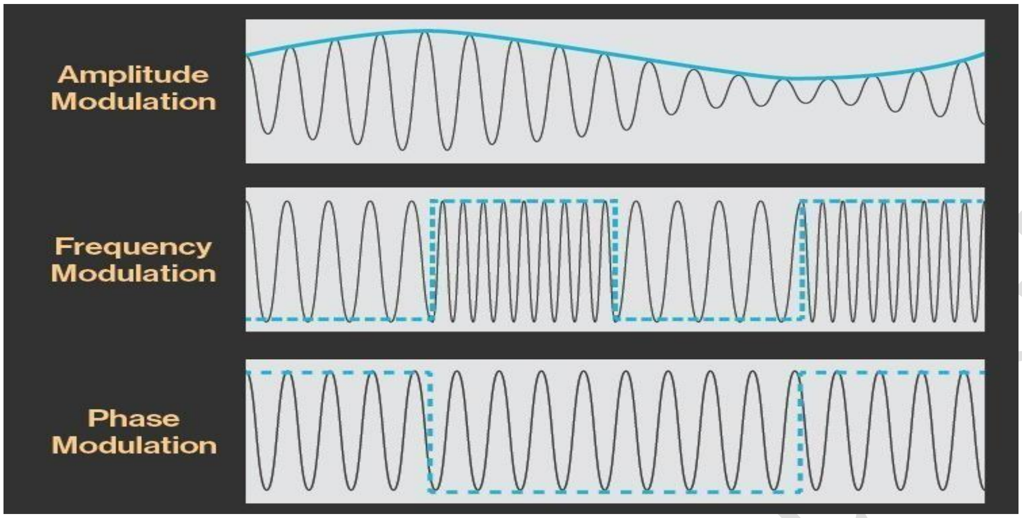
Typesofmodulation

Therearemanycommonmodulationmethods,includingthefollowing --averyincompletelist:

- **Amplitudemodulation(AM)**,inwhichtheheight--i.e.,thestrengthorintensity--ofthesignalcarrierisvariedtorepresentthedatabeing addedtothesignal.
- **Frequencymodulation(FM)**,inwhichthefrequencyofthecarrierwaveformisvariedtoreflectthe frequencyofthedata.

Phase modulation(PM), in which the phase of the carrier waveform is varied to reflectchanges in the frequency of the data. In PM, the frequency is unchanged while the phase ischangedrelative tothe basecarrierfrequency. Itissimilarto FM.

- **Polarization modulation**, in which the angle of rotation of an optical carrier signal is variedtoreflecttransmitteddata.
- **Pulse-code modulation**, in which an analog signal is sampled to derive a data stream that isusedtomodulateadigitalcarriersignal.
- **Quadrature amplitude modulation (QAM)**, which uses two AM carriers to encode two ormorebitsinasingle transmission.



Radio and television broadcastsand satellite radio typically use AM or FM. Most short-rangetwo-way radios -- up to tens of miles -- use FM, while longer-range two-way radios -- up tohundreds orthousands of miles--typically employamodeknownassinglesideband(SSB).

More complex forms of modulation include phase-shift keying(PSK) and QAM. Modern Wi-Fimodulation uses a combination of PSK and QAM64 or QAM256 to encode multiple bits ofinformationinto eachtransmittedsymbol.SPREADSPECTRUM:

Acollectiveclassofsignalingtechniquesareemployedbeforetransmittingasignaltoprovidease curecommunication,knownasthe**SpreadSpectrumModulation**.Themain advantage of spread spectrum communication technique is to prevent "interference" whetheritisintentionalor unintentional.

Thesignalsmodulatedwiththesetechniquesarehardtointerfereandcannotbejammed. An intruder with no official access is never allowed to crack them. Hence, thesetechniques are used for military purposes. These spread spectrum signals transmit at lowpowerdensityandhasawidespreadofsignals.

Pseudo-NoiseSequence

Acodedsequenceof **1s** and **0s** withcertainauto-correlationproperties,calledas **Pseudo-Noisecodingsequence** isusedinspreadspectrumtechniques.Itisamaximum-lengthsequence,whichisatypeofcycliccode.

Narrow-bandandSpread-spectrumSignals

Both the Narrow band and Spread spectrum signals can be understood easily by observingtheirfrequencyspectrumasshowninthe followingfigures.

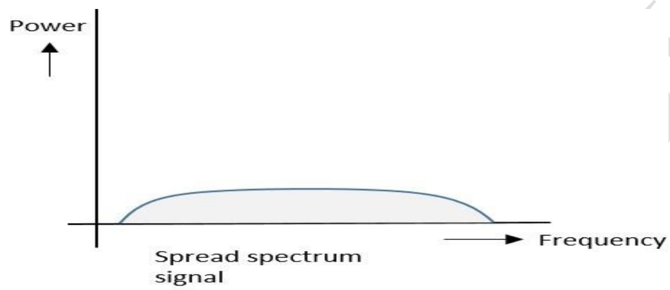
Followingaresomeofitsfeatures−

- Bandofsignalsoccupya narrowrange offrequencies.
- Powerdensityishigh.
- Spreadofenergyis lowandconcentrated.

Thoughthefeaturesaregood,thesesignalsarepronetointerference.Spre

adSpectrumSignals

Thespreadspectrumsignalshavethesignalstrengthdistributedasshowninthefollowing frequencyspectrumfigure.



Followingaresomeofitsfeatures−

- Bandofsignals occupyawiderangeoffrequencies.
- Powerdensityis verylow.
- Energyiswide spread.

Withthesefeatures,thespreadspectrumsignalsarehighlyresistanttointerferenceorjamming.Sincemu ltipleuserscansharethesamespreadspectrumbandwidthwithoutinterferingwithone another,these canbe calledas**multipleaccess techniques**.

AdvantagesofSpreadSpectrum

Followingaretheadvantages ofspreadspectrum−

- Cross-talkelimination
- Betteroutputwithdataintegrity
- Reducedeffect ofmultipathfading
- Bettersecurity
- Reductioninnoise
- Co-existencewithothersystems
- Longeroperativedistances
- Hardtodetect

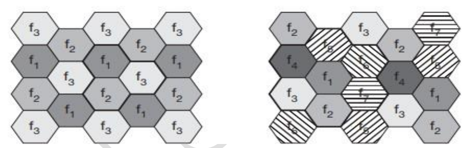
- Noteasytodemodulate/decode
- Difficulttojamthesignals

Althoughspreadspectrumtechniques wereoriginallydesignedfor militaryuses,theyarenowbeingusedwidelyfor commercialpurpose.

CELLULARSYSTEMS:

Cellularsystemsformobilecommunicationsimplement SDM.Eachtransmitter,typically called a base station, covers a certain area, a cell. Cell radii can vary from tens ofmetersinbuildings,andhundredsofmetersincities,uptotensofkilometersinthecountryside. The shape of cells are never perfect circles or hexagons (as shown in Figure), butdepend on the environment (buildings, mountains, valleys etc.), on weather conditions, andsometimesevenonsystemload.Typicalsystemsusingthisapproacharemobiletelecommunicat ion systems (see chapter 4), where a mobile station within the cell around abasestationcommunicateswiththisbasestationandviceversa.

Figure
Cellular system with three and seven cell clusters



Inthiscontext,thequestionarisesastowhymobilenetworkprovidersinstallseveralthousands of base stations throughout a country (which is quite expensive) and do not usepowerful transmitters with huge cells like, e.g., radio stations, use. Advantages of cellularsystemswithsmallcellsarethefollowing:

● **Higher capacity**: Implementing SDM allows frequency reuse. If one transmitter is far awayfrom another, i.e., outside the interference range, it can reuse the same frequencies. As mostmobile phone systems assign frequencies to certain users (or certain hopping patterns), thisfrequency isblockedforotherusers.

● **Less transmission power**: While power aspects are not a big problem for base stations, theyare indeed problematic for mobilestations.A receiverfar away from abase station wouldneed much more transmit power than the current few Watts. But energy is a serious problemformobilehandhelddevices.

● **Local interference only**: Having long distances between sender and receiver results in evenmore interference problems. With small cells, mobile stations and base stations only have todealwith'local' interference.

● **Robustness**: Cellular systems are decentralized and so, more robust against the failure ofsingle components. If one antenna fails, this only influences communication within a smallarea.Smallcellsalso havesomedisadvantages:

● **Infrastructure needed**: Cellular systems need a complex infrastructure to connect all basestations. This includes many antennas, switches for call forwarding, location registers to find amobilestationetc,whichmakesthe wholesystemquiteexpensive.

● **Handover needed**: The mobile station has to perform a handover when changing from onecell to another. Depending on the cell size and the speed of movement, this can happen quiteoften.

● **Frequencyplanning**:Toavoidinterferencebetweentransmittersusingthesamefrequencies, frequencieshavetobedistributedcarefully.Ontheonehand,interferenceshouldbeavoided, on theother,onlyalimitednumberof frequenciesisavailable.

MEDIUMACCESSCONTROL:

Motivationforaspecialized MAC:

The main question in connection with MAC in the wireless is whether it is possible touse elaborated MAC schemes from wired networks, for example, CSMA/CD as used in theoriginalspecificationof IEEE802.3networks(akaEthernet).

So let us consider carrier sense multiple access with collision detection, (CSMA/CD) whichworks as follows. A sender senses the medium (a wire or coaxial cable) to see if it is free. If themediumisbusy,thesenderwaitsuntilitisfree.Ifthemediumisfree,thesenderstarts transmittingdataandcontinuestolistenintothemedium.Ifthesenderdetectsacollisionwhilesending ,itstopsatonceand sendsajammingsignal.

Channelization:

It is amultipleaccessinwhichtheavailablebandwidthof alinkisshared inTime,frequency orthrough code.

Time→Time division multiple

accessFrequency→Frequencydivisionmultipleac

cessCode→Codedivisionmultipleaccess

MultipleAccessTechniques:

Inwirelesscommunicationsystems,itisoftendesirabletoallowthesubscribertosendinformationsimultaneouslyfromthemobilestationtothebasestationwhilereceivinginformationfromthebasestationtothemobile station.

Acellularsystemdividesanygivenareaintocellswhereamobileunitineachcellcommunicateswitha basestation.Themainaiminthecellularsystemdesignistobeableto **increase the capacity of the channel**, i.e., to handle as many calls as possible in a givenbandwidth withasufficientlevelofquality ofservice.

There are several different ways to allow access to the channel. These includes mainly thefollowing−

- Frequencydivisionmultiple-access(FDMA)
- Timedivisionmultiple-access(TDMA)
- Codedivisionmultiple-access(CDMA)
- Spacedivisionmultipleaccess(SDMA)

Dependingonhowtheavailablebandwidthisallocatedtotheusers,thesetechniquescanbeclassifiedas **narrowband**and**wideband**systems.

NarrowbandSystems:

Systems operating with channels substantially narrower than the coherence bandwidth arecalled as Narrow band systems. Narrow band TDMA allows users to use the same channel butallocates a unique time slot to each user on the channel, thus separating a small number ofusersintimeonasinglechannel.

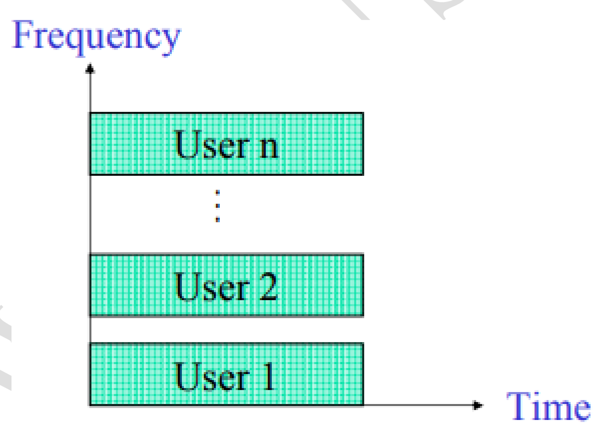
WidebandSystems

In wideband systems, the transmission bandwidth of a single channel is much larger than thecoherencebandwidthofthechannel.Thus,multipathfadingdoesn’tgreatlyaffectthereceived signal within a wideband channel, and frequency selective fades occur only in a smallfraction ofthe signalbandwidth.

FrequencyDivisionMultiple Access(FDMA)

FDMAisthebasictechnologyforadvancedmobilephoneservices.ThefeaturesofFDMAareasfollows.

- FDMAallotsadifferentsub-bandoffrequencytoeachdifferentusertoaccessthenetwork.
- IfFDMAis notinuse,thechannelis leftidleinsteadofallottingtotheotherusers.
- FDMA isimplementedinNarrowbandsystems anditislesscomplexthan TDMA.
- Tightfilteringisdoneheretoreduceadjacentchannelinterference.
- ThebasestationBSandmobilestationMS,transmitandreceivesimultaneouslyandcontinuou slyinFDMA.

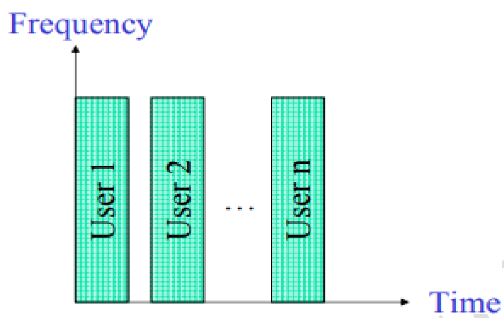


TimeDivisionMultipleAccess(TDMA)

Inthecaseswherecontinuoustransmissionisnotrequired,thereTDMAisusedinsteadofFDMA.The featuresof TDMAinclude thefollowing.

- TDMAsharesasinglecarrierfrequencywithseveraluserswhereeachusersmakesuseof non-overlappingtimeslots.
- DatatransmissioninTDMAisnotcontinuous,butoccursinbursts.Hencehandsoffprocessissi mpler.

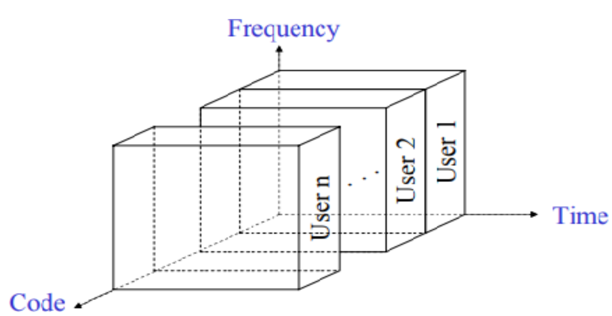
- TDMAusesdifferenttimeslotsfortransmissionandreceptionthusduplexersarenotrequired.
- TDMAhasanadvantagethatispossibletoallocatedifferentnumbersoftimeslotsperframetod ifferentusers.
- Bandwidthcanbesuppliedondemandtodifferentusersbyconcatenatingorreassigningtimesl otbasedonpriority.



CodeDivisionMultipleAccess(CDMA)

Codedivisionmultipleaccesstechniqueisanexampleofmultipleaccesswhereseveraltransmitters usea single channel tosend informationsimultaneously. Its features areasfollows.

- InCDMAeveryuserusesthefullavailablespectruminsteadofgettingallottedbyseparatefrequ ency.
- CDMAismuchrecommended forvoiceanddatacommunications.
- WhilemultiplecodesoccupythesamechannelinCDMA,theusershavingsamecodecancomm unicatewitheachother.
- CDMA offersmoreair-spacecapacitythanTDMA.
- Thehands-offbetweenbase stationsisverywellhandledbyCDMA.



SpaceDivisionMultipleAccess(SDMA)

Space division multiple access or spatial division multiple access is a technique which is MIMO(multiple-inputmultiple-output)architectureandusedmostlyinwirelessandsatellitecommunication.Ithasthefollowingfeatures.

- Alluserscancommunicateat thesametime usingthesamechannel.
- SDMAiscompletelyfreefrominterference.
- Asinglesatellitecancommunicate withmoresatellitesreceiversofthesame frequency.
- Thedirectionalspot-beamantennasareusedandhencethebasestationinSDMA,cantrack amovinguser.
- Controlstheradiatedenergyforeachuser inspace.

UNIT-II

GSM(GlobalSystemforMobileCommunication):

GSMisamobilecommunicationmodem;itisstandsforglobalsystemformobilecommunication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It iswidely used mobile communication system in the world. GSM is an open and digital cellulartechnology used for transmitting mobile voice and data services operates at the 850MHz,900MHz,1800MHzand1900MHz frequencybands.

GSM system was developed as a digital system using time division multiple access (TDMA)technique for communication purpose. A GSM digitizes and reduces the data, then sends itdown through a channel with two different streams of client data, each in its own particulartimeslot.Thedigitalsystemhasanabilitytocarry64kbpsto120Mbpsof datarates.

GSMservices:

GSMoffersmuchmorethanjustvoicetelephony.ContactyourlocalGSMnetworkoperatortothe specificservicesthatyoucanavail.

GSMoffersthreebasictypes ofservices:

- Telephonyservicesorteleservices
- Dataservicesor bearerservices
- Supplementaryservices

➢ **TELESERVICES**

TheabilitiesofaBearerServiceareusedbyaTeleservicetotransportdata.Theseservicesarefurthertransitedin thefollowing ways:

- VoiceCalls
- ThemostbasicTeleservicesupportedbyGSMistelephony.Thisincludesfull-ratespeech at 13 kbps and emergency calls, where the nearest emergency-service providerisnotifiedbydialingthree digits.
- VideotextandFacsmile
- Another group of teleservices includes Videotext access, Teletex transmission, FacsmilealternatespeechandFacsmileGroup 3, AutomaticFacsmileGroup, 3etc.
- ShortTextMessages
- Short Messaging Service (SMS) service is a text messaging service that allows sendingandreceivingtextmessagesonyourGSMmobilephone.

messages, othertext dataincluding news,sports,financial,language, and location-baseddatacanalsobetransmitted.

- **BEARERSERVICES**:

Data services or Bearer Services are used through a GSM phone. to receive and senddata is the essential building block leading to widespread mobile Internet access andmobile data transfer. GSM currently has a data transfer rate of 9.6k. New developmentsthat willpushupdatatransfer ratesfor GSM usersare HSCSD(highspeed circuitswitched data) and GPRS(generalpacketradioservice)arenowavailable.

- **SUPPLEMENTARYSERVICES:**

Supplementaryservicesareadditionalservicesthatareprovidedinadditiontoteleservicesan dbearerservices.Theseservicesincludecalleridentification,callforwarding,callwaiting,mult i-partyconversations,andbarringofoutgoing(international) calls, among others. A briefdescription of supplementary servicesisgivenhere:

- Conferencing :Itallowsamobilesubscribertoestablishamultipartyconversation,i.e.,a simultaneous conversation between three or more subscribers to setup a conferencecall.Thisserviceisonlyapplicabletonormaltelephony.
- Call Waiting : This service notifies a mobile subscriber of an incoming call during aconversation.Thesubscribercananswer,reject,orignoretheincoming call.
- Call Hold : This service allows a subscriber to put an incoming call on hold and resumeafterawhile. Thecallholdserviceisapplicabletonormaltelephony.
- Call Forwarding : Call Forwarding is used to divert calls from the original recipient toanother number. It is normally set up by the subscriber himself. It can be used by thesubscriber to divert calls from the Mobile Station when the subscriber is not available,andsotoensurethatcallsarenotlost.
- Call Barring : Call Barring is useful to restrictcertain types of outgoing calls such as ISDor stop incoming calls from undesired numbers. Call barring is a flexible service thatenablesthesubscribertoconditionallybarcalls.
- Number Identification : There are following supplementary services related to numberidentification:

<u>GSMArchitecture:</u>

AGSMnetworkcomprisesofmanyfunctionalunits.Thesefunctionsandinterfacesareexplainedinth ischapter. The GSMnetworkcanbebroadlydividedinto:

- TheMobileStation(MS)
- TheBaseStationSubsystem(BSS)

- TheNetworkSwitchingSubsystem(NSS)
- TheOperationSupportSubsystem(OSS)

➢ **Mobilestation(MS):**

TheMSconsists of thephysical equipment,such astheradio transceiver, displayand digital signal processors, and the SIM card. It provides the air interface to theuserinGSMnetworks.Assuch, otherservicesarealsoprovided,whichinclude:

- Voiceteleservices
- Databearerservices
- Thefeatures'supplementaryservices

TheMSFunctions

The MS also provides the receptor for SMS messages, enabling the user to toggle between thevoice and data use. Moreover, the mobile facilitates access to voice messaging systems. TheMS also provides access to the various data services available in a GSM network. These dataservicesinclude:

- X.25packetswitchingthroughasynchronousorasynchronousdial-upconnectiontothePADatspeedstypicallyat9.6Kbps.
- GeneralPacketRadioServices(GPRSs)usingeitheranX.25orIPbaseddatatransfermethodatspeedsupto115Kbps.
- Highspeed,circuit switcheddataatspeeds upto64Kbps.

SIM:

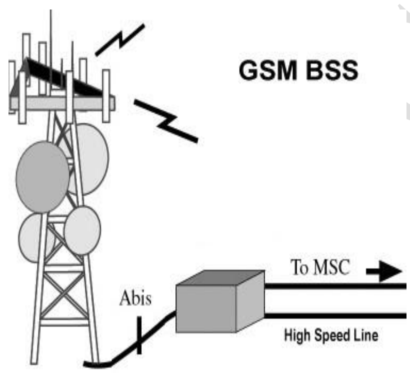
The SIM provides personal mobility so that the user can have access to all subscribed servicesirrespectiveofboththelocationoftheterminalandtheuseofaspecificterminal.Youneed toinserttheSIMcardintoanotherGSMcellularphonetoreceivecallsatthatphone,makecallsfromthat phone, or receiveothersubscribedservices.

- **TheBaseStationSubsystem(BSS):**

  TheBSSiscomposedoftwoparts:

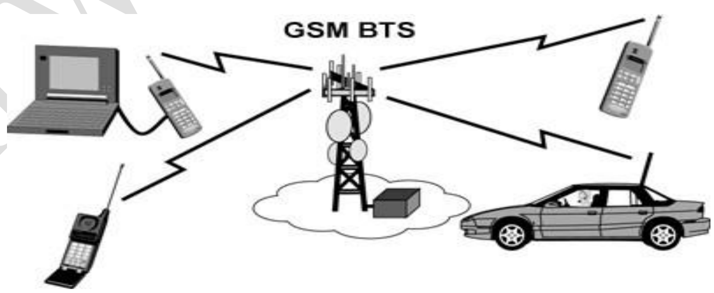
  - TheBaseTransceiverStation(BTS)
  - TheBaseStationController(BSC)

  TheBTSandtheBSCcommunicateacrossthespecifiedAbisinterface,enablingoperationsbet weencomponentsthataremadebydifferentsuppliers.Theradiocomponents of a BSS may consist of four to seven or nine cells. A BSS may have one ormore base stations. The BSS uses the Abis interface between the BTS and the BSC. Aseparatehigh-speedline(T1orE1)is thenconnectedfromtheBSStotheMobileMSC.



- **TheBaseTransceiverStation(BTS)**

  The BTS houses the radio transceivers that define a cell and handles the radio linkprotocolswiththeMS.Ina largeurban area,alargenumberofBTSs maybedeployed.



The BTS corresponds to the transceivers and antennas used in each cell of the network.A BTS is usually placed in the center of a cell. Its transmitting power defines the size of acell. Each BTS has between 1 and 16 transceivers, depending on the density of users inthecell.EachBTSservesasasinglecell.Italsoincludesthefollowingfunctions:

-

- Transcodingandrate adaptation
- Timeandfrequencysynchronizing
- Voicethroughfull-orhalf-rateservices
- Decoding,decrypting,andequalizingreceivedsignals
- Randomaccessdetection
- Timingadvances
- Uplinkchannelmeasurements

➢ **TheBaseStationController(BSC)**

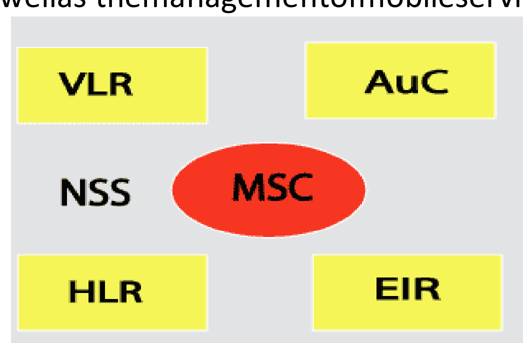
The BSC manages the radio resources for one or more BTSs. It handles radio channel setup,frequency hopping, and handovers. The BSC is the connection between the mobile and theMSC. The BSC also translates the 13 Kbps voice channel used over the radio link to thestandard64KbpschannelusedbythePublicSwitchedTelephoneNetwork(PSDN)orISDN.

- Controloffrequencyhopping
- Performingtrafficconcentrationtoreducethenumberoflinesfrom theMSC
- ProvidinganinterfacetotheOperationsandMaintenanceCenterfortheBSS
- ReallocationoffrequenciesamongBTSs
- Timeandfrequencysynchronization
- Powermanagement
- Time-

delaymeasurementsofreceivedsignalsfromtheMSTheNetworkSwi

tchingSubsystem(NSS):

TheNetworkswitchingsystem(NSS),themainpart ofwhichis theMobileSwitchingCenter(MSC), performs the switching of calls between the mobile and other fixed or mobilenetworkusers,aswellas themanagementofmobileservices suchasauthentication.



HomeLocationRegister(HLR)

TheHLRisconsideredthe mostimportantdatabase, as it storespermanent data aboutsubscribers,including a subscriber's service profile, location information, and activity status. When anindividualbuysasubscriptionintheformofSIM,thenalltheinformationaboutthissubscriptionisregisteredinthe HLRof thatoperator.

MobileServicesSwitchingCenter(MSC)

ThecentralcomponentoftheNetworkSubsystemistheMSC.TheMSCperformstheswitching of calls between the mobile and other fixed or mobile network users, as well as themanagementofmobileservicessuchasregistration,authentication,locationupdating,handovers, and call routing to a roaming subscriber. It also performs such functions as tollticketing, network interfacing, common channel signaling, and others. Every MSC is identifiedbyaunique ID.

VisitorLocationRegister(VLR)

The VLR is a database that contains temporary information about subscribers that isneededby the MSC in order to service visiting subscribers. The VLR is always integrated with the MSC.When a mobile station roams into a newMSC area, the VLR connected to that MSC willrequest data about the mobile station from the HLR. Later, if the mobile station makes a call,the VLR will have the information needed for call setup without having to interrogate the HLReachtime.

AuthenticationCenter(AUC)

The Authentication Center is a protected database that stores a copy of the secret key storedin each subscriber's SIM card, which is used for authentication and ciphering of the radiochannel. The AUC protects network operators from different types of fraud found in today'scellularworld.

EquipmentIdentityRegister(EIR)

The Equipment Identity Register (EIR) is a database that contains a list of all valid mobileequipmentonthenetwork,whereitsInternationalMobileEquipmentIdentity(IMEI)identifies each MS. An IMEI is marked as invalid if it has been reported stolen or is not typeapproved.

TheOperationSupportSubsystem(OSS)

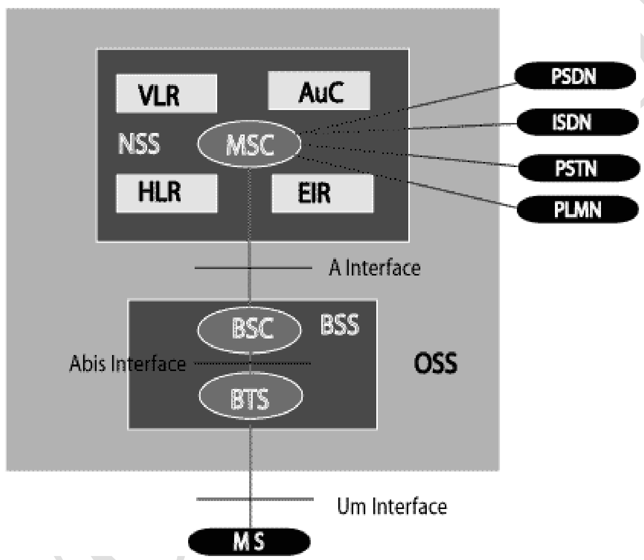
The operations and maintenance center (OMC) is connected to all equipment in the switchingsystem and to the BSC. The implementation of OMC is called the operation and supportsystem(OSS).

Herearesome oftheOMCfunctions:

- Administrationandcommercialoperation(subscription, endterminals, chargingandstatistics).
- SecurityManagement.
- Networkconfiguration,OperationandPerformanceManagement.
- MaintenanceTasks.

TheoperationandMaintenancefunctionsarebasedontheconceptsoftheTelecommunication Management Network (TMN), which is standardized in the ITU-T seriesM.30.

GSMARCHITECTURE:



The additional components of the GSM architecture comprise of databases and messagingsystemsfunctions:

- HomeLocationRegister(HLR)
- VisitorLocationRegister(VLR)
- EquipmentIdentityRegister(EIR)
- AuthenticationCenter (AuC)
- SMSServingCenter(SMSSC)
- GatewayMSC(GMSC)
- ChargebackCenter(CBC)
- TranscoderandAdaptationUnit(TRAU)

FeaturesofGSMModule:

- Improvedspectrumefficiency
- Internationalroaming
- Compatibilitywithintegratedservicesdigitalnetwork(ISDN)
- Supportfornewservices.
- SIMphonebookmanagement
- Fixeddialingnumber(FDN)
- Realtimeclockwithalarm management
- High-qualityspeech
- Usesencryptiontomakephonecallsmoresecure
- Shortmessageservice(SMS)

S.NO	GSM	CDMA
1.	GSM stands for Global System for Mobile communication.	CDMA stands for Code Division Multiple Access.
2.	GSM uses the technology named FDMA and TDMA.	While it uses the technology CDMA.
3.	GSM is in roaming in worldwide.	While it is in roaming in limited.
4.	GSM has slow data rate.	While it has fast data rate.
5.	In GSM, information in addition as voice each are transmitted at the same time.	While CDMA have not this facility.
6.	GSM is specific for SIM.	While it is specific for headset or phone.

DECT:

➢ Anotherfullydigitalcellularnetworkisthedigitalenhancedcordlesstelecommunications(DECT)systemspecifiedby ETSI (2002,1998j,k),(DECTForum,2002).

➢ FormerlyalsocalleddigitalEuropeancordlesstelephoneanddigitalEuropeancordlesstelecommunications,DECTreplacesolderanalogcordlessphonesystemssuchasCT1andCT1+.

➢ These analog systems only ensured security to a limited extent as they did not use encryptionfordatatransmissionandonly offeredarelativelylowcapacity.

➢ DECTisalsoamorepowerfulalternativetothedigitalsystemCT2,whichismainlyusedintheUK(the DECT standardworksthroughoutEurope).

- DECT is mainly used in offices, on campus, at trade shows, or in the home. Furthermore,access points to the PSTN can be established within, e.g., railway stations, large governmentbuildingsandhospitals,offeringamuchcheapertelephoneservicecomparedtoaGSMsystem.
- DECT could also be used to bridge the last few hundred meters between a new networkoperatorandcustomers.
- Using this 'small range' local loop, new companies can offer their service without having theirown lines installed in the streets. DECT systems offer many different interworking units, e.g.,withGSM,ISDN,ordatanetworks.
- AbigdifferencebetweenDECTandGSMexistsinterms ofcelldiameterandcellcapacity.
- WhileGSMis designed foroutdooruse with a cell diameter of up to 70 km, the rangeofDECT is limited to about 300 m from the base station (only around 50 m are feasible insidebuildingsdependingonthe walls).
- Due to this limited range and additional multiplexing techniques, DECT can offer its service tosome10,000people withinonekm2.
- DECTworksata frequencyrangeof1880–1990MHzoffering120fullduplexchannels.
- Time divisionduplex(TDD)isapplied using10msframes.
- The frequency range is subdivided into 10 carrier frequencies using FDMA, each frame beingdividedinto 24slotsusingTDMA.

DECTSystemarchitecture:

- A DECT system, may have various different physical implementation depending on its actualuse.
- Different DECT entities can be integrated into one physical unit; entities can be distributed,replicated etc. However, all implementations are based on the same logical reference model ofthesystemarchitectureasshown inFigure.
- A global network connects the local communication structure to the outside world and offersitsservicesviathe interfaceD1.
- Globalnetworkscouldbeintegratedservicesdigitalnetworks(ISDN),publicswitchedtelephone networks (PSTN), public land mobile networks (PLMN), e.g., GSM, or packet switchedpublicdatanetwork(PSPDN).
- The services offered by these networks include transportation of data and the translation ofaddressesandroutingof databetweenthelocalnetworks.

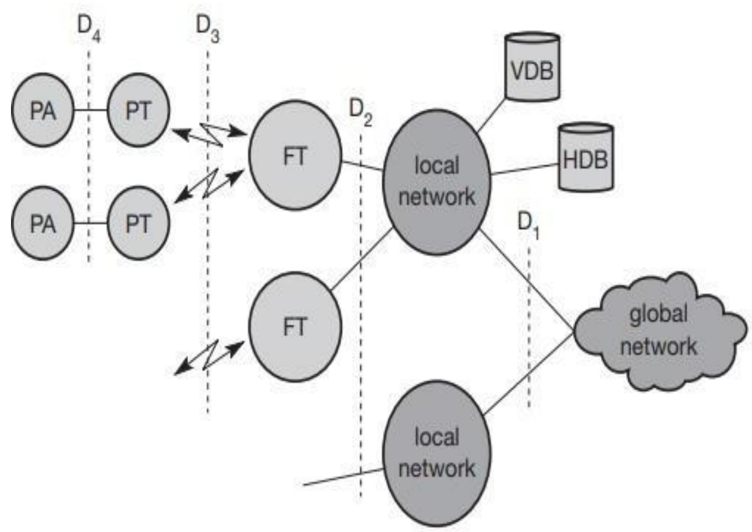
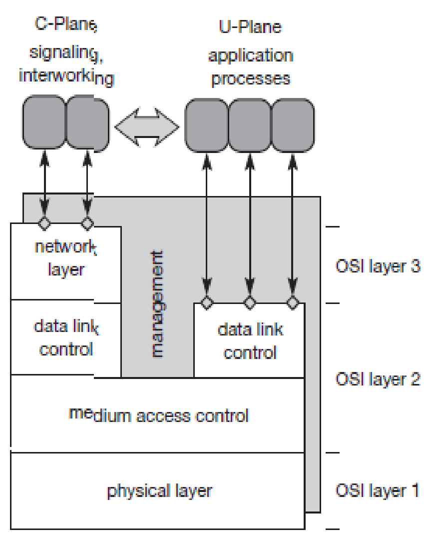


Figure
DECT system architecture reference model

The DECT core network consists of the **fixed radio termination (FT)** and the **portable radiotermination (PT)**, and basically only provides a multiplexing service. FT and PT cover layers oneto three at the fixed network side and mobile network side respectively. Additionally, severalportableapplications(PA)canbeimplementedonadevice.

Protocolarchitecture:

The DECT protocol reference architecture follows the OSI reference model. Figure4.19 showsthe layers covered by the standard: the physical layer, medium access control, and data linkcontrol8forboth the**controlplane(C-Plane)**and the **userplane(U-Plane)**. An additionalnetwork layer has been specified for the C-Plane, so that user data from layer two is directlyforwarded to the U-Plane. A management plane vertically covers all lower layers of a DECTsystem.



Mediumaccesscontrollayer:

The**mediumaccesscontrol(MAC**)layerestablishes,maintains,andreleaseschannelsforhigher layers by activating and deactivating physical channels. MAC multiplexes several logicalchannels onto physical channels. Logical channels exist for signaling network control, user datatransmission,paging,orsendingbroadcastmessages.Additionalservicesofferedincludesegmentation/reassemblyof packetsand error control/errorcorrection.

Datalinkcontrollayer:

The**datalinkcontrol(DLC)**layercreatesandmaintainsreliableconnectionsbetweenthemobileterminalandthebasestation.Twoserviceshavebeendefinedforthe**C-Plane**: a**connectionless broadcast** service for paging (called **Lb**) and a **point-to-point** protocol similar toLAPDinISDN.

Networklayer:

The **network laye**r of DECT is similar to those in ISDN and GSM and only exists for the **C-Plane**.This layer provides services to request, check, reserve, control, and release resources at thefixed station (connection to the fixed network, wireless connection) and the mobile terminal(wirelessconnection).

<u>WIRELESSLAN:</u>

WLANsaretypicallyrestrictedintheirdiametertobuildings,acampus,singleroomsetc.andareoperated byindividuals,notbylarge-scalenetworkproviders.TheglobalgoalofWLANsistoreplaceofficecabling,toenabletetherlessaccesstotheinternetand,tointroduceahigherflexibilityforad-hoccommunicationin,e.g.,groupmeetings.Thefollowingpointsillustratesome general advantages anddisadvantages of WLANs compared to their wired counterparts.**ADVANTAGES:**

● **Flexibility:** Within radio coverage, nodes can communicate without further restriction. Radiowaves can penetrate walls, senders and receivers can beplaced anywhere(also non-visible,e.g.,withindevices, inwallsetc.).

● **Planning:** Only wireless ad-hoc networks allow for communication without previous planning,any wired network needs wiring plans. As long as devices follow the same standard, they cancommunicate.Forwirednetworks,additionalcablingwiththerightplugsandprobablyinterworking units(suchasswitches)have to be provided.

● **Design:** Wireless networks allow for the design of small, independent devices which can forexample be put into a pocket. Cables not only restrict users but also designers of small PDAs,notepads etc. Wireless senders and receivers can be hidden in historic buildings, i.e., currentnetworkingtechnologycan be introducedwithoutbeingvisible.

● **Robustness:** Wireless networks can survive disasters, e.g., earthquakes or users pulling a plug.Ifthewirelessdevicessurvive,peoplecanstillcommunicate.Networksrequiringawiredinfrastructurewillusuallybreak downcompletely.

● **Cost:** After providing wireless access to the infrastructure via an access point for the first user,addingadditionaluserstoawirelessnetwork willnotincreasethecost.

DISADVANTAGES:

Qualityofservice:WLANs typicallyofferlowerqualitythantheirwiredcounterparts.

● **Proprietary solutions:** Due to slow standardization procedures, many companies have comeup with proprietary solutions offering standardized functionality plus many enhanced features(typically a higher bit rate using a patented coding technology or special inter-access pointprotocols).

● **Restrictions:**Allwirelessproductshavetocomplywithnationalregulations.Severalgovernment and non-government institutions worldwide regulate the operation and restrictfrequenciesto minimizeinterference.

● **Safety and security:** Using radio waves for data transmission might interfere with other high-tech equipment in, e.g., hospitals. Senders and receivers are operated by laymen and, radiationhastobelow.Specialprecautionshavetobetakentopreventsafety hazards.

● **Global operation:** WLAN products should sell in all countries so, national and internationalfrequencyregulationshaveto beconsidered

● **Low power:** Devices communicating via a WLAN are typically also wireless devices running onbattery power. The LAN design should take this into account and implement special power-savingmodesandpowermanagementfunctions.

● **License-free operation:** LAN operators do not want to apply for a special license to be able touse the product. The equipment must operate in a license-free band, such as the 2.4 GHz ISMband.

● **Robusttransmission technology:**Compared to their wired counterparts, WLANs operateunder difficult conditions. If they use radio transmission, many other electrical devices caninterferewiththem(vacuumcleaners,hairdryers,trainenginesetc.).

● **Simplified spontaneous cooperation:** To be useful in practice, WLANs should not requirecomplicatedsetuproutinesbutshouldoperatespontaneouslyafterpower-up.TheseLANswouldnotbe useful forsupporting, e.g.,ad-hocmeetings.

● **Easy to use:** In contrast to huge and complex wireless WANs, wireless LANs are made forsimple use. They should not require complex management, but rather work on a plug-and-playbasis.

● **Protectionofinvestment:** Alotofmoney hasalreadybeeninvestedintowired LANs.

● **Safetyandsecurity:**WirelessLANsshouldbesafetooperate,especiallyregardinglowradiation if used,e.g.,inhospitals.Userscannotkeepsafety distancestoantennas..

● **Transparency for applications:** Existing applications should continue to run over WLANs, theonly differencebeing higherdelayandlowerbandwidth.

INFRAREDVSRADIOTRANSMISSION:

Today,twodifferentbasictransmissiontechnologiescanbeusedtosetupWLANs.Onetechnology is based on the transmission of infra red light (e.g., at900 nm wavelength), theother one, which is much more popular, uses radio transmission in the GHz range (e.g., 2.4 GHzin the license-free ISM band). Both technologies can be used to set up ad-hoc connections forwork groups, to connect, e.g., a desktop with a printer without a wire, or to support mobilitywithinasmallarea.

Infra red technology uses diffuse light reflected at walls, furniture etc. or directed light if a line-of-sight (LOS) exists between sender and receiver. Senders can be simple light emitting diodes(LEDs)orlaserdiodes.

- The main advantages of infra red technology are its simple and extremely cheap senders andreceivers which are integrated into nearly all mobile devices available today. PDAs, laptops,notebooks, mobile phones etc. have an infra red data association (IrDA) interface. Version 1.0 ofthis industry standard implements data rates of up to 115 kbit/s, while IrDA 1.1 defines higherdataratesof1.152and4Mbit/s.Nolicensesareneededforinfraredtechnologyandshieldingisverysimple.Electrical devicesdonotinterferewithinfraredtransmission.
- DisadvantagesofinfraredtransmissionareitslowbandwidthcomparedtootherLANtechnologies.

Typically, IrDA devices are internally connected to a serial port limiting transferrates to 115 kbit/s. Even 4 Mbit/s is not a particularly high data rate. However, their maindisadvantage is that infra red is quite easily shielded. Infra red transmission cannot penetratewalls or other obstacles. Typically, for good transmission quality and high data rates a LOS, i.e.,directconnection, isneeded.

INFRASTRUCTUREANDAD-HOCNETWORKS:

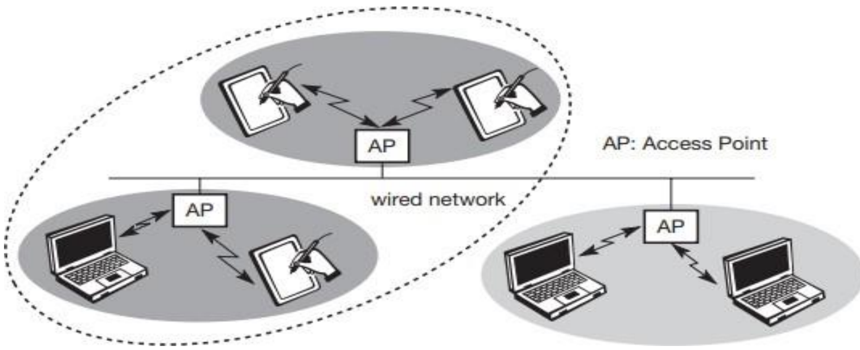
➢ Many WLANsof today need an infrastructure network. Infrastructure networks not onlyprovide access to other networks, but also include forwarding functions, medium access controletc.

➢ In these infrastructure-based wireless networks, communication typically takes place onlybetween the wireless nodes and the access point (see Figure), but not directly between thewirelessnodes.

➢ The access point does not just control medium access, but also acts as a bridge to otherwirelessor wirednetworks.

➢ Figureshowsthreeaccesspointswiththeirthreewirelessnetworksandawirednetwork.

➢ Severalwirelessnetworksmayformonelogicalwirelessnetwork,sotheaccesspointstogether with the fixed network in between can connect several wireless networks to form alargernetworkbeyondactualradiocoverage.



➢ Ad-hoc wireless networks, however, do not need any infrastructure to work. Each node cancommunicatedirectlywithothernodes,sonoaccesspointcontrollingmediumaccessisnecessary.

➢ Inad-hocnetworks,thecomplexityofeachnodeishigherbecauseeverynodehastoimplement medium access mechanisms, mechanisms to handle hidden or exposed terminalproblems,andperhapsprioritymechanisms,toprovide acertainquality ofservice.

➢ This type of wireless network exhibits the greatest possible flexibility as it is, for example,neededforunexpectedmeetings,quickreplacementsofinfrastructureorcommunicationsc enariosfarawayfromany infrastructure.

IEEE802.11:

➢ The IEEE standard 802.11 (IEEE, 1999) specifies the most famous family of WLANs in whichmany productsare available.

➢ Asthestandard'snumberindicates,thisstandardbelongstothegroupof802.xLANstandards,e.g.,8 02.3Ethernetor 802.5TokenRing.

➢ This means that the standard specifies the physical and medium access layer adapted to thespecial requirements of wireless LANs, but offers the same interface as the others to higherlayerstomaintaininteroperability.

➢ The primary goal of the standard was the specification of a simple and robust WLAN whichofferstime-boundedandasynchronousservices.

➢ The MAC layer should be able to operate with multiple physical layers, each of which exhibitsadifferentmediumsenseandtransmissioncharacteristic.

➢ Candidatesforphysicallayerswereinfraredandspreadspectrumradiotransmissiontechniques.

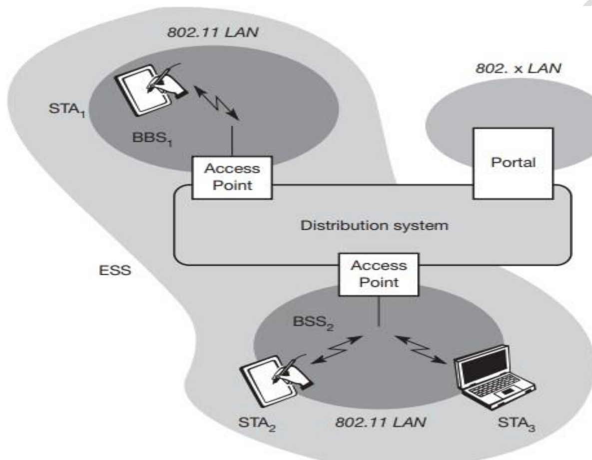
➢ ThefollowingsectionswillintroducethesystemandprotocolarchitectureoftheinitialIEEE 802.11andthen discusseachlayer,i.e.,physicallayerandmedium access.

➢ Afterthat,thecomplexandveryimportantmanagementfunctionsofthestandardarepresented.

➢ Finally, this subsection presents the enhancements of the original standard for higher datarates, 802.11a (up to 54 Mbit/s at 5 GHz) and 802.11b (today the most successful with 11Mbit/s)togetherwithfurtherdevelopmentsforsecuritysupport,harmonization,orothermodulati onschemes.

- **Systemarchitecture:**

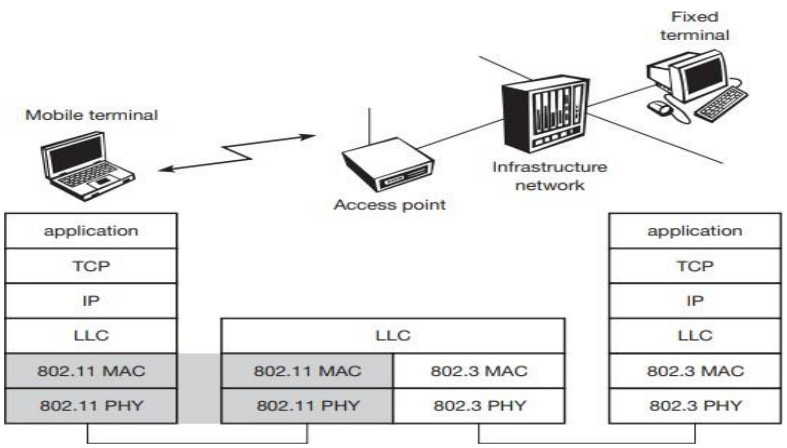
Wirelessnetworkscanexhibittwodifferentbasicsystemarchitecturesasshownininfrastructure-basedorad-hoc.FigureshowsthecomponentsofaninfrastructureandawirelesspartasspecifiedforIEEE802.11.Severalnodes,calledstations(STAi),areconnectedtoaccesspoints(AP).



- **Protocolarchitecture:**

As indicated by the standard number, IEEE 802.11 fits seamlessly into the other 802.x standardsfor wiredLANs (seeHalsall,1996;IEEE,1990).Figureshowsthemostcommonscenario:anIEEE 802.11 wireless LAN connected to a switched IEEE 802.3 Ethernet via a bridge. Applicationsshould not notice any difference apart from the lower bandwidth and perhaps higher accesstime from the wireless LAN. The WLAN behaves like a slow wired LAN. Consequently, the higherlayers (application, TCP, IP) look the same for wireless nodes as for wired nodes. The upper partof the data link control layer, the logical link control (LLC), covers the differences of the mediumaccess control layers needed for the different media. In many of today's networks, no explicitLLClayerisvisible.

The IEEE 802.11 standard only covers the physical layer PHY and medium access layer MAC likethe other 802.x LANs do. The physical layer is subdivided into the physical layer convergenceprotocol (PLCP) and the physical medium dependent sublayer PMD (see Figure). The basic tasksoftheMAClayercomprisemediumaccess,fragmentationof userdata,andencryption.



HIPERLAN(highperformancelocalareanetwork):

- HIPERLAN standsforhighperformancelocal areanetwork. Itisawireless standardderivedfromtraditionalLANenvironmentsandcansupportmultimediaandasynchronousdataeffectively athighdataratesof23.5Mbps.
- Itisdefinedbythe EuropeanTelecommunicationsStandardsInstitute(ETSI).
- It does not necessarily require any type of access point infrastructure for its operation,althoughaLANextension viaaccesspointscanbeimplemented.
- HIPERLANuses cellular-baseddata networkstoconnect toanATM backbone.
- ThemainideabehindHIPERLANistoprovideaninfrastructureorad-hocwirelesswithlowmobilityandasmallradius.
- HIPERLANsupportsisochronoustrafficwithlowlatency.TheHiperLANstandardfamilyhasfour differentversions.
- Thekeyfeatureofallfournetworksistheirintegrationoftime-sensitivedatatransferservices.
- Overtime,nameshavechangedandtheformerHIPERLANs2,3,1nd4arenowcalledHiperLAN2, HIPERACCESS,andHIPERLINK.

Table : HIPERLAN protocol family

	HIPERLAN 1	HIPERLAN 2	HIPERLAN 3	HIPERLAN 4
Application	wireless LAN	access to ATM fixed networks	wireless local loop	point-to-point wireless ATM connections
Frequency	5.1-5.3GHz			17.2-17.3GHz
Topology	decentralized ad-hoc/infrastructure	cellular, centralized	point-to-multipoint	point-to-point
Antenna	omni-directional		directional	
Range	50 m	50-100 m	5000 m	150 m
QoS	statistical	ATM traffic classes (VBR, CBR, ABR, UBR)		
Mobility	<10m/s		stationary	
Interface	conventional LAN	ATM networks		
Data rate	23.5 Mbit/s	>20 Mbit/s		155 Mbit/s
Power conservation	yes		not necessary	

HIPERLAN1:

OnthephysicallayerFSKandGMSKmodulationsareusedinHiperLAN/1.HiperLANfeatures:

○range50m

○slowmobility(1.4m/s)

○supportsasynchronousandsynchronoustraffic

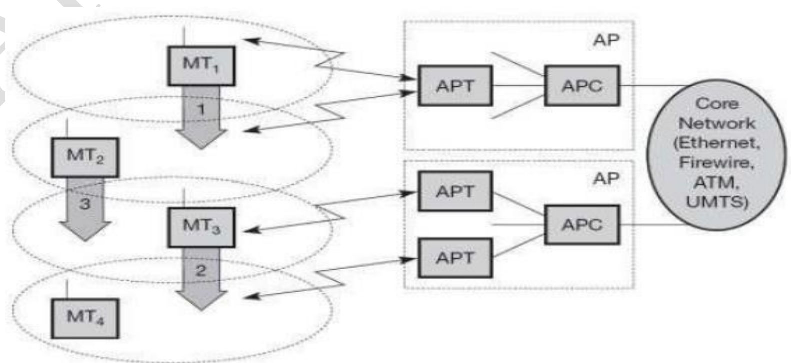
○sound32kbit/s,10nslatency

○video2Mbit/s,100nslatency

○data 10Mbit/s

➢ **HIPERLAN2:**
WhileHIPERLAN1didnotsucceedHiperLAN2mighthaveabetterchance.HiperLAN2offersmorefeatures inthe mandatory partsofthestandard (HiperLAN2,2002).
○ **Qualityofservicesupport:**supportofQoSismuchsimpler.Eachconnectionhasitsownsetof QoSparameters(bandwidth,delay,jitter, biterror rateetc.).
○ **Dynamicfrequencyselection:**HiperLAN2doesnotrequirefrequency
○ **Securitysupport:**Authenticationaswellasencryptionaresupportedby HiperLAN2.
○ **Mobilitysupport:**Mobileterminalscanmovearoundwhiletransmissionalwaystakesplacebetwee ntheterminalandthe accesspointwiththebestradiosignal.

○ **Application and network independence:** HiperLAN2 was not designed with a certain group ofapplications or networks in mind. Access points can connect to LANs running ethernet as well asIEEE 1394 (Firewire) systemsused toconnecthomeaudio/video devices.
○ **Powersaves:** Mobileterminalscannegotiatecertainwake-uppatternstosavepower.



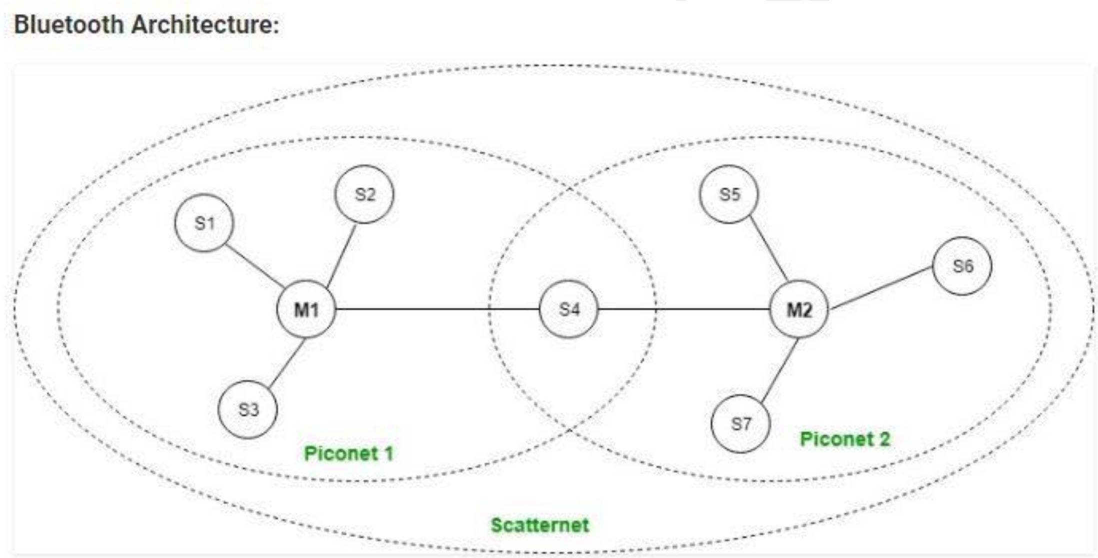
TheaboveFigureshowsthestandardarchitectureofaninfrastructure-basedHiperLAN2network.
Here, two **access points** (AP) are attached to a core network. Core networks might beEthernet LANs, Firewire (IEEE 1394) connections between audio and video equipment,

ATMnetworks,UMTS3Gcellularphonenetworksetc.EachAPconsistsofan **accesspointcontroller**(APC) and one ormore**access pointtransceivers**(APT).

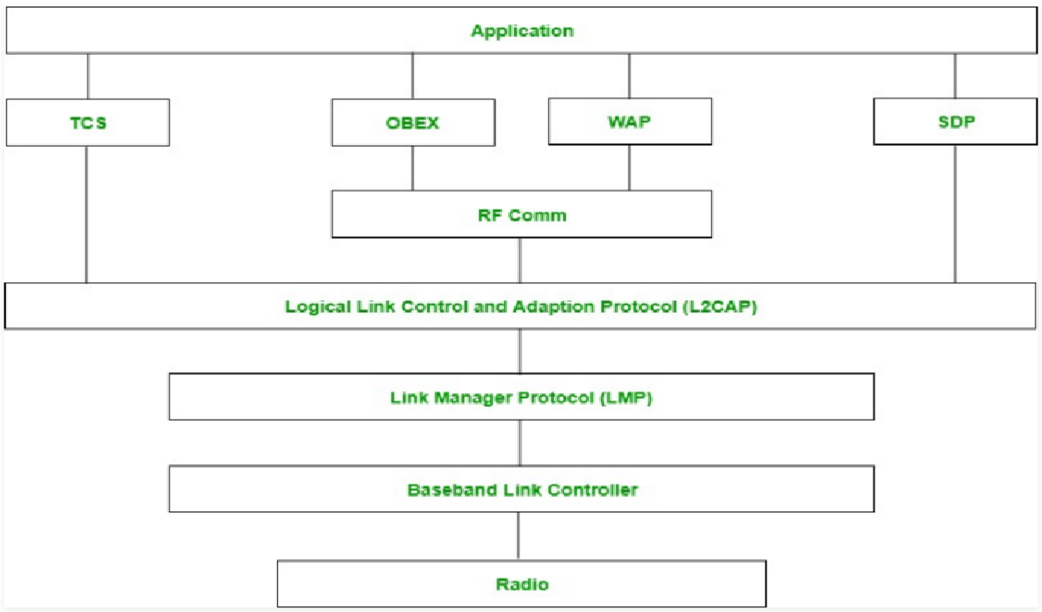
BLUETOOTH:

Bluetooth is a wireless technology standard for exchanging data over short distances (usingshort-wavelength radio transmissions in the ISM band from 2400–2480 MHz) from fixed andmobile devices, creating personal area networks (PANs) with high levels of security. Differenttype of network is needed to connect different small devices in close proximity (about 10 m)without expensive wiring or the need for a wireless infrastructure .Bluetooth is a new standardsuggested by a group of electronics manufacturers that will allow any sort of electronic toolsfrom computers and cell phones to keyboards and headphones to make its own connections,withoutwires,cablesor anydirectactionfromauser.

BLUETOOTHARCHITECTURE:



Bluetooth protocol stack:



1. **Radio(RF)layer:**
   It performs modulation/demodulation of the data into RF signals. It defines the physicalcharacteristics of bluetooth transceiver. It defines two types of physical link: connection-lessand connection-oriented.
2. **BasebandLinklayer:**
   Itperformstheconnectionestablishmentwithinapiconet.
3. **LinkManagerprotocollayer:**
   Itperformsthemanagementofthealreadyestablishedlinks.Italsoincludesauthenticationanden cryption processes.
4. **LogicalLinkControlandAdaptionprotocollayer:**
   Itisalsoknownastheheartofthebluetoothprotocolstack.Itallowsthecommunicationbetween upper and lower layers of the bluetooth protocol stack. It packages the datapackets received from upper layers into the form expected by lower layers. It alsoperformsthe segmentationand multiplexing.
5. **SDPlayer:**
   ItisshortforServiceDiscoveryProtocol.Itallowstodiscovertheservicesavailableonanotherbluet oothenabled device.
6. **RFcommlayer:**
   Itisshortfor RadioFrontendComponent.ItprovidesserialinterfacewithWAPandOBEX.
7. **OBEX:**
   ItisshortforObjectExchange.Itisacommunicationprotocoltoexchangeobjectsbetween2devic es.
8. **WAP:**
   Itis shortforWirelessAccess Protocol.Itis usedforinternet access.
9. **TCS:**
10. ItisshortforTelephonyControlProtocol.Itprovidestelephonyservice.

Applicationlayer:

Itenablestheusertointeractwiththeapplication.

Advantages:

- Lowcost.
- Easyto use.
- Itcanalsopenetratethroughwalls.
- Itcreatesanadhocconnectionimmediatelywithoutanywires.
- Itisusedfor voiceanddatatransfer.

Disadvantages:

- Itcanbehackedand hence,less secure.
- Ithas slowdata transferrate:3 Mbps.
- Ithassmallrange:10meters.

UNIT-III

MOBILENETWORKLAYER:

MOBILEIP:

This is an **IETF (Internet Engineering Task Force)** standard communications protocol designedto allow mobile devices' (such as laptop, PDA, mobile phone, etc.) users to move from onenetworktoanother whilemaintainingtheirpermanentIP(InternetProtocol)address.

Defined in RFC (Request for Comments) 2002, mobile IP is an enhancement of the internetprotocol (IP) that adds mechanisms for forwarding internet traffic to mobile devices (known asmobilenodes) whenthey areconnectingthrough otherthantheirhomenetwork.

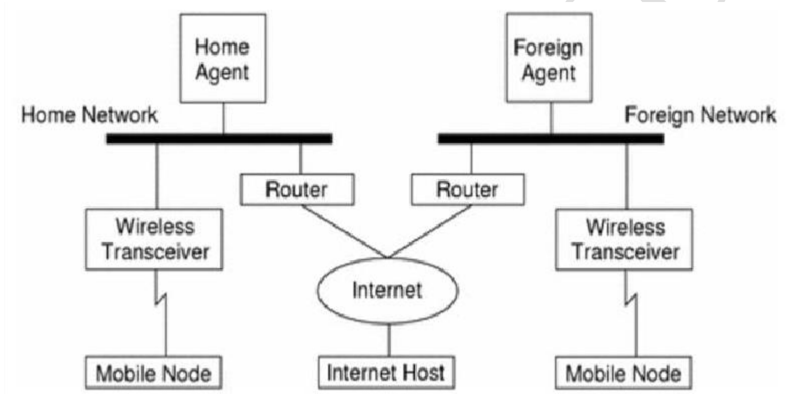


Fig: Mobile IP topology

The following case shows how a datagram moves from one point to another within the MobileIPframework.

- First of all, the internet host sends a datagram to the mobile node using the mobilenode'shomeaddress(normal IP routingprocess).
- If the mobile node (MN) is on its home network, the datagram is delivered through thenormal IP (Internet Protocol) process to the mobile node. Otherwise the home agentpicksupthe datagram.
- If the mobile node (MN) is on foreign network, the home agent (HA) forwards thedatagramtotheforeignagent.
- Theforeignagent(FA)deliversthedatagramtothemobilenode.
- DatagramsfromtheMNtotheInternethostaresentusingnormalIProutingprocedures. If the mobile node is on a foreign network, the packets are delivered to theforeign agent.The FAforwardsthedatagramtotheInternethost.

In the case of wireless communications, the above illustrations depict the use of wirelesstransceivers to transmit the datagrams to the mobile node. Also, all datagrams between theInternet host and the MN use the mobile node's home address regardless of whether themobile node is on a home or foreign network. The care-of address (COA) is used only forcommunicationwithmobilityagentsandisneverseenby the Internethost.

ComponentsofMobileIP

ThemobileIP hasfollowingthreecomponentsasfollows:

1. MobileNode(MN)

Themobilenodeisanendsystemordevicesuchasacellphone,PDA(PersonalDigitalassistant),orlaptop whosesoftwareenablesnetworkroamingcapabilities.

2. HomeAgent(HA)

The home agent provides several services for the mobile node and is located in the homenetwork. The tunnel for packets towards the mobile node starts at home agent. The homeagent maintains a location registry, i.e. it is informed of the mobile node's location by thecurrentCOA(careofaddress).Followingalternativesforthe implementationofanHAexist.

- Home agent can be implemented on a **router** that is responsible for the home network.Thisisobviouslythebestposition,becausewithoutoptimizationtomobileIP,allpack etsfor theMN have togothroughthe routeranyway.
- Ifchangingtherouter'ssoftwareisnotpossible,thehomeagentcouldalsobeimplemented onan**arbitrary node**inthe subset..

3. ForeignAgent(FA)

The foreign agent can provide several services to the mobile node during its visit to the foreignnetwork.TheFAcanhavetheCOA(careoraddress)actingasatunnelendpointandforwardingp acketstotheMN.Theforeignagentcan bethedefaultrouterfor theMN.

Foreign agent can also provide security services because they belong to the foreign network asopposedtotheMN whichisonlyvisiting.

In short, FA is a router that may function as the point of attachment for the mobile node whenitroamstoaforeign networkdeliverspacketsfrom thehomeagenttothemobilenode.

4. CareofAddress(COA)

The Care- of- address defines the current location of the mobile node from an IP point of view.All IP packets sent to the MN are delivered to the COA,notdirectly to the IP address oftheMN. Packet delivery toward the mobile node is done using a tunnel. To be more precise, theCOAmarkstheendpoint of thetunnel,i.e.theaddress wherepacketsexit thetunnel.

Therearetwodifferentpossibilitiesforthelocationofthecareofaddress:

1. **Foreign Agent COA:** The COA could be located at the foreign agent, i.e. the COA is an IPaddress of the foreign agent. The foreign agent is the tunnel endpoint and forwardspacketstotheMN.ManyMNusing theFAcan sharethisCOAascommonCOA.
2. **Co-located COA:** The COA is co-located if the MN temporarily acquired an additional IPaddress which acts as a COA. This address is now topologically correct, and the tunnelendpoint is at the mobile node. Co-located address can be acquired using services suchas DHCP. One problem associated with this approach is need for additional addresses ifMNs request a COA. This is not always a good idea considering the scarcity of IPv4addresses.

5. CorrespondentNode(CN)

At least one partner is needed for communication. The correspondent node represents thispartnerfortheMN.Thecorrespondentnodecanbeafixedormobilenode.

6. HomeNetwork

The home network is the subset the MN belongs to with respect to its IP address. No mobile IPsupportisneededwithinthisnetwork.

7. Foreignnetwork

The foreignnetworkisthecurrentsubsettheMNvisitsandwhichisnotthehome network.

ProcessofMobileIP

ThemobileIPprocesshasfollowingthreemainphases,whichare:

1. AgentDiscovery

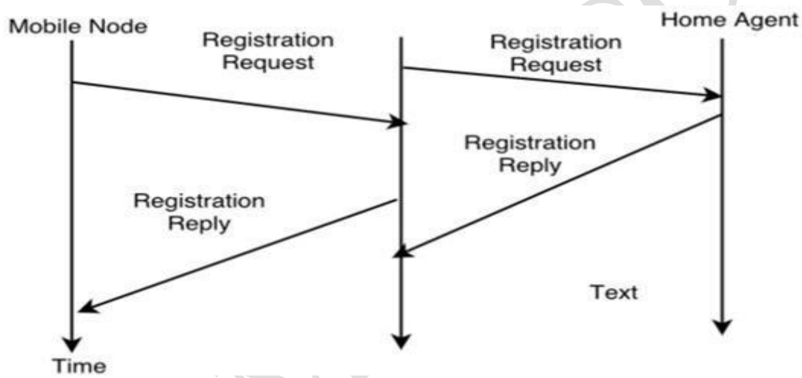
During the agent discovery phase the HA and FA advertise their services on the network byusingthe ICMP routerdiscoveryprotocol(IROP).

Mobile IP defines two methods: agent advertisement and agent solicitation which are in factrouterdiscoverymethodsplusextensions.

- **Agentadvertisement:** Forthefirstmethod,FAandHAadvertisetheirpresenceperiodicallyusingspecialagentadvertisementmessages.Thesemessagesadvertisementcanbeseenasabeaconbroadcastintothesubnet.Forthisadvertisement internet control message protocol (ICMP) messages according to RFC1256,are usedwithsomemobilityextensions.
- **Agent solicitation:** If no agent advertisements are present or the inter arrival time is toohigh, and an MN has not received a COA, the mobile node must send agent solicitations.Thesesolicitationsare again basesonRFC1256for routersolicitations.

2. Registration

The main purpose of the registration is to inform the home agent of the current location forcorrectforwardingofpackets.



Registrationcanbedoneintwowaysdependingonthelocationof theCOA.

- **If the COA is at the FA**, the MN sends its registration request containing the COA to theFAwhichisforwardingtherequesttotheHA.TheHAnowsetupa **mobilitybinding**containingthemobilenode'shomeIPaddressand thecurrentCOA.

Additionally, the mobility biding contains the lifetime of the registration which is negotiatedduring the registration process. Registration expires automatically after the lifetime and isdeleted; so a mobile node should register before expiration. After setting up the mobilitybinding,theHAsendareplymessagebacktothe FAwhichforwardsitto theMN.

- **If the COA isco-located**, registration can be very simpler. The mobile node may sendthe request directly to the HA and vice versa. This by the way is also the registrationprocedurefor MNsreturningtotheir homenetwork.

3. Tunneling

A tunnel isused to establisha virtual pipefordatapackets between atunnel entry and atunnel endpoint. Packets which are entering in a tunnel are forwarded inside the tunnel andleave the tunnel unchanged. Tunneling, i.e., sending a packet through a tunnel is achieved withthehelpofencapsulation.

Tunneling is also known as "**portforwarding**" is the transmission and data intended foruseonlywithinaprivate, usuallycorporatenetwork throughapublicnetwork.

<u>DYNAMICHOSTCONFIGURATIONPROTOCOL:</u>

DynamicHostConfigurationProtocol(DHCP)isanetworkmanagementprotocolusedtodynamicallyassignanIPaddresstonaydevice,ornode,onanetworksotheycancommunicateusingIP(InternetProtocol).DHCPautomatesandcentrallymanagestheseconfigurations. There is no need to manually assign IP addresses to new devices. Therefore,thereisno requirementforany userconfigurationtoconnecttoaDHCPbasednetwork.

DHCP can be implemented on local networks as well as large enterprise networks. DHCP is thedefault protocol used by the most routers and networking equipment. DHCP is also called RFC(Requestfor comments)2131.

DHCPDOESTHEFOLLOWING:

- DHCP manages the provision of all the nodes or devices added or dropped from thenetwork.
- DHCPmaintainstheuniqueIPaddressofthehost usingaDHCPserver.
- ItsendsarequesttotheDHCPserverwheneveraclient/node/device,whichisconfigured to work with DHCP, connects to a network. The server acknowledges byprovidinganIP addresstothe client/node/device.

DHCP is alsoused to configure the propersubnet mask, default gateway and DNS serverinformationonthe nodeordevice.

HowDHCPworks

DHCPrunsattheapplicationlayeroftheTCP/IPprotocolstacktodynamicallyassignIPaddresses to DHCP clients/nodes and to allocate TCP/IP configuration information to the DHCPclients.Informationincludessubnetmaskinformation,defaultgateway,IPaddressesanddomain namesystemaddresses.

DHCP is based on client-server protocol in which servers manage a pool of unique IP addresses,as wellasinformation aboutclient configuration parameters,andassign addressesoutofthoseaddresspools.

TheDHCPleaseprocessworksasfollows:

- Firstofall,aclient(networkdevice)mustbeconnectedtotheinternet.
- DHCPclientsrequestanIPaddress.Typically,clientbroadcastsaqueryforthisinformation.
- DHCP server responds to the client request by providing IP server address and otherconfigurationinformation.Thisconfigurationinformationalsoincludestimeperiod,call edalease, for whichthe allocationisvalid.
- When refreshing an assignment, a DHCP clients request the same parameters, but theDHCP server may assign a new IP address. This is based on the policies set by theadministrator.

ComponentsofDHCP

WhenworkingwithDHCP,itisimportanttounderstandallofthecomponents.Followingarethelistofco mponents:

- **DHCP Server:** DHCP server is a networked device running the DCHP service that holds IPaddresses and related configuration information. This is typically a server or a router butcouldbeanythingthatactsasahost,suchasanSD-WAN appliance.
- **DHCP client:** DHCP client is the endpoint that receives configuration information from aDHCP server. This can be any device like computer, laptop, IoT endpoint or anything elsethat requires connectivity to the network. Most of the devices are configured to receiveDHCPinformationbydefault.
- **IP address pool:** IP address pool is the range of addresses that are available to DHCPclients.IPaddressesaretypicallyhandedoutsequentially fromlowesttothehighest.
- **Subnet:** Subnet is the partitioned segments of the IP networks. Subnet is used to keepnetworksmanageable.
- **Lease:** LeaseisthelengthoftimeforwhichaDHCPclientholdstheIPaddressinformation.Whenalease expires,theclienthastorenew it.
- **DHCP relay:** A host or router that listens for client messages being broadcast on thatnetworkandthenforwardsthemtoaconfiguredserver.Theserverthensendsresponses back to the relay agent that passes them along to the client. DHCP relay canbeusedtocentralizeDHCPserversinstead ofhavingaserveroneachsubnet.

BenefitsofDHCP

TherearefollowingbenefitsofDHCP:

CentralizedadministrationofIPconfiguration: DHCPIPconfigurationinformationcanbestored in a single location and enables that administrator to centrally manage all IP addressconfiguration information.

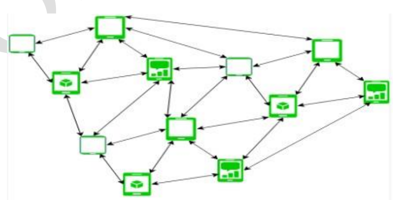
Dynamic host configuration: DHCP automates the host configuration process and eliminatestheneedtomanuallyconfigureindividualhost.WhenTCP/IP(Transmissioncontrolprotocol/Internet protocol)is first deployed orwhenIPinfrastructurechangesarerequired.

Seamless IP host configuration: The use of DHCP ensures that DHCP clients get accurate andtimely IP configuration IP configuration parameter such as IP address, subnet mask, defaultgateway,IPaddressofDNDserverand so onwithoutuserintervention.

Flexibility and scalability: Using DHCP gives the administrator increased flexibility, allowing theadministratortomove easilychange IPconfigurationwhentheinfrastructurechanges.

MOBILEADHOCNETWORK(MANET):

MANET stands for Mobile adhoc Network also called as wireless adhoc network or adhocwireless network that usually has a routable networking environment on top of a Link Layer adhoc network.. They consist of set of mobile nodes connected wirelessly in a self configured, selfhealingnetworkwithouthavingafixedinfrastructure.MANETnodesarefreetomoverandomly as the network topology changes frequently. Each node behave as a router as theyforwardtrafficto otherspecifiednodeinthenetwork.



MANET may operate as standalonefashion or they can be thepart of larger internet. Theyform highly dynamic autonomous topology with the presence of one or multiple differenttransceivers between nodes. The main challenge for the MANET is to equipped each devices tocontinuously maintain the information required to properly route traffic. MANETs consist of apeer-to-peer,self-forming,self-healingnetworkMANET'scirca2000-2015typicallycommunicate at radio frequencies (30MHz-5GHz). This canbe used in road safety, rangingfromsensorsforenvironment,home,health,disasterrescueoperations,air/land/navydefense,weapons,robots,etc.

Characteristics ofMANET–

: Networktopologywhichistypicallymultihops,maychangerandomlyandrapidlywithtime,itcan formunidirectional orbi-directionallinks.

- **Bandwidthconstrained,variablecapacitylinks:** Wirelesslinksusuallyhavelowerreliability, efficiency, stability and capacity as compared to wired network.The throughputof wireless communication is even less than a radio's maximum transmission rate afterdealingwith theconstraints likemultipleaccess, noise,interferenceconditions,etc.
- **AutonomousBehavior:** Eachnodescanactasahostandrouter,whichshowsitsautonomousbehavior.
- **EnergyConstrainedOperation:** Assomeorallthenodesrelyonbatteriesorotherexhaustible means for their energy.Mobilenodes are characterized with less memory,powerandlightweightfeatures.
- **LimitedSecurity:** Wirelessnetworkaremorepronetosecuritythreats.Acentralizedfirewall is absent due to its destributed nature of operation for security, routing and hostconfiguration.
- **Less Human Intervention:** They require minimum human intervention to configure thenetwork,thereforetheyare dynamicallyautonomousinnature.

ProsandConsofMANET–

Pros:

1. Seperationfromcentralnetworkadministration.
2. Eachnodescanplayboththerolesie.ofrouterandhostshowingautonomousnature.
3. Selfconfiguringandselfhealingnodes,doesnotrequirehumanintervention.

Cons:

1. Resourcesarelimitedduetovariousconstraintslikenoise,interferenceconditions,etc.
2. Lackofauthorizationfacilities.
3. Morepronetoattacksduetolimitedphysicalsecurity.

<u>TRADITIONALTCP:</u>

- **Congestioncontrol:**
  - ✓ A transport layer protocol such as TCP has been designed for fixed networks withfixedend-systems.
  - ✓ Data transmission takes place using network adapters, fiber optics, copper wires,special hardwareforroutersetc.
  - ✓ Congestionmayappearfromtime totime evenincarefullydesignednetworks.
  - ✓ Thepacketbuffersofarouterarefilledandtheroutercannotforwardthepackets fast enough because the sum of the input rates of packets destined foroneoutputlinkishigherthanthecapacity of the outputlink.

etocongestion.

- ✓ Retransmitting the missing packet and continuing at full sending rate would nowbeunwise,asthismightonly increasethecongestion.

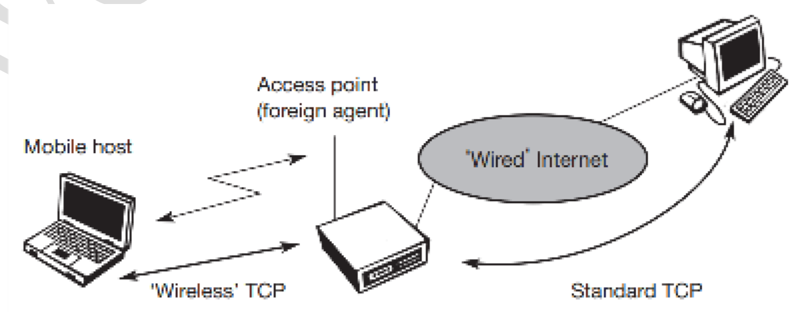
- **Slowstart:**
  - ✓ TCP's reaction to a missing acknowledgement is quite drastic, but it is necessaryto get rid of congestion quickly. The behavior TCP shows after the detection ofcongestion iscalledslow start.
  - ✓ Thesenderalwayscalculatesacongestionwindowforareceiver.
  - ✓ Thestartsizeofthecongestionwindowisonesegment(TCPpacket).
  - ✓ Thesendersendsonepacketandwaitsforacknowledgement.Ifthisacknowledgement arrives, the sender increases the congestion window by one,nowsendingtwo packets(congestion window=2).
  - ✓ After arrival of the two corresponding acknowledgements, the sender again adds2to thecongestionwindow,oneforeachofthe acknowledgements.
  - ✓ Nowthecongestionwindowequals 4.
  - ✓ This scheme doubles the congestion window every time the acknowledgementscomeback, whichtakesone roundtriptime(RTT).
  - ✓ This is called the exponential growth of the congestion window in the slow startmechanism.
- **Fastretransmit/fastrecovery:**
  - ✓ Two thingslead to areduction of the congestion threshold. Oneis a senderreceivingcontinuousacknowledgementsfor thesamepacket.
  - ✓ This informs the sender of two things. One is that the receiver got all packets uptothe acknowledgedpacketinsequence.
  - ✓ In TCP, a receiver sends acknowledgements only if it receives any packets fromthesender.
  - ✓ Receivingacknowledgementsfromareceiveralsoshowsthatthereceivercontinuouslyreceivessomethingfromthe sender.
  - ✓ The gap in the packet stream is not due to severe congestion, but a simple packetloss due to a transmission error. The sender can now retransmit the missingpacket(s)beforethetimerexpires.This behavioris calledfastretransmit.
- **Implicationsonmobility:**
  - ✓ Whileslow startisoneof the mostuseful mechanismsin fixednetworks, itdrastically decreases the efficiency of TCP if used together with mobile receiversorsenders.

- ✓ Thereasonforthisisthe use ofslowstartunderthewrongassumptions.
- ✓ Fromamissingacknowledgement,TCPconcludesacongestionsituation.
- ✓ Whilethismay alsohappeninnetworkswithmobileand wirelessend-systems,itisnotthe mainreasonfor packetloss.
- ✓ Errorratesonwirelesslinksareordersofmagnitudehighercomparedtofixedfiberor copperlinks.

CLASSICALTCPIMPROVEMENTS:

TogetherwiththeintroductionofWLANsinthemid-ninetiesseveralresearchprojectswerestartedwiththegoal toincreaseTCP's performanceinwirelessandmobileenvironments.

- **IndirectTCP:**
  - ✓ TwocompetinginsightsledtothedevelopmentofindirectTCP(I-TCP)(Bakre,1995).
  - ✓ OneisthatTCPperforms poorlytogetherwithwirelesslinks;the other isthatTCPwithinthefixednetworkcannotbechanged.
  - ✓ I-TCPsegments aTCPconnection intoafixed partandawirelesspart.
  - ✓ Figureshowsanexamplewithamobilehostconnectedviaawirelesslinkandanaccesspoint tothe'wired'internetwherethecorrespondent host resides.
  - ✓ The correspondent node could also use wireless access. The following would thenalsobeappliedtothe accesslink ofthecorrespondenthost.
  - ✓ StandardTCPisusedbetweenthefixedcomputerandtheaccesspoint. Nocomputerinthe internetrecognizesanychangestoTCP.



AdvantageswithI-TCP:

- ✓ I-TCPdoesnotrequireanychangesintheTCPprotocolasusedbythehostsinthefixednetworkorotherhosts inawireless network thatdonot usethis optimization.
- ✓ Duetothestrictpartitioningintotwoconnections,transmissionerrorsonthewirelesslink,i.e., lostpackets,cannotpropagateintothe fixednetwork.

- ✓ It is always dangerous to introduce new mechanisms into a huge network such as theinternetwithoutknowing exactlyhowtheywillbehave.
- ✓ The authors assume that the short delay between the mobile host and foreign agentcouldbedeterminedandwasindependentofothertrafficstreams.
- ✓ Partitioninginto two connectionsalso allows theuseofadifferenttransportlayerprotocol between the foreign agent and the mobile host or the use of compressedheaders etc. The foreign agent can now act as a gateway to translate between thedifferentprotocols.

Disadvantages:

- ✓ The loss of the end-to-end semantics of TCP might cause problems if the foreign agentpartitioningthe TCP connectioncrashes.
- ✓ Ifasenderreceives anacknowledgement,itassumes thatthereceivergotthepacket.
- ✓ Receivinganacknowledgementnowonlymeans(forthemobilehostandacorrespondenthost)thatthe foreignagentreceivedthepacket.
- ✓ The correspondent node does not know anything about the partitioning, so a crashingaccess node may also crash applications running on the correspondent node assumingreliableend-to-enddelivery.
- ✓ The foreign agent must be a trusted entity because the TCP connections end at thispoint.Ifusersapplyend-to-endencryption.

TCPOVER2.5/3GWIRELESSNETWORKS:

The current internet draft for TCP over 2.5G/3G wireless networks (Inamura, 2002) describes aprofile for optimizing TCP over today's and tomorrow's wireless WANs such as GSM/GPRS,UMTS, or cdma2000. The configuration optimizations recommended in this draft can be foundin most of today's TCP implementations so this draft does not require an update of millions ofTCP stacks. The focus on 2.5G/3G for transport of internet data is important as already morethan 1 billion people use mobile phones and it is obvious that the mobile phone systems willalsobe usedtotransport arbitrary internetdata.

The following characteristics have to be considered when deploying applications over 2.5G/3Gwirelesslinks:

- ➢ **Data rates**:
    - ✓ While typical data rates of today's 2.5G systems are 10–20 kbit/s uplink and 20–50 kbit/s downlink, 3Gandfuture2.5G systems will initiallyoffer dataratesaround64kbit/suplink and115–384kbit/sdownlink.

- ✓ Typically, data rates are asymmetric as it is expected that users will downloadmoredatacomparedtouploading.
- ✓ Uploadingislimitedbythelimitedbatterypower.
- ✓ Incellularnetworks,asymmetrydoesnotexceed3–6times,however,consideringbroadcastsystemsasadditionaldistributionmedia(digitalradio,satellitesystems),asymmetry mayreach afactorof1,000.
- ✓ Seriousproblemsthatmayreducethroughputdramaticallyarebandwidthoscillations due todynamicresource sharing.
- ✓ To support multiple users within a radio cell, a scheduler may have to repeatedlyallocateanddeallocateresourcesfor eachuser.
- ✓ This may leadtoaperiodicallocationandreleaseofahigh-speedchannel.

- ➢ **Latency**: All wireless systems comprise elaborated algorithms for error correction andprotection,suchasforwarderrorcorrection (FEC),checksumming,andinterleaving.
- ➢ **Jitter:** Wireless systems suffer from large delay variations or 'delay spikes'. Reasons forsudden increase in the latency are: link outages due to temporal loss of radio coverage,blocking duetohigh-priority traffic,orhandovers.
- ➢ **Packet loss:** Packets might be lost during handovers or due to corruption. Thanks to link-level retransmissions the loss rates of 2.5G/3G systems due to corruption are relativelylow(butstillordersofmagnitudehigherthan,e.g.,fiberconnections!).However,recoveryatthelinklayerappearsasjittertothehigherlayers.

Basedonthesecharacteristics,suggeststhefollowingconfigurationparameterstoadaptTCPtowirelessenvironments:

- **Largewindows:**TCPshouldsupportlargeenoughwindowsizesbasedonthebandwidthdelayproduct experiencedinwireless systems.With thehelpofthewindows scale option (RFC 1323) and larger buffer sizes this can be accomplished(typicalbuffer size settingsof 16 kbyte arenot enough). Alarger initial window(more than the typical one segment) of 2 to 4 segments may increase performanceparticularly forshort transmissions(afewsegmentsintotal).
- **Limitedtransmit:**Thismechanism,definedinRFC3042(Allman,2001)isanextension of Fast Retransmission/Fast Recovery (Caceres, 1995) and is particularlyuseful when small amounts of data are to be transmitted (standard for, e.g., webservicerequests).
- **Large MTU**: The larger the MTU (Maximum Transfer Unit) the faster TCP increasesthecongestionwindow.LinklayersfragmentPDUsfortransmissionanywayaccordingtotheirneedsandlargeMTUsmaybeusedtoincrease performance.MTU

path discovery according to RFC 1191 (IPv4) or RFC 1981 (IPv6) should be used toemploy largersegmentsizesinstead ofassumingthesmall defaultMTU.

- **SelectiveAcknowledgement(SACK):**SACK(RFC2018)allowstheselectiveretransmission of packets and is almost always beneficial compared to the standardcumulativescheme.
- **Explicit Congestion Notification (ECN):** ECN as defined in RFC 3168 (Ramakrishna,2001) allows a receiver to inform a sender of congestion in the network by settingtheECN-EchoflagonreceivinganIP packetthathasexperiencedcongestion.
- **Timestamp:** TCP connections with large windows may benefit from more frequentRTT samples provided with timestamps by adapting quicker to changing networkconditions.
- **No header compression:** As the TCP header compression mechanism according toRFC 1144 does not perform well in the presence of packet losses this mechanismshouldnotbe used.

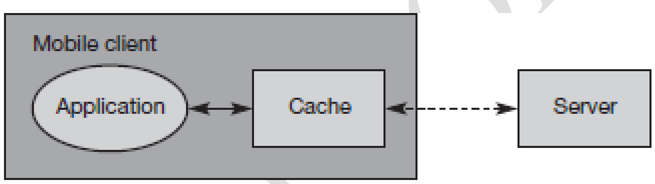
UNIT-4

Filesystems:

The general goal of a file system is to support efficient, transparent, and consistent access tofiles, no matter where the client requesting files or the server(s) offering files are located.**Efficiency** is of special importance for wireless systems as the bandwidth is low so the protocoloverhead and updating operations etc. should be kept at a minimum. **Transparency** addressesthe problemsof location-dependent views on a file system. To support mobility, the filesystemshouldprovideidenticalviewsondirectories,filenames,accessrightsetc.,independentoft he currentlocation.

Consistency:

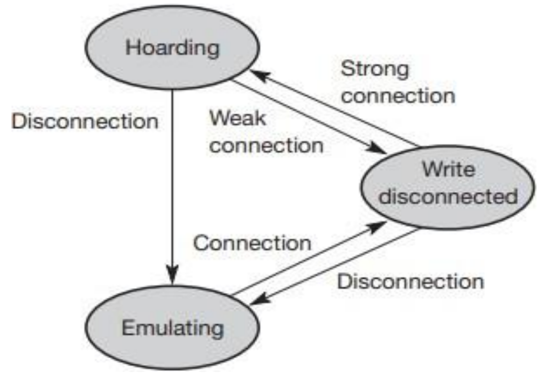
The basic problem for distributed file systems that allow replication of data for performancereasons is the consistency of replicated objects (files, parts of files, parts of a data structureetc.). What happens, for example, if two portable devices hold copies of the same object, thenonedevicechanges thevalueoftheobject and after that,bothdevicesreadthevalue?Without further mechanisms, one portable device reads an old value. To avoid inconsistenciesmany traditional systems apply mechanisms to maintain a permanent consistent view for allusersofafilesystem.This**strongconsistency**isachievedbyatomicupdatessimilartodatabasesyste



ms.

Coda:

Coda is the successor of AFS and offers two different typesof replication: server replicationand caching on clients. Disconnected clients work only on the cache, i.e., applications use onlycached replicated files. Figure shows the cache between an application and the server. Coda isa transparent extensionof the client’s cachemanager. Thisverygeneral architectureis validformostoftoday’smobilesystemsthatutilizeacache.



Little Work: The distributed file system Little Work is, like Coda, an extension of AFS (Huston,1993), (Honeyman, 1995). Little Work only requires changes to the cache manager of the clientanddetectswriteconflictsduringreintegration.LittleWorkhasnospecifictoolsforreintegrationandoffersnotransactionservice.

● **Connected:** The operation of the client is normal, i.e., no special mechanisms from LittleWork are required. This mode needs a continuous high bandwidth as available in typical officeenvironmentsusing,e.g., aWLAN.

● **Partiallyconnected**: If aclienthasonlyalowerbandwidth connection,butstillhasthepossibilitytocommunicatecontinuously, itisreferredtoaspartially connected.

● **Fetchonly**:Iftheonlynetworkavailableoffersconnectionsondemand,theclientgoesintothefetch onlystate.

● **Disconnected**:Withoutanynetwork,theclientisdisconnected.LittleWorknowabortsifacachemis-occurs,otherwisereplicatesareused.

Ficus:

Ficus is a distributed file system, which is not based on a client/server approach (Popek, 1990),(Heidemann, 1992). Ficus allows the optimistic use of replicates, detects write conflicts, andsolvesconflictsondirectories.Ficususesso-calledgossipprotocols,anideamanyother systemstookoverlater.Amobilecomputerdoesnotnecessarilyneedtohaveadirectconnectiontoaserver.

MIo-NFS:

The system mobile integration of NFS (MIo–NFS) is an extension of the Network File System(NFS, (Guedes, 1995)). In contrast to many other systems, MIo-NFS uses a pessimistic approachwith tokens controling access to files. Only the token-holder for a specific file may change thisfile, so MIo-NFS avoids write conflicts. Read/write conflicts are cannot be avoided. MIo-NFSsupportsthreedifferentmodes:

● Connected:Theserverhandlesallaccesstofilesas usual.

● Looselyconnected:Clientsuselocalreplicates,exchangetokensoverthenetwork,andupdatefiles viathenetwork.

● Disconnected:Theclientusesonlylocalreplicates.Writingisonlyallowediftheclientistoken-holder

Rover:

Compared to Coda, the Rover platform uses another approach to support mobility (Joseph,1997a and 1997b). Instead of adapting existing applications for mobile devices, Rover providesa platform for developing new, mobility aware applications. Two new components have beenintroduced in Rover. Relocatable dynamic objects are objects that can be dynamically loadedintoaclientcomputerfromaserver(orvice-versa)toreduceclient-servercommunication.

WWW:

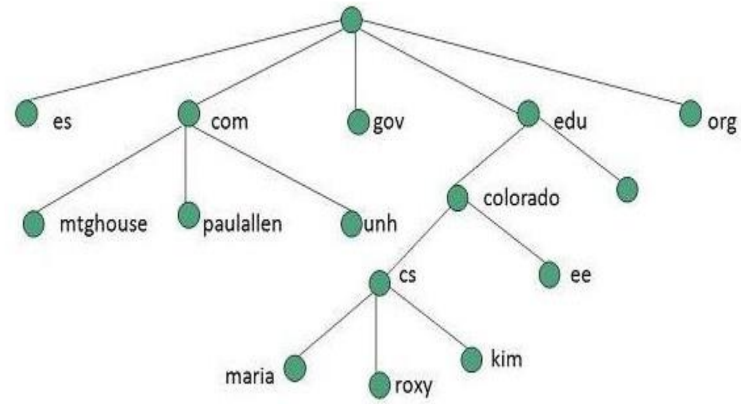
WWWstandsfor**WorldWideWeb.**AtechnicaldefinitionoftheWorldWideWebis:alltheresourcesand usersontheInternetthatareusingtheHypertextTransferProtocol(HTTP).

AbroaderdefinitioncomesfromtheorganizationthatWebinventor**TimBerners-Lee**helpedfound,the **WorldWideWebConsortium (W3C).**

TheWorldWideWebistheuniverseofnetwork-accessibleinformation,anembodimentofhumanknowledge.

Insimpleterms,TheWorldWideWebisawayofexchanginginformationbetweencomputersontheInternet, tyingthemtogetherintoavastcollection ofinteractivemultimediaresources.

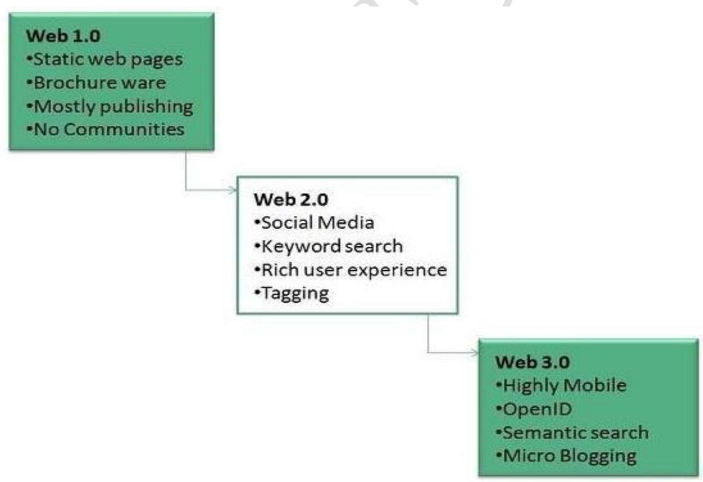
Internetand**Web**is notthesamething:Webusesinternettopassovertheinformation.



Evolution:

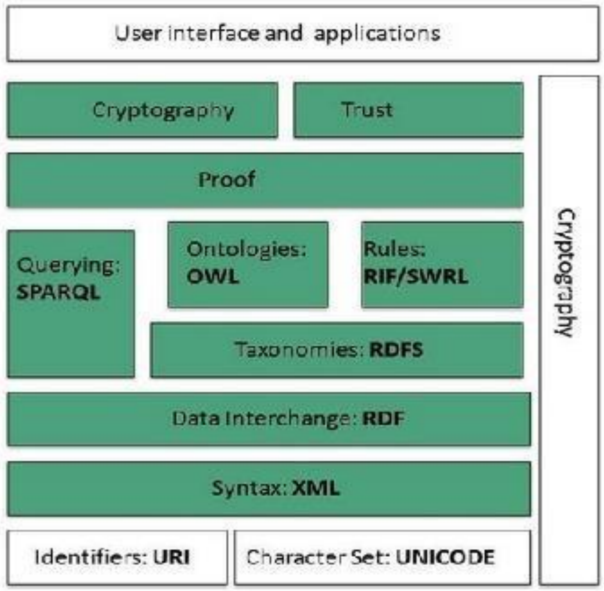
World Wide Web was created by **Timothy Berners Lee** in 1989 at **CERN** in **Geneva.** World WideWebcameintoexistenceasaproposalbyhim,toallowresearcherstoworktogethereffectivelyandefficientlyat **CERN.**Eventuallyitbecame**WorldWideWeb.**

ThefollowingdiagrambrieflydefinesevolutionofWorldWideWeb:



WWWArchitecture:

WWWarchitectureisdividedintoseverallayersasshowninthefollowingdiagram:



IdentifiersandCharacterSet

UniformResourceIdentifier(URI)isusedtouniquelyidentifyresourcesonthe weband **UNICODE**makesit possibletobuilt webpagesthatcanbe readandwriteinhumanlanguages.

Syntax

XML(ExtensibleMarkupLanguage) helpstodefinecommonsyntaxinsemanticweb.

DataInterchange

ResourceDescriptionFramework(RDF)frameworkhelpsindefiningcorerepresentationofdatafor web.RDFrepresentsdataaboutresource in graphform.

Taxonomies

RDFSchema (RDFS) allows more standardized description of **taxonomies** and other **ontological**constructs.

Ontologies

WebOntologyLanguage(OWL)offersmoreconstructsoverRDFS.Itcomesinfollowingthreeversions:

- OWLLitefortaxonomiesandsimpleconstraints.
- OWLDLforfulldescriptionlogicsupport.
- OWLfor moresyntacticfreedomofRDF

Rules

RIF and **SWRL** offers rules beyond the constructs that are available from **RDFs** and **OWL.**

SimpleProtocol and **RDF Query Language (SPARQL)** is SQL like language used for querying RDF dataandOWLOntologies.

Proof

AllsemanticandrulesthatareexecutedatlayersbelowProofandtheirresultwillbeusedtoprovedeductions.

Cryptography

Cryptographymeanssuchasdigitalsignatureforverificationoftheoriginofsourcesisused.

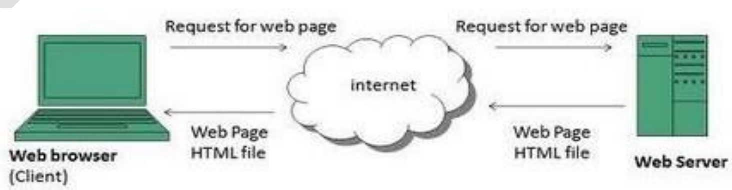
UserInterfaceandApplications

Onthetopoflayer**UserinterfaceandApplications**layerisbuiltforuserinteraction.

WWWOperation

WWWworksonclient- serverapproach.Followingstepsexplainshowthewebworks:

1. UserenterstheURL(say,**http://www.tutorialspoint.com**)ofthewebpageintheaddressbarofwebbrowser.
2. Then browser requests the Domain Name Server for the IP address corresponding towww.tutorialspoint.com.
3. After receiving IP address, browser sends the request for web page to the web serverusingHTTPprotocolwhichspecifiesthewaythebrowserandwebservercommunicates.
4. Then web server receives request using HTTP protocol and checks its search for therequested web page. If found it returns it back to the web browser and close the HTTPconnection.
5. Now the web browser receives the web page, It interprets it and display the contents ofwebpageinwebbrowser'swindow.



Future

There had been a rapid development in field of web. It has its impact in almost every area suchas education, research, technology, commerce, marketing etc. So the future of web is almostunpredictable.

Apart from huge development in field of WWW, there are also some technical issues that W3consortiumhastocope upwith.

UserInterface

Workonhigherqualitypresentationof3-Dinformationisunderdeveopment.TheW3Consortium is alsolooking forward to enhancetheweb tofull fill requirements of globalcommunitieswhichwould includeall regional languagesand writing systems.

Technology

Workonprivacyandsecurityisunderway.Thiswouldincludehidinginformation,accounting,accessco ntrol,integrity andrisk management.

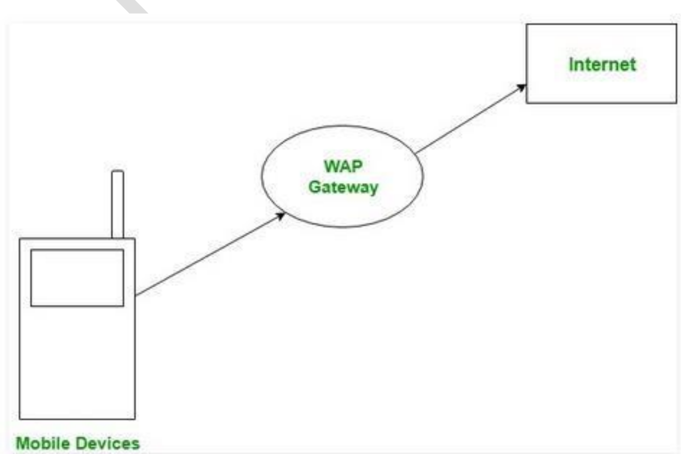
Architecture

Therehasbeenhugegrowthinfieldofwebwhichmayleadtooverloadtheinternetanddegradeits performance.Hencemorebetterprotocol arerequired tobedeveloped.

WIRELESSAPPLICATIONPROTOCOL(WAP):

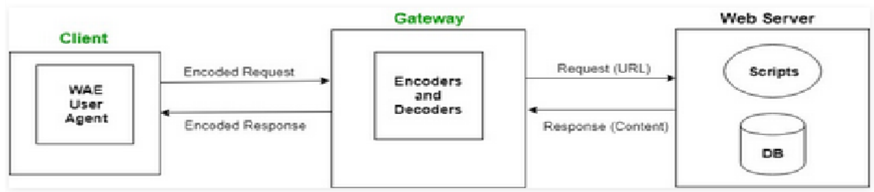
WAP stands for **Wireless Application Protocol**. It is a protocol designed for micro-browsers andit enables the access of internet in the mobile devices. It uses the mark-up language WML(Wireless Markup Language and not HTML), WML is defined as XML 1.0 application. It enablescreating web applications for mobile devices. In 1998, *WAP Forum* was founded by Ericson,Motorola,NokiaandUnwiredPlanetwhoseaimwastostandardizethevariouswirelesstechn ologiesviaprotocols.

WAP protocol was resulted by the joint efforts of the various members of WAP Forum. In 2002,WAP forum was merged with various other forums of the industry resulting in the formation of**Open MobileAlliance(OMA)**.



WAPModel:

The user opens the mini-browser in a mobile device. He selects a website that he wants toview. The mobile device sends the URL encoded request via network to a WAP gateway usingWAPprotocol.



TheWAPgatewaytranslatesthisWAPrequestintoaconventionalHTTPURLrequestandsendsit over the internet. The request reaches to a specified Web server and it processes the requestjust as it would have processed any other request and sends the response back to the mobiledevicethroughWAPgateway inWMLfilewhichcan beseen in themicro-browser.

WAPProtocolstack:

1. **Applicationlayer:**
   Thislayercontainsthe*WirelessApplicationEnvironment(WAE)*.Itcontainsmobiledevicespecificationsandcontentdevelopmentprogramminglanguageslike WML.
2. **SessionLayer:**
   Thislayercontains*WirelessSessionProtocol(WSP)*.Itprovidesfastconnectionsuspension andreconnection.
3. **TransactionLayer:**
   Thislayercontains*WirelessTransactionProtocol(WTP)*.ItrunsontopofUDP(UserDatagramProtocol)andisapartofTCP/IPandofferstransactionsupport.

4. **SecurityLayer:**
   Thislayercontains*WirelessTransactionLayerSecurity(WTLS)*.Itoffersdataintegrity,privacyan dauthentication.
5. **TransportLayer:**
   Thislayercontains*WirelessDatagramProtocol*.Itpresentsconsistentdataformattohigherlaye rsofWAPprotocolstack.

<u>WAP2.0:</u>

- ✓ The recently released then extrevision(Version2.0) of specifications for the Wireless Application Protocol(WAP).
- ✓ As an evolution of the open wireless standards for delivering applications to mobiledevicessuchascellularphonesandpersonaldigitalassistants,WAP2.0soundspromisin g.
- ✓ WAP2.0nowsupportsXHTML(ExtensibleHypertextMarkupLanguage)Basicbyprovidingthe WirelessMarkupLanguage(WML)asabasicprofile WML2.
- ✓ Theadditionof supportforXHTML(theXMLversionofthepopularHTMLtagginglanguage) is a good step in the unification of the various presentation formats for Webandwirelessdelivery.
- ✓ TheWAPForumhasalsoensuredbackwardcompatibilitywithWML1(partoftheWAP 1.2 specification). This is particularly important because part of the WAP stack --theWireless Application Environment --lives on the device, and it can take quite some timeforthe newstack tobe availableonnew handsets.

A significant aspect of the WAP 2.0 specification is its support for the popular Web protocolssuch as TCP/IP, TLS and HTTP. In the previous versions of the WAP specification, a new set ofprotocols, collectively known as WAP 1 Stack, were created to make use of low-bandwidthmobilenetworks.ThisstackincludedtheWirelessSessionProtocol,WirelessTransactionP rotocol,WirelessTransportLayerSecurityandWirelessDatagramProtocol.Withtheadventof the next-generation 2.5G and 3G high-speed wireless networks, it has become increasinglyimportant to support the same set of protocols that are available on the Web. As anothermeasure to ensure backward compatibility, manufacturers of devices and microbrowsers canchoosetoimplementadualstack tosupportbothsetsof protocols.

Anumberofkeyvendorshaveannouncedsupportforthe WAP2.0standard.However,widespreadusa gefor applications based on WAP 2.0 will surface only whendevelopmenttools,microbrowsers,gatewaysandhandsetsareavailablewithWAP2.0support. UnlikedesktopWebbrowsers,upgradingwirelessmicrobrowsersinahandsetitisn'tastraightforwar dtask.MostconsumerswillhavetowaituntilnewWAP2.0-compatiblehandsetsare available.