Performance of LTE vehicle-to-vehicle

Darshan S
darshushetty7@gmail.com
Bangalore Institute of Technology,
Bengaluru, Karnataka

Dr. K. V. Prasad
drsvt@yahoo.com
Bangalore Institute of Technology,
Bengaluru, Karnataka

ABSTRACT

Interchanges Vehicle-to-vehicle (V2V) have seen enhancing consideration over the most recent couple of years. In this work, we specify the utilization of the 3GPP Long Term Evolution (LTE) standard innovation connected to V2V. We create experimental models for the V2V channel, and the show comes about because of far reaching PC reenactments, in light of both the uplink (UL) and downlink (DL) principles for LTE. We give results to 10 MHz and 20 MHz channels, as far as BER, BLER, phantom effectiveness and throughput, utilizing numerous MIMO modes. Results demonstrate the intriguing achievability of the LTE innovation in V2V correspondence frameworks.

Keywords— *LTE, V2V, MIMO*

1. INTRODUCTION

Now a days vehicle-to-vehicle communication has found the growth in terms of study safety on the roads will be the primary concentration of this project. In addition to this, we can concentrate on the reduction of energy usages, the efficiency of the traffic can be increased. We can also have other applications like accidents, constructions happening on roads. In other countries, this kind of communication will be considered under the intelligent sector. It has the two divisions to study vehicle-to-vehicle roadside and vehicle-to-vehicle infrastructure.in this, we will have the transmitter and receiver placed on the both of the roads and they will be the mobiles. They will have the reflecting and scattering objects or elements nearby, which will create the Doppler spectra with TX and RX in motion .fading rate will be twice of the speed in cellular.

2. LITERATURE REVIEW

Study of Vehicle-to-vehicle communication has been done on the millimeter waves bands, and also it uses the ultra-high frequency band (UHF). different bands are used for the measuring of the channel. American are having their own band of 5GHz which will be used for the vehicle-to-vehicle communication soon. American has the permission to use the 75MHz of spectra for vehicle-to-vehicle communication.in this project we are using both uplink and downlink properties of LTE. We are using computer simulations to show effective results. We are also developing the empirical model for a vehicle-to-vehicle communication system. Shown results will be of MHz and 10MHz channel. This will be expressed in terms of the bit error ratio, block error ratio, efficiency of spectra, throughout

3. PROPOSED METHODOLOGIES

3.1 VANET

It is derived from the MANET. Also, it comes under the subclass of this section.in this vehicles will be used as the nodes.it also used as the route.so this will be used for transmitting and receiving the messages by using the roadside unit it can communicate with the different n/w.

Here we have different sectors of the protocol. They are a proactive protocol. Another one is reactive protocol. The proactive protocol is the one which is having the total information of the nodes. The reactive protocol is the one which will have all the information of the destination.it is also called the on-demand protocol.

We come across the other routing protocols like DYMO, fisheye, AODV. Also, we concentrate on the handoff problems. Then the streaming of the media will be discussed.

3.2 Routing of QoS

3.2.1 On-demand routing: It is one of the kinds of reactive protocol. It is used for the establishing of the routing b/w the different nodes.it is done on the information based on on-demand. The fascinating feature of this protocol is that it will have the data of

sequential number. This gives the updates of the paths. This will be having both multicast routing and unicast routing.it does not require the much space which is considered as the advantage. Also, it stops the row redundancy .some time will be required to maintain the route & multipath considered as its disadvantage.

3.2.2 Fisheye routing: Fish Eye State Routing (Paul et. al, 2012) is a proactive routing protocol where the node data are continued in a table. It interchanges only the partial routing information with its nearest which reduces routing overhead. On node failure, the information will not be sent back in the routing table.

3.2.3 ON demand routing (DYMO): It is the protocol that comes under both categories of proactive protocol & reactive protocol.it is designed on the basis AODV.
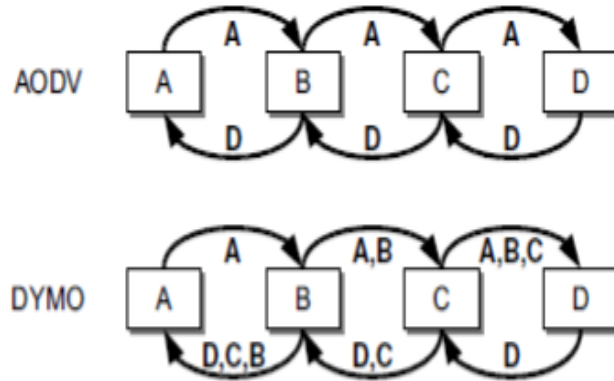

Fig. 1: Routing information

It is the protocol which has all the data of the target.it also will have the data of intermediate node.it will send the request for the node.it will keep the data of the intermediate node.

3.2.4 VANET issues: It will not provide the QOS which is depended on the medium access control.it is very complication to analyze the task done by the DSRC. If we want to establish or make decisions on the controlling, adopting. Here we develop the empirical model for analyzing he DSRC.it is depended on the inner vehicular communication .the analysis have the greater collision of the parameters. This channel is attached to the various series like contention window, arbitration interframe space. We have developed the structure which is called as AQUA.it gives the complete information about the messages that have been reached.it perform in such mechanism which suits the DSRC.

It has the five categories in VANET:
- Topology
- Position
- Cluster
- Geo cast
- Broadcast

Every protocol has its own advantages and limitations. Here the target route is saved under the background. It won't stick to any routing mechanism. It is considered as the advantages. It will be having less latency in the real-time work.it is considered as the disadvantage. The path of data which are not used are maintained better.it utilizes the bandwidth which is existing.

A few investigations have been distributed contrasting the execution of steering conventions utilizing diverse portability models or execution measurements. The principal far-reaching contemplates was done inside the system of the City Urban situation. Studies by thought about a bigger number of VANET conventions. Be that as it may, interface level points of interest and MAC obstruction are not demonstrated. Concentrate by author analyzed indistinguishable conventions from the work by Haerri since for particular situations as the creators comprehended that arbitrary versatility would not accurately show practical system practices, and thusly the execution of the conventions tried.

The enthusiasm for viable portability structures for VANET had initiated an immense number of review concentrates to be done to fathom and assess the generation of VANET on comes about verifies that these models make urban particular spatial and worldly conditions, where the genuine versatility parameters change from the beginning and controlled ones. Execution correlation has turned out to be unfair and faultless.

3.3 Middleware to media streaming in VANET
3.3.1 Requirement for middleware: Various specialized difficulties do exist to create VANET correspondence for making wellbeing and non-security administrations. As indicated by Torrent the fundamental difficulties are dense as: (i) Due to the enormous versatility of vehicles and activity situation, hub forward a message is overwhelming (ii) Higher number of hubs produces channel clog (iii) degrading problems when numerous hubs cheapen the quality and nature of getting signal. Brought up the parcel conveyance proportion, end to end deferral, jitter association term as incitement Quality of Service (QoS) estimation for correspondence. The principle donation of the creators is: (i) specific investigation of QoS parameters for Vehicular Ad hoc organize in both interstate and urban criteria. (ii) Examine the association span of VANET structure (iii) reviewing the undesirable deferral and overhead in directing and usages.

3.3.2 VANET Middleware: The different cases of VANET middleware could be condensed as takes: coordination of crude information, difficulty in reasoning, dynamic exchange of data, communication time took imperatives and different QoS. Here a portion of VANET middleware methodologies is debated.

Meier suggested a constant occasion based tool for Vehicular Ad hoc organize known RT-STEA. Here isn't depending on brought together server or query benefit for occasion taking care of. Nearness channels are actualized to deal with activities which have a place with their topographical scope. For activity control application at the intersection, a V_to_I correspondence happens where a vehicle can caution to the movement controller about the landing. Along these lines, movement lights utilized with the circumstance at intersections to give the vehicle relying upon the moving vehicles. VMTL (Weiss, Gejlen, Lukas, and Rokitansjy, 2006) is a web benefit depended on middleware to vehicles application.

For accomplishing the inner probability web administrations utilized as middleware system and SOAP convention is utilized for informing reason. To thinking reason Rule ML dialect grammar have been clarified. J2ME upheld portable hardware is utilized for creating and checking the vehicular application. Area following and visit information are finished up as contextual analysis for dissecting the execution of the middleware. The runtime cost of middleware is exceedingly lessened and is by all accounts simple to use the application.

SCUDEWAR was a good and versatile middleware for shrewd vehicles which contains three fundamental parts: virtual specialists, semantic setting administration and versatile administration. The setting information is worked with metaphysics dialects like Ontological Web Languages (OWL). Initially arrange predicate is utilized for setting prevailing upon OWL-Lite connotation.

Festagee proposed half and half engineering that joins Vehicle-to-vehicle and V_to_I correspondence for VANETS appeal. Board sector with coordinate sensors is utilized to gather the natural data, processes, translate the circumstance and trigger cautioning messages. The operator conduct regarding street conditions at the season of mischance are put away and approved clients can get to this information for criminological examination.

Distribute buy in middleware for VANET appeals is proposed by Caviglion. Here every one of the information is spoken to in XML organize and for information recovery, XQueri dialect is utilized. This middleware contains with three principal segments: situating, archive and warning administrations. The situation of the vehicle and other similar information are occasionally sent to the different vehicle to the assistance of spiteful memberships.

3.3.3 QoS media stream in VANETS: Different streams gushing methodologies for VANETs are characterized Hsieh as appeared in Fig 2.2. The creators investigated these written works and talked about their attainability of media gushing to a gathering of hubs in urban VANET. In view of the prerequisite of the proposition work, just jump by bounces.
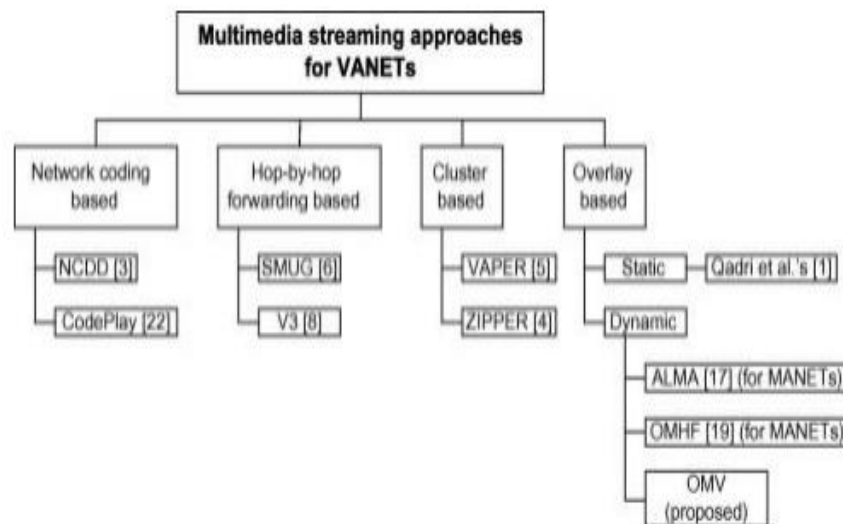

Fig. 2: Multimedia stream methods for VANETS

Here SMUG a media path is created from a specific point and the path is encouraged to SMUGS -skilled hubs and is circulated over a VANETS. In this hubs are chosen for sending and transmission and is finished by TDMA conspire.

V three gives a plan to recover the scene of a specific zone to an intrigued vehicle. furthermore, the creators portray that the appeal situation of V three is that for a specific district out and about, the scene can be caught by at least one video sources, for example. Present stations or vehicles cruising by. Since every recipient needs to set up a way, this may not be reasonable for aggregate correspondence

3.4 Handoff in VANETS
For giving nature of administration (QoS) with versatile all over detain, one of the middleware methods is approached with help for handoff systems. On investigation, this had been recognized that the present age of business off-the-rack steering conventions needs in giving sufficient QoS hold up and handoff financier in any changing, powerful situations.

3.4.1 Traffic structure: Movement structure Based Cluster Routing Protocols with Handoffs in VANETS. Here they recommended that it embraces the system movement foundation and groups the hub in coordinate with help over steering with Handoff abilities. This appeal embraces the vehicular thickness with its speed (portability). Separate amongst vehicles and time took to cross between vehicles. Despite the fact that group examination offers help in QoS yet ace dynamic help to handoffs will not exist as handoff metric investigation isn't powerful in execution.

3.4.2 SIP: There is a Session starting Protocol upheld as a standard by IETF for summoning different sessions over a correspondence situation. Taste had been executed over VANETS. For keeping up a hearty handoff over various middle hubs however this convention did not claim to give a productive QoS instrument.

Mulsoni defined on Context mindful Adaptive Routing (CAR). Which forecast depended on steering convention with help over postpone tolerant impromptu systems. The source node willing to make an impression on a goal receives Kalman Filter expectation with multiple-criteria basic leadership hypothesis to choose next bounce for message sending. One hub with high versatility is viewed as a decent transporter of information since it takes after various hubs amid its transmission. Thus the current colocation design demonstrates that the hub will meet the beneficiary repeatedly amid next transmit.

3.4.3 ABSRP: The suggested methods of administrations talked about in. the Service Discovery Appeal for Vehicular Ad hoc arranges by Mohanda. Considering the strategies for exchanging system assets. For example, transmission capacity, course limit administration alongside benefit profile inclinations, in this way permitting to tailor the system administrations. Asset mindfulness administrations are layered under an arrangement of correspondence benefits in a middleware engineering empowering interchanges among hubs having a place with particular Ad hoc organizes.

3.5 Conclusion

The research thinks about in this proposal gives examinations identified with QoS in VANEST which can label on the accompanying: directing, middleware, media gushing, and handoff. The diverse QoS parameters to help high versatility and correspondence requirements over VANET were talked about as far as steering convention, middlewares, handoffs, and media gushing. Particularly, in directing AODVs, FSRs and DYMO conventions had being dissected and distinguished the need to an upgrade over these conventions for dependable correspondence. The investigation of various VANETS middleware investigates the issues in powerful sharing of information and postpone limitations.

Henceforth, it has watched that apply QoS measurements over VANETS middlewares significantly enhance the quality in vehicular hub correspondence. As the principal goal of the proposition work concentrated on VANETS correspondence over urban situations, bounce by jump sending approaches have been concentrated to address the defer limitations in media gushing administrations. For labeling the handoffs QoS issues in VANET. All over defer measurements is considered with various conventions in particular TIBCRPH, SIP & ABSRP.

3.6 Description

Research on vehicle-to-vehicle correspondences has developed relentlessly as of late. There has been various paper, workshop, gathering sessions, and meetings concentrated on this vital zone. The very critical applications are for street security, however, there are likewise various different appeals that mean to diminish vitality utilize, increment movement effectiveness, and influence the traveler to encounter much pleasing ("solace" or "infotainment") applications. Illustration applications incorporate communicate of activity admonitions for street hindrances, mishaps, work zones, climatings, and so on. Communicate applications would utilize neighborhood handsets at both sides of the road and would be termed as v_to_r or v_to_i correspondence.

Vehicle-to-vehicle organizing is additionally conceivable, wherein various V2V joins (bounces) would be utilized to transfer data. In America, little working on vehicle-to-vehicle advancements goes under the zone of Intelligent Transportation Systems. Portable specially appointed systems administration is additionally a region of concentrate inside Vehicle-to-vehicle correspondences; comparably, military associations are likewise intrigued by vehicular impromptu systems. The writing on Vehicle-to-vehicle interchanges is thriving. Situations for Vehicle-to-vehicle correspondence are for the most part cleared streets, and these can be in urban, rural, and country zones. The V2V condition is altogether not the same as the conventional cell environment. In particular, in the vehicle-to-vehicle model, transmitter and beneficiary might be versatile, and both may have various dissipating/reflecting items adjacent, which is additionally portable.

The diffusing geometry will generally be nonlinear isotropic. This might be quickly time-fluctuating. It will create time fluctuating Doppler spectra: with every Transmitter and receiver in movement. The rate of blurring can be double as quick as in cell. The low-rise reception apparatus statures for both transmitter and Receiver is an essential driver of the deterrent of observable pathway ways. With impediments around both transmitter and Receiver, supposed "various dissipating" can emerge, and this produces more serious blurring than in cell channels. Along these lines in contrast with cell channels, Vehicle-to-vehicle channels can acquire more extreme blurring, and they will be measurably stationary for smaller spans. The significance of exact channel design is notable.

Great channel designs are needed for the investigation, PC recreations, and equipment checking, which are all key essentials to framework plan and organization. Up to there had been various endeavors to survey and model vehicle-to-vehicle channels. Utilizing both examination and estimations. To our investigation here. We utilize observational channel design from (7) and (8). Recent work on vehicle-to-vehicle interchanges has worked for millimeter wave groups. Also, UH recurrence bands. Some channel estimations have likewise been making in different groups. The 2.1-2.4 GHz band and the 900 MHz band. However the American and Europeans range administrative offices have saved range in the 5 GHz band, this band is in all probability for vehicle-to-vehicle utilize fast.

America has dispensed 75 MHz of range in the 5.85-5.925 GHz. Till now coming vehicle-to-vehicle frameworks are probably going to be sent in the 5 GHz band. That band is our concentration here. Likewise, albeit a few transmission plans had been examined for vehicle-to-vehicle utilize, the altered IEEE 802.11a standard meant 802.11p or WAVE is destined to see the introductory application. This standard was initially (once in a while still) named the Dedicated lesser targeted Communications standard. Our investigation of LTE ought to be helpful for future vehicle-to-vehicle applications. From Section 2, we portray the design to the LTE framework as connected to the vehicle-to-vehicle setting and furthermore depict the particular channel designs they utilize. The area includes a depiction to recreations, alongside reproduction, brings about terms of bit blunder proportion (BER) & square mistake proportion (BLER), ghostly effectiveness, and throughput. In Sector 4 we give summarization.

3.7 Systems and channel models

To our examination, we use channel data transfer capacities of 10 MHz and 20 MHz and taking an expressway domain. They investigate execution utilizing both the UL and DL LTE groups, with different MIMO alternatives.

3.7.1 LTE summary: LTE involves the Evolution of UMTS Terrestrial Radio Access, which is an innovation intended to join high-information rate, low-idleness and packetize radio access. Keeping in mind the end goal to meet these prerequisites, essential plans were needed to physical level layer. New balance and coding plans are utilized and the Transmission Time Interval (TTI) was decreased. Truth be told, huge numbers of the highlights considered by the 3GPP in LTE were initially considered for "fourth era" cell frameworks.

Here media get to plot for LTE is OFDM Access to dl and Single for UL with two conceivable methods of transmission. FDD and TDD. The inspiration driving the decision of SC-FDMA to the UL is its less P_to_A Power Ratio that lessens the finest necessity for portable terminal intensifiers and, in this way, the versatile end rate.

Furthermore, progressed MIMO spatial multiplexing systems. Contains plans for DL and UL, and in addition, multi-client MIMO are likewise upheld. The asset distribution in the recurrence space happens with a determination of 180 kHz asset squares both in UL and DL. The uplink client particular allotment is constant to empower single bearer transmission while the dl can utilize asset squares openly from various parts of the range. Here LTE arrangement empowers range adaptability where the transmission transfer speed can be chosen between 1.4 MHz and 20 MHz relying upon the accessible range. The 20 MHz transfer speed can give up to 150 Mbps downlink client information rate with 2×2 MIMO, and 300 Mbps with 4 * 4 MIMO.

The UL top information rate is 75 Mbps. LTE, DSR, and WMAX all utilize OFDMAs and current prescribed procedures in different zones of their plans. Including forwarding blunder adjustment, MIMO handling, and versatile MAC activity. The purpose behind examining utilization of LTE is its legacy in the cell radio network. It is being effectively helping consistently expanding information rates in exceedingly versatile situations till 10 years. Conversely. The DRC standard has advanced from the remote LAN people group, which has not already bolstered portable information. Obviously, the two models will probably enhance after some time.

3.7.2 Vehicle-to-vehicle channel models: The Vehicle-to-vehicle direct replica is of the conventional tapped-postpone line shape. It was a discrete design to the paths to drives the reaction. Adequacy blurring is displayed utilizing the adaptable Weibull dispersion. The every channel tap relates to a blurring many paths part. Tap stages are consistently drawn at the recreation begin and are then low pass sifted utilizing a similar channel compose with respect to plentifulness blurring (second request Butterworth).

Here Weibull appropriation needed two factors: the shape parameter β. it will be closely resembling a Ricean K-factor, and the scale factor α, identified with MPC mean-square esteem (vitality). What's more, likewise fuse factual non-statistical by the righteousness of the MPC diligence process, an "on-off" changing procedure used to display the "birth-demise" of MPC. Fig'' indicates fragments of illustration estimated diligence forms in a little city. For the steadiness forms, [11] and [12] utilize first request discrete Markov chains (DMC) where the state of chain ({0,1}) is the yield, with 0 comparing to MPC truant, and 1 relating to MPC exhibit.

Every tapling had a DMC related to this, and the DMC is portrayed by the relentless state probabilities (P(state=0)=P0. and P(state=1)=P1=1-P0), and a state progress network. The 2*2 change lattice has components Pij, i,j∈{0,1}, speaking to the likelihood of a progress from the state I to state j, with P01=1-P00, and P10=1-P11. State advances happen on square limits characterized by the channel rationality times. Table 1 will provide channel factors to a 10 MHz urban.

Table 1: 10 MHZ Urban Channel

TAP INDEX K	ENERGY	WEIBULL SHAPE FACTOR (β_K)	$P_{00,K}$	$P_{11,K}$	$P_{1,K}$
1	0.88	3.19	NA	1.0000	1.0000
2	0.08	1.61	0.2717	0.9150	0.8956
3	0.03	1.63	0.4401	0.8171	0.7538
4	0.01	1.73	0.5571	0.7488	0.6382

We make MIMO channel basis on these SISO model through particular of the relationships among the different MPC for numerous CIR. In this way, we can produce M=NTNR MIMO channels with self-assertive (client choosable) relationships between them; here NT transmit radio wires, NR get receiving wires. Our suspicion is that every one of the M channels has the same measurable attributes over a reenactment run.
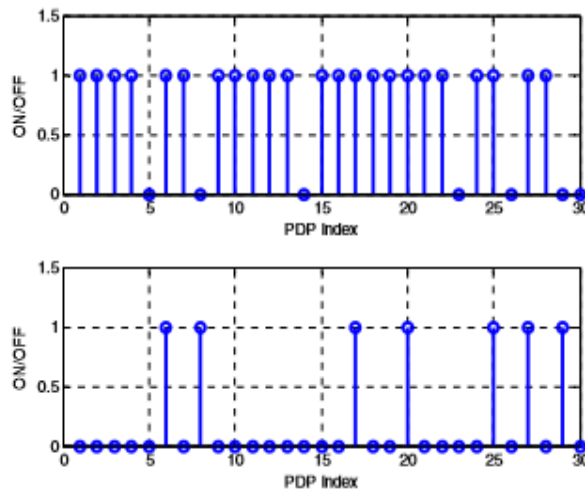
Fig. 3: the case of persistence processes for vehicle-to-vehicle channel taps 3 and 5 segments if moved in the tiny city

3.8 LTE Simulation
Here this area, we depict the LTE recreations utilized as a part of our investigation. We likewise depict in which way the vehicle-to-vehicle channel designs are consolidated.
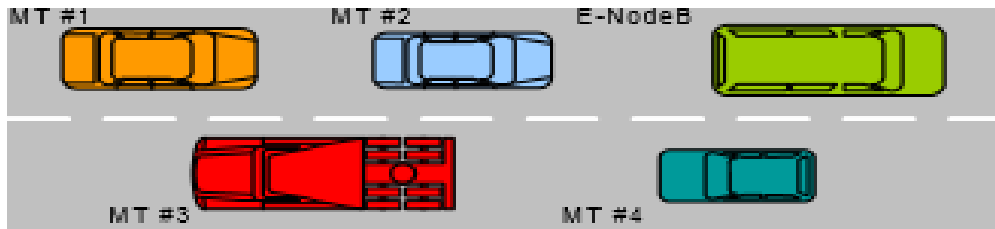

Fig. 4: Scenario analysis

3.8.1 Simulation description: To study reenactments we had utilized the WM-SIM stage, in which we had constructed both DL and UL recreations of LTE FDD remote framework it could service with 10 and 20 MHz data transfer capacities. Here dissect a thruway high thickness situation; it is made out of various vehicles filling in as Mobile Terminals which were associated with a different vehicle that is incidentally going about as E-Node B. Connection between every MT and the E-Node B is thought to be a recurrence particular radio channel. The principle recreation features are abridged in Table 2.

Table 2: Simulation parameters

Carrier Frequency (f_c)	5.2 GHz
Sampling Frequency (f_s)	30.72 MHz
Channel type	NS Weibull
Cyclic prefix length	144 samples
Bandwidth	10/20 MHz
Number of data carriers	600/1200
FFT size	1024/2048

We accept a similar connection parameter ρ for every MPC at a similar estimation of postponement, that is if hij(τ 0;t) signifies the MPC at delay τ 0, time t for the channel from Transmitter radio wire j to Receiver recieving wire I, at that point the relationship coefficient between this MPC and those of hkj(τ 0;t) and him(τ 0;t) is ρ for all k and m. In the accompanying, we consider two cases: a perfect one in which there is no relationship between's MPC among the MIMO channels (ρ =0) and a more practical one where ρ = 0.5.

3.9 Simulation results
Bit error ratio comes about for the distinctive MIMO plans have been acquired. Every outcome is for the coded tweak. Maximal Ratio Combining with one receiving a wire at the transmitter and two at the beneficiary [1*2] is the favored MIMO plot for LTE uplink. Spatial Multiplexing and Space Frequency Blocks Coding systems have additionally been assessed in a 2*2 reception apparatus design. These speak to the downlink.

With a specific end goal to acquire a reasonable examination, the phantom productivity for all MIMO plans has been set to 4 bits/s/Hz. To spacial multiplex, regulation is QPSK utilizing two layers, with transportation square size of 320 bit. Here MRC conspire utilizes 16 QAM with single layer, transportation block size of 640 bits, and the SFBC utilizes indistinguishable parameters from spacial. This was demonstrated that transfer and get decent variety systems plainly outflank the SM plan as far as BER & BLER. Furthermore, SFBC accomplishes preferred outcomes over maximum ratio combining. This was because of the diverse receiving wire design of downlinks and uplinks.

The comparative conduct can be found in Figure.4 for BLER. This could be finished up from these assumes that the between channel connection among MPC at a similar estimation of deferral scarcely influences execution regarding BERs/BLERs. To larger estimations of SNR, there will be slight execution corruption. These would probably increment as BERs or BLERs diminish.

Along these lines, for this situation, the phantom effectiveness is up to 12 bits/s/Hz larger SNR. while the another MIMO plots just accomplish a most extreme of 6 bits/s/Hz. mention it unearthly productivity for SFBC is constantly over that for MRC by plan MRC is gone for execution.

4. TOOLS USED

4.1 Introduction

This name is obtained from MATRIX LAB MATLAB is a case sensitive code0 MATLAB works with matrices, all the things MATLAB knew is a matrix .different data types exist within this. It is basically a high level language this is having many special features that make analyzing bit simpler.
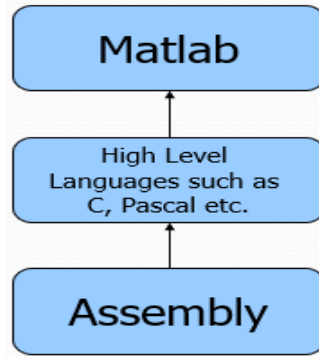

Fig. 5: Tools used

4.2 Power of MATLAB

This tool is comparatively easy to study. Its code is advanced to be relatively speedy during matrix operations. It may act as a calculator and also as programmer languages. It interferes, analyzing of errors are simpler.
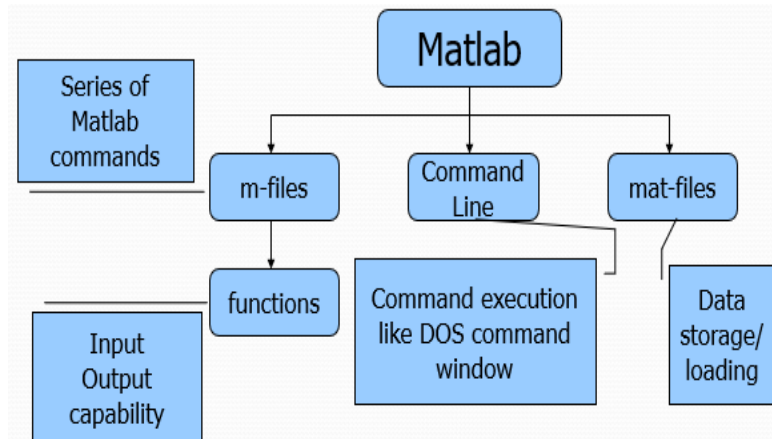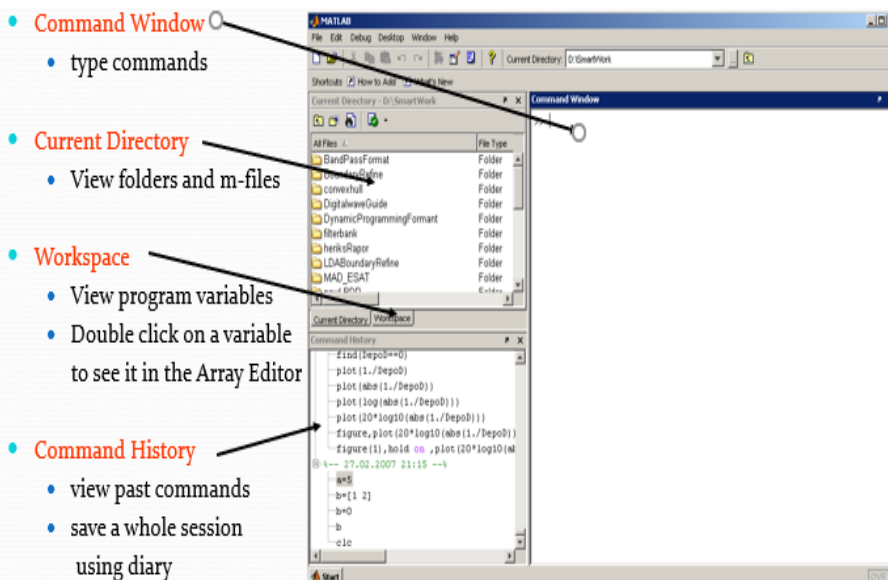

Fig. 6: Areas of MATLAB

Fig. 7: MATLAB screen

4.3 Commanding window
The charge window enables you to interface with this tool similarly as though you write things in a mini-computer Cut and glue activities facilitate the reiteration of assignments Use 'up-bolt' key to rehash orders (summon data).
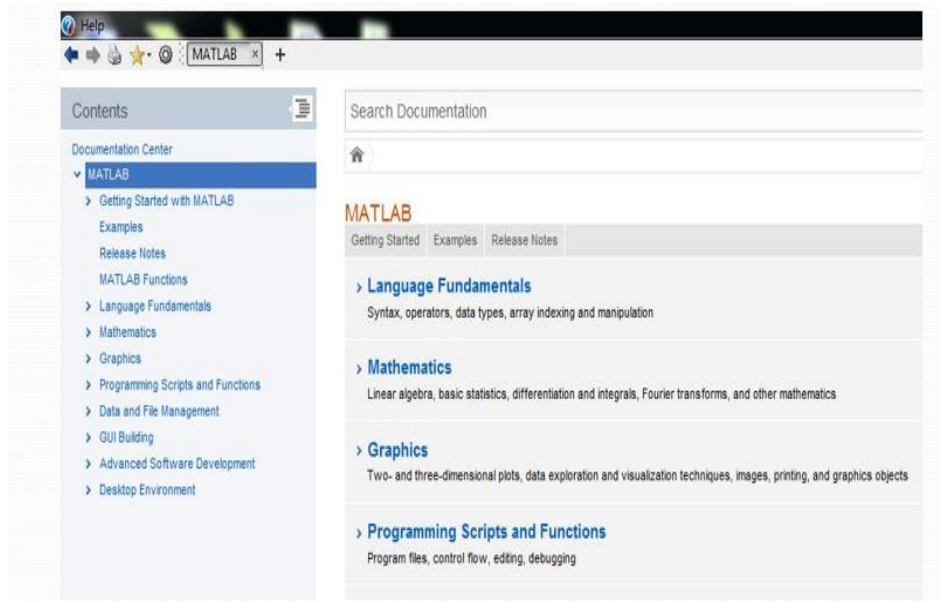

Fig. 8: Command window

4.4 Image processing
Picture handling is the learning of portrayal and adjustment of pictorial data by a PC. Create pictorial data for better clearness (human translation) Example: increment the edges of a picture to influence it to seem more honed Remove "clamor" from a picture.

4.5 Important steps in Image processing
  Step 1: Image acquisition
          Capturing visual data by an image sensor
  Step 2: Discretization/ Digitization; Quantization; Compression
          Convert data into discrete form; Compress for efficient storage/Transmission
  Step 3: Image Enhancement and restoration
          Improving image quality (Low contrast, Blur noise)
  Step 4: Image Segmentation
          Partition and image into objects or constituent parts
  Step 5: Feature Selection
          Extracting pertinent features from an image that are important for differentiating one class of objects from another.
  Step 6: Image Representation
          Assigning labels to an object based on information provided by descriptors
  Step 7: Image Interpretation
          Assigning meaning to an ensemble of recognized objects.

4.6 Reading images

Format name	Description	Recognized Extension
TIFF	Tagged Image File Format	.tif, .tiff
JPEG	Joint Photograph Experts Group	.jpg, .jpeg
GIF	Graphics Interchange Format	.gif
BMP	Windows Bitmap	.bmp
PNG	Portable Network Graphics	.png
XWD	X Window Dump	.xwd

4.7 Image types
The tool kit bolsters four sorts of pictures:

1.Intensity pictures
2. Parallel pictures
3. Recorded pictures
4. R G B pictures

4.7.1   Intensity image: A power picture just comprises of one grid, I, which qualities speak to powers inside the fixed range.

Fig. 9: Intensity image

4.7.2 Binary image: In a paired picture, every pixel accept one of just two discrete qualities: 0&1

Fig. 10: Binary image

4.7.2 Index Images: An ordered picture comprises of an information network, X, and a shading map grid, delineate.

Fig. 11: Index Image

4.7.3 RGB Images: This picture is stored in this tool as an m-by-n-by, 3 information where every m-by-n page characterizes red, green and blue coloring.

Fig. 12: RGB Image

4.8 Conversion between image types

We utilize some basic MATLAB command for conversion of image, types. The commands are:

rgb2gray	-Change over RGB picture or shading guide to grayscale
rgb2ind	-Change over RGB picture to filed picture
rgb2ntsc	-Change over RGB shading esteems to NTSC shading space
ntsc2rgb	-Change over NTSC esteems to RGB shading space
gray2ind	-Change over grayscale or paired picture to indexed
mat2gray	-Change over the framework to grayscale picture
grayslice	-Change over the grayscale picture to listed picture using multilevel thresholding
im2bw	-Change over the picture to paired picture, in light of edge
Dither	-Change over the picture, expanding obvious colour determination by dithering
double	-Change over information to double precision
ind2rgb	-Change over the indexed picture to RGB.
im2double	-Change over the picture to double precision

4.9 Conversion between data classes

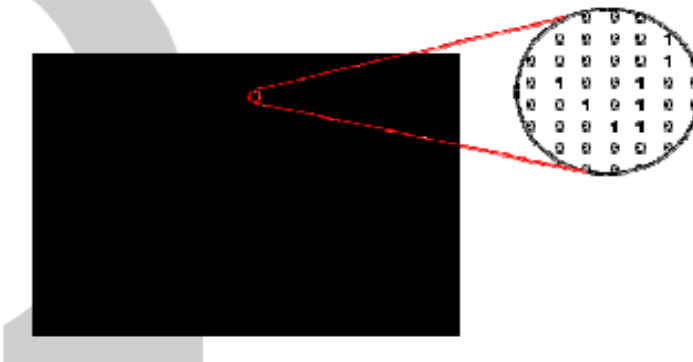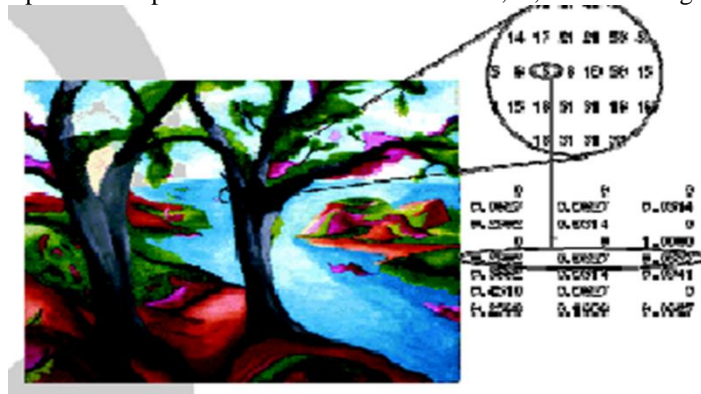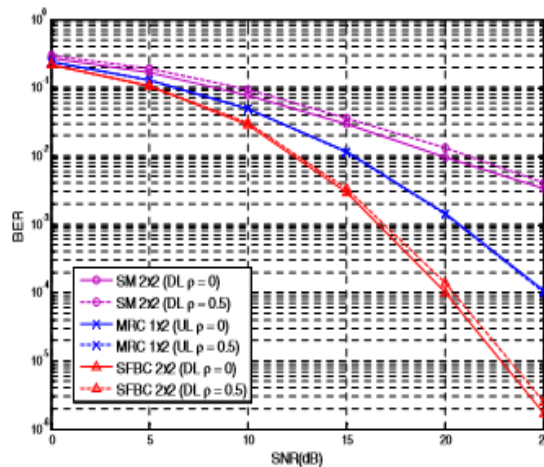|	
str2num	-Change over the string to a number
num2str	-Change over the number to a string
hex2num	-Change over hexadecimal number string to twofold exactness number
mat2str	-Change over the framework to string
int2str	-Change over the number to a string
num2hex	-Change over singles and pairs to IEEE hexadecimal strings
hex2dec	-Change over hexadecimal number string to a decimal number
dec2hex	-Change over decimal to hexadecimal number in the string
dec2bin	-Change over decimal to paired number in the string
bin2dec	-Change over twofold number string to a decimal number
str2double	-Change over the string to twofold exactness esteem
base2dec	-Change over base N number string to a decimal number
unicode2native	-Change over Unicode characters to numeric bytes

5. RESULTS

Fig. 13: BER for various MIMO setups over the Weibull Vehicle-to-vehicle blurring channel of 10 Mhz
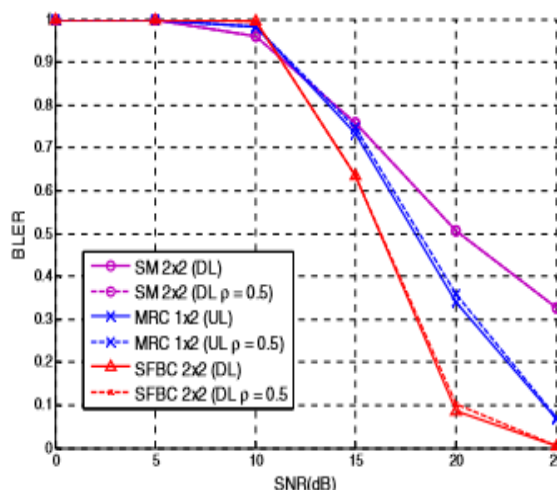

Fig. 14: BER for various MIMO configurations over the Weibull Vehicle-to-vehicle fading channel of 10 Mhz
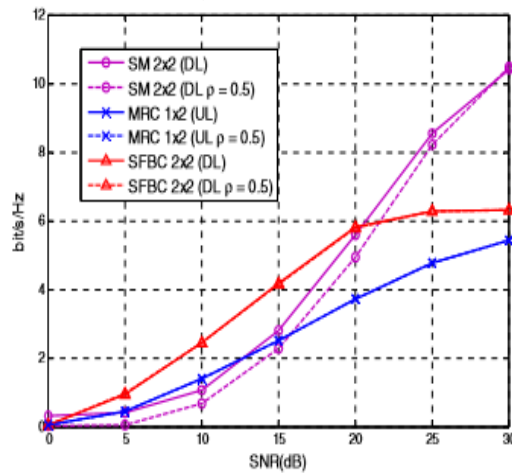
Fig. 15: Spectral efficiency to various MIMO setups over the Weibull Vehicle-to-vehicle blurring channel of 10 Mhz
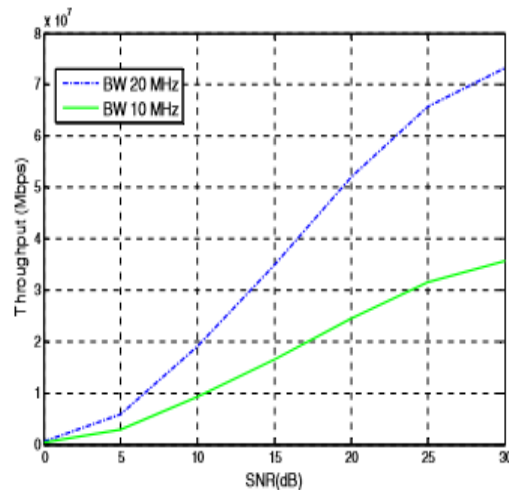

Fig. 16: Throughput comes about for UL transmission with 10 and 20 MHz transfer speeds and BERT=10-3

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APPENDIX

CODE

```
clc;
clear all;
close all;
 choice=input('Do you want to work with random data or an image? 1 for random and 2 for image : ');
channel_type=input('Select the Channel type:- 0 for AWGN type, 1 for Rayleigh--> ');
disp('NOTE: Press any key to move to the next checkpoint');

N=512; %total number of subcarriers,also size of FFT
%SNR_DB=[-20:4:40];
SNR_DB=[-10 -5 -2.5 0 2.5 5 7.5 10 12.5 15 20 25 ]; % SNR values
count=0;

%% In an LTE frame
slots_per_frame=20;
symbols_per_slot=7;
symbols_per_slot_pilot=2;
symobols_per_slot_data=5;
r=0;
data_demod=[length(SNR_DB),160000];

 %%%% Generating the random data %%%%%
 % Uncomment the below line if you want to use randomly generated data
% instead
if(choice==1)
   data=randi([0,1],1,160000);%slots_per_frame*(1000*symbols_per_slot_pilot+1200*symobols_per_slot_data)
end
if(choice==2)
   data=image_data_generator();
end

% Checkpoint_1(a)---Time and Frequency domains of data generating module
disp('Checkpoint_1(a)---Time and Frequency domains of data generating module');
pause
subplot(2,1,1);
time(data(1:200),'time response','B');
subplot(2,1,2);
frequency_response(data(1:200),'frequency response','B');
%==================================================================%
%% Pilot Generation %%
% Generating per frame
Nc=1600;
N_CP=1; %for normal CP
x1=zeros(1,1701);
x2=zeros(1,1701);
c=zeros(1,101);
temp_matrix=zeros(1,50);
pilot_matrix=[];
x1(1)=1;% Intializing the first m-sequence with x(0)=1 (3gpp pg98)
b=[];
cell_id=1;
```

```matlab
for n_s=1:40 %n_s - slot number within a radio frame
    for l=1:3:4 % l-OFDM symbol number within the slot, first and fifth slots.
        c_init=power(2,10)*(7*(n_s+1)+l+1)*(2*cell_id+1)+2*cell_id+N_CP;
        b=dec2bin2(c_init);

        for ii=length(b):-1:1
            x2(ii)=b(ii);
        end
        for jj=1:1670
            x1(jj+31)=(mod(x1(jj+3)+x1(jj),2));
        end
        for kk=1:1670
            x2(kk+31)=(mod(x2(kk+3)+x2(kk+2)+x2(kk+1)+x2(kk),2));
        end
        for ll=1:101
            c(ll)=(mod(x1(ll+Nc)+x2(ll+Nc),2));
        end

        % PILOT MODULATION USING QPSK %
        pilot_symbol=modulator_QPSK(c);
        l=numel(pilot_symbol);
    end
    pilot_matrix=[pilot_matrix, pilot_symbol];

end
%%% Checkpoint 1.b.i--- Time ,Frequency and Constellation Plot of QPSK
%%% modulated pilot samples
    if(count==0)
        disp('Checkpoint 1.b.i--- Time ,Frequency and Constellation Plot of QPSK');
        pause
    end
    figure;
    subplot(2,1,1);
    time(real(pilot_matrix(1:100)),'Time Response of 100 QPSK Modulated Pilot Samples(Real Part)','B');
    hold on;
    time(imag(pilot_matrix(1:100)),'Time Response of 100 QPSK Modulated Pilot Samples(Imaginary)','R');
    subplot(2,1,2);
    frequency_response(pilot_matrix(1:100),'Freq Response of 100 QPSK Modulated Pilot Samples','B');

    figure;
    scatter(real(pilot_matrix),imag(pilot_matrix));
    xlabel('In phase');
    ylabel('Quarature phase');
    title('Constellation plot of Pilot Symbols')
%================================================================%
data_counter=1;
pilot_counter=1;
null_matrix=[]; % used for multiplexing in the absence of pilot bits
for each_slot=1:slots_per_frame
    for each_symbol=1:symbols_per_slot
%%%%%%Modulating random data bits using 16 QAM %%%%%%
% Taking the first 1200 data bits and modulating it using QAM%
        %  In this case symbol data is present in 300 carriers
        if (rem(each_symbol-1,4)~=0)
            data_symbol=modulator_QAM(data(data_counter:data_counter+1199));
            data_counter=data_counter+1200;

% In this case symbol data is present in 250 carriers and hence
% we modulate the first 1000 bits only %
        else
            data_symbol=modulator_QAM(data(data_counter:data_counter+999));
            data_counter=data_counter+1000;
        end

%%%%%% Checkpoint 1.b.ii---- Time, Frequency and Constellation plots of 16QAM modulated data samples
        if(count==0)
```

```matlab
        disp('Checkpoint 1.b.ii---- Time, Frequency and Constellation plots of 16QAM modulated data samples');
        pause
    end
    if each_symbol==1 && each_slot==1
        figure;
        subplot(2,1,1);
        time(real(data_symbol(1:100)),'Time Response of 100 16QAM Modulated Samples','B');
        hold on;
        time(imag(data_symbol(1:100)),'Time Response of 100 16QAM Modulated Samples(I-blue Q-red)','R');
        subplot(2,1,2);
        frequency_response(data_symbol(1:100),'Freq Response of 100 16QAM Modulated Samples','B');
    end
    % Generating Constellation Plot
    if each_slot==1 && each_symbol==1
        figure;
        scatter(real(data_symbol),imag(data_symbol));
        xlabel('In phase');
        ylabel('Quadrature phase');
        title('Constellation plot');
    end
%===================================================================%
%%%%%%%%%%Multiplexing Data and Pilot %%%%%%%%%
    if(rem(each_symbol-1,4)~=0)
        multiplexed_data=multiplexing(data_symbol,null_matrix,each_symbol);
    else
        multiplexed_data=multiplexing(data_symbol,pilot_matrix(pilot_counter:pilot_counter+49),each_symbol);
        pilot_counter=pilot_counter+50;
    end
%===================================================================%
%%%%%%%%%%Subcarier mapping%%%%
    mapped_data=zeros(512,1);
    subcarrier_index=[-150:-1 1:150]; %300 usable subcarriers range taken from -150 to 150 so the DC carrier is at zero
    for zz=1:300
        mapped_data(subcarrier_index(zz)+512/2+1)=multiplexed_data(zz);
    end
%===================================================================%
%%% IFFT %%%%%%
    output_ifft=ifft_block(mapped_data);
%%%Checkpoint 1.c---Output of the IFFT
    if(count==0)
        disp('Checkpoint 1.c---Output of the IFFT');
        pause
    end
    if each_slot==1 && each_symbol==1
        figure;
        subplot(2,1,1);
        time(real(output_ifft(1:100)),' Output of the IFFT for first 100 carriers(real)','B');
        hold on;
        time(imag(output_ifft(1:100)),' Output of the IFFT for first 100 carriers(imag)','R');
        subplot(2,1,2);
        frequency_response(output_ifft(1:100),'Frequency response of IFFT','B');
    end
%===================================================================%
%%% Cyclic Prefix %%
    sequence_cp=cyclic_prefix(output_ifft);
%%%Checkpoint 1.d---Output of the ICP in time domain
    if(count==0)
        disp('Checkpoint 1.d---Output of the ICP in time domain')
        pause
    end
    if each_slot==1 && each_symbol==1
        figure;
        plot(1:10);
        zoom on
% zoom in on the plot
        sequence_cp_zp=[zeros(36,1); sequence_cp];
```

```
            time(sequence_cp_zp(1:36),'','W');
            hold on;
            time(sequence_cp_zp(37:572),' Time response of the rest of the sequence','R');
            hold on;
            time(sequence_cp(1:36),' Time response of the CP','B');
            legend('','Without Cyclic Prefix','Cyclic Prefix','Location','SouthOutside');
        end
%===========================================================================%
%%% Upsampling %%%
        upsampled_data=zeros(1,length(sequence_cp)*4);
        for i=0:1:length(sequence_cp)-1
            upsampled_data(1,4*i+1)=sequence_cp(i+1);
        end;

%%%Checkpoint 1.e---Output of the upsampler%%%
        if(count==0)
            disp('Checkpoint 1.e---Output of the upsampler')
            pause
        end
        if each_slot==1 && each_symbol==1
         figure;
         subplot(2,1,1);
         time(real(upsampled_data),'Time Response of Upsampler','Y');
         hold on;
         time(imag(upsampled_data),'Time Response of Upsampler(I-yellow Q-green)','G');
         subplot(2,1,2);
         frequency_response(upsampled_data,'Freq Response of Upsampler','B');
        end
%===========================================================================%
% TX Filter%
% Order 60 filter coeffiecents %
h=[-0.000784349139504251,-0.000176734735785689,0.000724012692320556,0.00118554682461376,0.000561224222290113,-
0.00100201539035489,-0.00222659432222206,-
0.00152383506917547,0.00128589170200708,0.00400894535406963,0.00348933001770781,-0.00115361405151310,-
0.00650114618880027,-0.00691923964988450,5.99346493618398e-
18,0.00952959027858301,0.0123552446794401,0.00303688616696274,-0.0127969830957593,-0.0206395422737169,-
0.00938114247892921,0.0159261635482031,0.0337387363038249,0.0222822647110203,-0.0185216204263869,-
0.0586008851851700,-
0.0540413312902093,0.0202371971192971,0.145587146371200,0.264043788776860,0.312554129058022,0.264043788776860,
0.145587146371200,0.0202371971192971,-0.0540413312902093,-0.0586008851851700,-
0.0185216204263869,0.0222822647110203,0.0337387363038249,0.0159261635482031,-0.00938114247892921,-
0.0206395422737169,-
0.0127969830957593,0.00303688616696274,0.0123552446794401,0.00952959027858301,5.99346493618398e-18,-
0.00691923964988450,-0.00650114618880027,-
0.00115361405151310,0.00348933001770781,0.00400894535406963,0.00128589170200708,-0.00152383506917547,-
0.00222659432222206,-0.00100201539035489,0.000561224222290113,0.00118554682461376,0.000724012692320556,-
0.000176734735785689,-0.000784349139504251];
        output_filter=conv(upsampled_data,h,'same');

%Checkpoint 1.f--Frequency domain input to TX Filter, the frequency
%response of the Tx. Filter and the output of the filter
        if(count==0)
            disp('Checkpoint 1.f--Frequency domain input to TX Filter, the frequency response of the Tx. Filter and the output of
the filter');
            pause
        end
        if each_slot==1 && each_symbol==1
            figure;
            subplot(2,2,1);
            frequency_response(upsampled_data(1:2192),'Freq domain input to Tx filter','B');
            subplot(2,2,2);
            frequency_response(h,'Freq response of the TX Filter','B');
            subplot(2,2,3);
            frequency_response(output_filter(1:2192),'output of filter','B');
        end
```

```
%Checkpoint 1.g--Display analog signal
        if(count==0)
            disp('Checkpoint 1.f--Frequency domain input to TX Filter, the frequency response of the Tx. Filter and the output of
the filter');
            pause
        end
        if each_slot==1 && each_symbol==1
            figure;
            fs=7.68*10^6;
            t=[0:5.94*10^-11:1/fs];
            t=t(1:2192);
            plot(t,abs(output_filter(1:2192)));
            title('Analog output of filter');
            xlabel('time');
            ylabel('amplitude');
        end
        legend('Oversampling rate: 7.68/1.15');
%=========================================================================%
%%%%%% AWGN Channel and Rayleigh %%%%%

        for ss=1:length(SNR_DB)

          if(channel_type==0);

              output_channel=awgnChannel(output_filter,SNR_DB(ss));
%Checkpoint 2.a Received I and Q Response
              if(count==0)
                  disp('Checkpoint 2.a Received I and Q Response');
                  pause
              end
              if SNR_DB(ss) == 5 && each_symbol==1 && each_slot==1

                  figure;
                  subplot(2,1,1);
                  time(real(output_filter(200:400)),'I and Q phase response (I-Blue, Q-Red) for 200 samples','B');
                  hold on;
                  time(imag(output_filter(200:400)),'I and Q phase response (I-Blue, Q-Red) for 200 samples','R');

                  subplot(2,1,2);

                  time(real(output_channel(200:400)),'I(Red) and Q(Blue) channel response ','B');
                  hold on;
                  time(imag(output_channel(200:400)),'I(Red) and Q(Blue) channel response ','R');
              end

          else(channel_type==1)

            [output_channel,HH]=rayleigh(output_filter,SNR_DB(ss));
              if(count==0)
                  disp('Checkpoint 2.a Received I and Q Response');
                  pause
              end
              if SNR_DB(ss) == 5 && each_symbol==1 && each_slot==1
                  figure;
                  subplot(2,1,1);
                  time(real(output_filter(200:400)),'I and Q phase response (I-Blue, Q-Red) for 200 samples','B');
                  hold on;
                  time(imag(output_filter(200:400)),'I and Q phase response (I-Blue, Q-Red) for 200 samples','R');

                  subplot(2,1,2);

                  time(real(output_channel(200:400)),'I(Red) and Q(Blue) channel response ','B');
                  hold on;
                  time(imag(output_channel(200:400)),'I(Red) and Q(Blue) channel response ','R');
              end
          end
```

```
%==============================================================================%
%%%% Receiver %%%%
% RX FILTER %
% filter-coefficents
h=[-0.000784349139504251,-0.000176734735785689,0.000724012692320556,0.00118554682461376,0.000561224222290113,-
0.00100201539035489,-0.00222659432222206,-
0.00152383506917547,0.00128589170200708,0.00400894535406963,0.00348933001770781,-0.00115361405151310,-
0.00650114618880027,-0.00691923964988450,5.99346493618398e-
18,0.00952959027858301,0.0123552446794401,0.00303688616696274,-0.0127969830957593,-0.0206395422737169,-
0.00938114247892921,0.0159261635482031,0.0337387363038249,0.0222822647110203,-0.0185216204263869,-
0.0586008851851700,-
0.0540413312902093,0.0202371971192971,0.145587146371200,0.264043788776860,0.312554129058022,0.264043788776860,
0.145587146371200,0.0202371971192971,-0.0540413312902093,-0.0586008851851700,-
0.0185216204263869,0.0222822647110203,0.0337387363038249,0.0159261635482031,-0.00938114247892921,-
0.0206395422737169,-
0.0127969830957593,0.00303688616696274,0.0123552446794401,0.00952959027858301,5.99346493618398e-18,-
0.00691923964988450,-0.00650114618880027,-
0.00115361405151310,0.00348933001770781,0.00400894535406963,0.00128589170200708,-0.00152383506917547,-
0.00222659432222206,-0.00100201539035489,0.000561224222290113,0.00118554682461376,0.000724012692320556,-
0.000176734735785689,-0.000784349139504251];
%h=[-4.16883250902603e-05,-0.000562112610859686,-0.000668172258129623,-
0.000200366236118458,0.000575738390893345,0.00104558986233150,0.000661028519118995,-0.000513664719458405,-
0.00161475528998131,-
0.00152174570424262,0.000111932099033970,0.00221646960370360,0.00287217061851728,0.000943368102579544,-
0.00252353600280363,-0.00463599353503190,-
0.00293518443132191,0.00206562617985091,0.00651963900819132,0.00602886680469975,-0.000281546938115915,-
0.00799051464772451,-0.0102018045957769,-
0.00342795512612827,0.00827163881541604,0.0152088969695628,0.00970137036555585,-0.00629737236414732,-
0.0205958112965991,-
0.0193996445836007,0.000451197196714892,0.0257609669932866,0.0344095580701570,0.0126523522504150,-
0.0300554155900923,-0.0615066056698756,-
0.0453644633626440,0.0329002136074827,0.150853332876701,0.257163963472810,0.299848866961441,0.257163963472810,
0.150853332876701,0.0329002136074827,-0.0453644633626440,-0.0615066056698756,-
0.0300554155900923,0.0126523522504150,0.0344095580701570,0.0257609669932866,0.000451197196714892,-
0.0193996445836007,-0.0205958112965991,-
0.00629737236414732,0.00970137036555585,0.0152088969695628,0.00827163881541604,-0.00342795512612827,-
0.0102018045957769,-0.00799051464772451,-
0.000281546938115915,0.00602886680469975,0.00651963900819132,0.00206562617985091,-0.00293518443132191,-
0.00463599353503190,-
0.00252353600280363,0.000943368102579544,0.00287217061851728,0.00221646960370360,0.000111932099033970,-
0.00152174570424262,-0.00161475528998131,-
0.000513664719458405,0.000661028519118995,0.00104558986233150,0.000575738390893345,-0.000200366236118458,-
0.000668172258129623,-0.000562112610859686,-4.16883250902603e-05];
            Rx_filter_output=conv(output_channel,h,'same').';
            if (channel_type==1)
% Equalisation
                G_ZF =1./ HH;
                Rx_fft=fft(Rx_filter_output);
                equ_op_fft=G_ZF'.*Rx_fft;
                equ_op=fft(equ_op_fft);

% Checkpoint --Before Rx Filter and After Rx.Filter
                if(count==0)
                    disp('Checkpoint 3a.--Before Rx Filter and After Rx.Filter')
                    pause
                end

            if  SNR_DB(ss) == 5 && each_symbol==1 && each_slot==1
                figure;
                subplot(2,1,1);
                frequency_response(output_channel,'Freq response before Rx. filter','B');
                subplot(2,1,2);
                frequency_response(Rx_filter_output,'Freq response after Rx.filter','R');
            end

            % Checkpoint 3a.--Before and After Equalisation
```

```matlab
              if  SNR_DB(ss) == 5 && each_symbol==1 && each_slot==1
                 figure;
                 subplot(2,1,1);
                 frequency_response(equ_op,'Freq response before Equalization','B');
                 subplot(2,1,2);
                 frequency_response(Rx_filter_output,'Freq response after Equalisation','R');
              end

              else
              if  SNR_DB(ss) == 5 && each_symbol==1 && each_slot==1
                 figure;
                 subplot(2,1,1);
                 frequency_response(output_channel,'Freq response before Rx. filter','B');
                 subplot(2,1,2);
                 frequency_response(Rx_filter_output,'Freq response after Rx.filter','R');
              end
              end
%=========================================================================%
% Downsampler %
              if(channel_type==0)
              downsampled_data=downsampling(Rx_filter_output);
              else
              downsampled_data=downsampling(equ_op);
              end
%=========================================================================%
% Removing cyclic prefix %
               data_ncp=cyclic_prefix_remove(downsampled_data);
%=========================================================================%
% FFT %
              output_fft=fft_block(data_ncp);
%=========================================================================%
% subcarrier demapper %
              demapper_output=subcarrier_demapping(output_fft);
%=========================================================================%
% demultiplexer %

              [data_d, pilot]=demultiplexing(demapper_output,each_symbol);
%=========================================================================%
% Demodulate only data symbols
              demod_data=demodulator_QAM(data_d);
              Rx_data(ss,r+1:r+length(demod_data))=demod_data;

% Checkpoint 3.b-Demodulated signal(200 samples) in time and frequency domain
              if(count==0)
                disp('Checkpoint 3.b-Demodulated signal(200 samples) in time and frequency domain for SNR=-10dB ');
                pause
              end
              if SNR_DB(ss) == 5 && each_symbol==1 && each_slot==1
                figure;
                subplot(2,1,1);
                time(Rx_data(200:400),'Time domain of demodulated signal','B');
                subplot(2,1,2);
                frequency_response(Rx_data(200:400),'Frequency domain of demodulated signal','R');
              end

% Checkpoint 3.c-- Comparing for SNR_dB=-10 and SNR_dB=10 and SNR_dB=0
              if(count==0)
                disp('Checkpoint 3.c-- Comparing for SNR_dB=-10 and SNR_dB=10 and SNR_dB=0');
                pause
              end

              if SNR_DB(ss) == -10  && each_symbol == 1 && each_slot == 1
                SNR_db=-10;
                figure;
                subplot(3,1,1);
```

```matlab
              time(data(200:400),'Time Response of Tx Data Bits at SNR -10 db','B');
              subplot(3,1,2);

              time(Rx_data(200:400),'Time Response of Rx Data Bits at SNR -10 db','R');
              subplot(3,1,3);
              time(data(200:400) - Rx_data(200:400),'Comparing the Tx and Rx bits at-10db','G');
          end

          if SNR_DB(ss) == 0  && each_symbol == 1 && each_slot == 1
            SNR_db=0;

              figure;
              subplot(3,1,1);

              time(data(200:400),'Time Response of Tx Data Bits at SNR 0 db','B');
              subplot(3,1,2);

              time(Rx_data(200:400),'Time Response of Rx Data Bits at SNR 0 db','R');
              subplot(3,1,3);
              time(data(200:400) - Rx_data(200:400),'Comparing the Tx and Rx bits at 0','G');
          end


          if SNR_DB(ss) == 10  && each_symbol == 1 && each_slot == 1
            SNR_db=10;

              figure;
              subplot(3,1,1);
              time(data(200:400),'Time Response of Tx Data Bits at SNR 10 db','B');

              subplot(3,1,2);
              time(Rx_data(200:400),'Time Response of Rx Data Bits at SNR 10 db','R');

              subplot(3,1,3);
              time(data(200:400) - Rx_data(200:400),'Comparing the Tx and Rx bits at 10db','G');
          end
          count=count+1;
        end
      r=r+length(demod_data);
    end
end
if(choice==2)
    image_data_receiver(Rx_data(12,:));
end

k=4;
for ss=1:length(SNR_DB)

  error(ss)=length(find(xor(data(1:8000),Rx_data(ss,1:8000))))/8000;
  theoryBer = (1/k)*3/2*erfc(sqrt(k*0.1*(10.^(SNR_DB/10))));

end

figure;
semilogy(SNR_DB,error,'B');
hold on
semilogy(SNR_DB,theoryBer,'R');
title('BER curve');
xlabel('SNR');
ylabel('BER');
axis([-10 20 10^-2.6 1]);
legend('Simulated value','theoretical value');
```