Collision Probability Estimation in 5G Networks

MUJTABA ALI SATTI

01-244202-025

A thesis submitted in fulfilment of the requirements for the award of the degree of Masters

(Electrical Engineering)

Department of Electrical Engineering

Bahria University, Islamabad

AUGUST 2022

APPROVAL FOR EXAMINATION

Scholar's Name: **Mujtaba Ali**

Registration No. **01-244202-025**

Program of study: **MS-EE (Communication and IOT'S)**

Thesis Title: **Collision Probability Estimation in 5G Networks**

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ACKNOWLEDGEMENTS

I dedicate my thesis work to my supervisor Dr. Junaid Imtiaz and co supervisor Dr. Adil Ali raja, my parents and all those people who have supported and motivated me.

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ABSTRACT

5G and Cognitive Radio (CR) are rising technologies to meet mobile data traffic of upcoming wireless networks, 5G networks have been generally mounted with the help of Cognitive base station (BTS) and Cognitive radio terminals (CRT). In 5G networks band is divided into sub band for efficient utilization, providing better services towards user. The term cognitive radio terminals (CRT) are responsible for efficient utilization of radio band with the collaboration with cognitive base station (BTS). Cognitive terminals consist of dual channel, Data channel (DCH) and Reporting channel (RCH). To meet the traffic growth all over the next phase,5G mobile networks are likely to attain higher capacity increases matched to previous networks, with significantly higher-speed data rates. This aim can be achieved with cell intelligent utilization of the band and reduction in collision and loss probability, active and sleep mode is helpful the requirement of 5G networks. CBS is responsible to configure the cognitive terminal for active and sleep mode base on their decision for improve energy efficiency and system performs. The terminals which work actively is well-known as Quality base activation (QBA).

Collision probability is a one of the key challenges in 5G networks which degrades the preforms of network, reporting time of packet length must be synchronous with transmitter and receiver time span may improve preforms, threshold and feedback-error is defined to overcome the collision loss probability with cognitive terminals. Node selection approach works on Active and sleep mode of cognitive terminals may improve system performs, which improves the collision probability loss and provides the significant improvement in throughput of system. Software such as MATLAB and (Google Colabatory name as "Google colab") demonstrate the outcome. Machine learning method such as "Support Vector Machine" (SVM) platform is used to find the threshold value for cognitive terminal for optimal result of reporting loss probability for effective system.

ABREVATION

mmWave	Millimeter waves
THz	Terahertz
ITU	International telecommunication union
IoNT	Internet of nano things
OFDM	Orthogonal frequency-division multiplexing
OFDMA	Orthogonal frequency-division multiple access
MIMO	Multiple input multiple output
UAV	Unmanned air vehicle
IoE	Internet of everything
IMT	International mobile telecommunication
BER	Bit error rate
LoS	Line of sight
NLoS	Non line of sight
MAC	Media Access Control
TCP	Transmission control protocol
EHF	Extremely high frequency
3GPP	Third generation partnership project
IEEE	Institute of Electrical and Electronics Engineers
WLAN	Wireless Local area network
WPAN	Wireless private area network

PPM	Pulse position modulation
HBF	Hybrid beamforming
LTE	Long term evolution
SNR	Signal to noise ratio
UE	User equipment
AI	Artificial Intelligence
CRS	Cognitive radio systems
CBS	Cognitive base station
CCC	Centralized cloud computing
CR	Cognitive radio
CT	Cognitive terminals
DCH	Data channel
EE	Energy Efficiency
HCC	Hybrid cloud computing
LTE	Long Term Evolution
MEC	Multi access Edge Computing
OSS	Operational support system
PCRF	Policy and charging rules function
QBA	Quality base activation
RCH	Reporting channel
SNR	Signal-to-noise ratio
URLLC	Ultra-Reliable Low Latency Communication

CHAPTER 1

1 INTRODUCTION

1.1 Thesis Background Overview

1.1.1 5G Network

In telecommunication, Fifth Generation (5G) networks is well-known as a cellular networks and radio access network (RANs). Several companies within mobile ecosystem are funding to fetch 5G to life, Qualcomm has played key role in 5G network. 5G networks band is divided into sub band for providing different services to different users [1]. SDN controller is responsible for configure to dynamically adjust resources at the mobile traffic.5G wireless devices relates to internet through antennas or aerials surrounded by cell. Main benefit of 5G networks have wide variety of bandwidth, offers higher speed, allows to enable the platform for internet of things (IOT), devices are communicating easier with 5G networks [2]. 5G networks provides some identical features which contains maximum throughput, reliability, and low latency requirements of the ever-evolving ecosystem of applications that must be supported by modern networks. Evolution of wireless technology as illustrated below in Fig. 1.1.

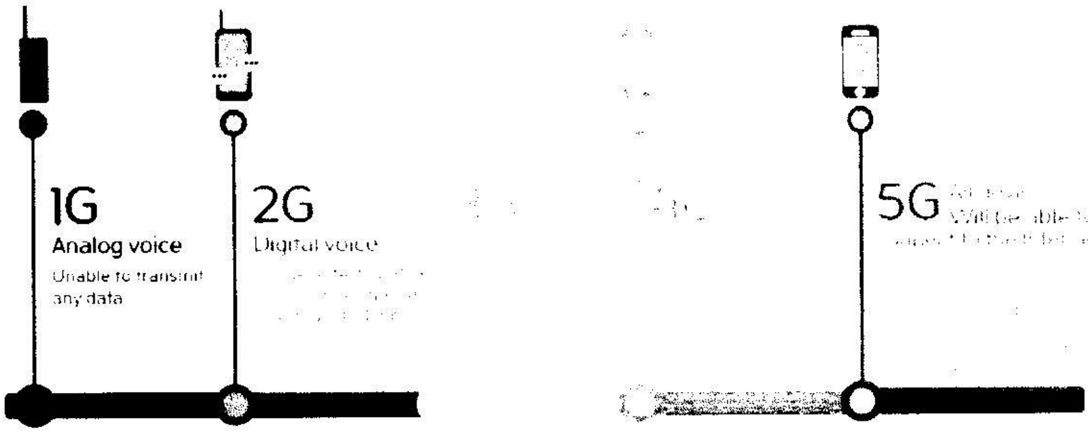

Fig 1. 1 Evolution of wireless technology among 1G to 5G [1],[2]

1.1.2 Features of 5G

Main feature of 5G consist of Enhanced Mobile Broadband services is Enabling application of 5G contains "Enhanced Mobile Broadband (eMBB), Ultra low latency Communications (URLLC)", Latency in a 5G network will be less than 1ms, Massive Machine Type Communication *(mMTC)* [3]. which includes 10 Tera bit per second (Tbps) of Extreme Capacity, multi-Giga bit per second (Gbps) consider as an extreme rate, Peak data rate 100 Mega bit per second client qualified rates, Deep awareness comprise invention and optimization techniques in network for cost effectiveness [3]. Ultra-high reliability <10^-5 per 1 millisecond is Mission critical control,1millisecond consider as an Ultra -low latency rate, 500 km/h consider as a user mobility. Massive internet of things devices includes deep coverage platform of different networks,10+years of battery life consider ultra-low energy, 10s of bits per second consider as an Ultra-low complexity, 1 million nodes per km square consider Ultra-high density. All devices will be able to link or fix with internet as illustrated in Fig. 1.2.

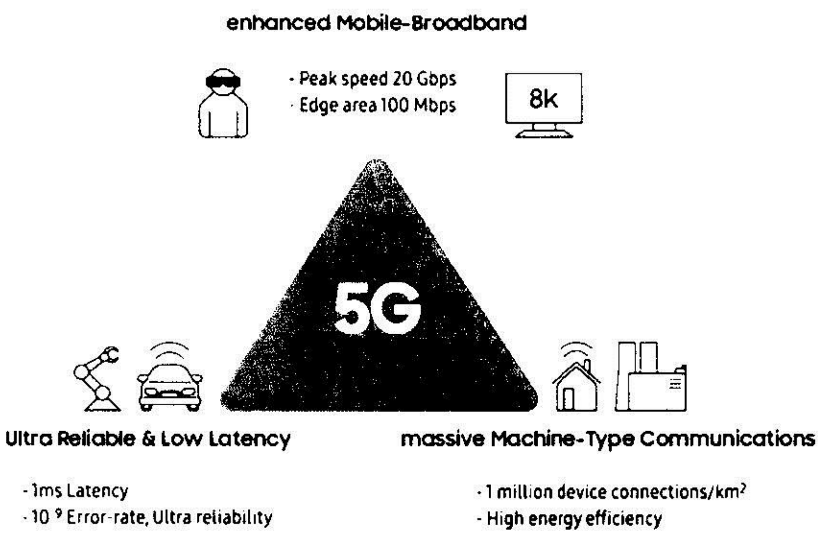

Fig 1. 2 *5G networks provide some undistinguishable features [3]*

Factor affecting preforms of 5G networks [4], includes white spaces, energy, and power losses, increase in fading, reporting loss probability etc. When transmission time is limited in real time system the information or reporting data is not full delivered by transmitter to receiver which may loss due to limited time. Synchronization of clock is key role to prevent the losses.

Many users are active, it increases the reporting loss probability, limited total number of reporting users improve the capability with (Quality base reporting) QBR, Node selection approach works on Active and sleep mode of cognitive terminals may improve system performs which may degrades in reporting loss probability [5]. Active cognitive terminals well-known as Quality base activation (QBA), Technology needs for fulfilling the industry needs as shown below table1.

Technology/Communication need	Example use case
High data rates	watching an HD video
Low data rates	sending a text message on WhatsApp
Highly reliable connection, no matter what data rates are available	Traffic lights
Very low latencies	Self-driving cars where you can't afford any delays
Very little power consumption so that the battery can last for years instead of days	IoT devices like sensors and actuators
Works with standard hardware and software to cost-effectively support billions of devices	Low-cost IoT devices, e.g., sensors

Table 1: Technology needs for fulfilling the industry needs

5G features hold on Expanded bandwidth, low latency rate, significantly expanded number of linked devices, network slicing and Easy Distribution of data, covers transport technologies' vehicle to everything communication mean smart connectivity, real time monitoring of customers and carriage. use cases with connected and autonomous vehicles', smart and efficient logistics, improve urban mobility and public transport.

1.2 Numerous technologies

5G enables coherent and flexible structure for numerous technologies with passage of time. Provide a range of quality connection with Internet of things. 5G operates a more intelligent structural design as compared to previous all generations, with RAN such as "Radio access networks" [6] no longer required through Base station providing or challenging platform. 5G starts the mode providing more adaptable and virtualization visual RAN with new boundaries producing.

1.2.1 Multi Access Edge Computing

MEC such as "Multi Access Edge Computing" is more significant and play more important part in 5G networks. Cloud computing provides applications from central data hubs by network edge, which makes more fast access provides 5G users, accordingly nearer to the end clients between devices for rapid access [8]. fundamentally technique a cut the time span among the user and clients, the extended network. Features parameter MEC consist of the low latency, high amount of bandwidth variety and RAN discriminate 5G architecture from its competitors, as illustrated below in Fig. 1.3. 5G benefits the approaching for edge computing [9],accepting MEC and 5G to collaboratively route traffic, collected to the latency and bandwidth advantages of the MEC structure, Division of computing power will facilitate the high variety of connected devices essential to 5G implementation connectivity with Internet of things which is future of all enabling technology.

1.2.2 Network Function Virtualization

NFV enables 5G structure by virtualizing, which involves network slicing feature technology which enables several virtualization visual networks operate at the same spell [7]. NFV able to deliver additional 5G assessments through virtual computing process, storage space, and network properties that are personalized based on the applications and clients' base sections, as illustrated in Fig. 1.3.

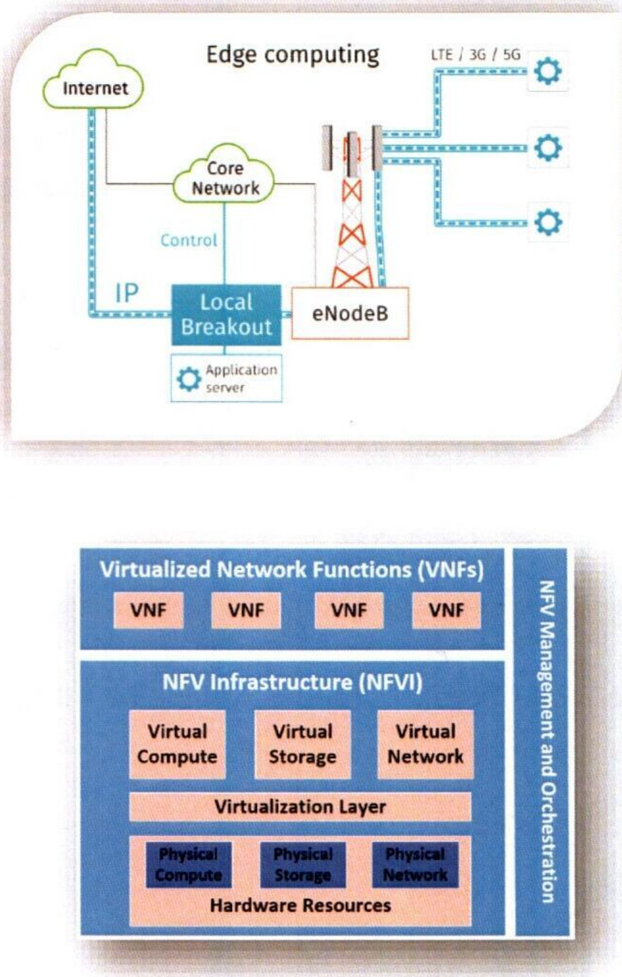

Fig 1. 3 Edge computing and Network function virtualization [7],[8],[9]

1.3 5G System Architecture

SK Telecom 5G contain three levels which includes innovative Service, Enabling Platform, and hyper connected Infrastructure as illustrated in Fig. 1. 4.

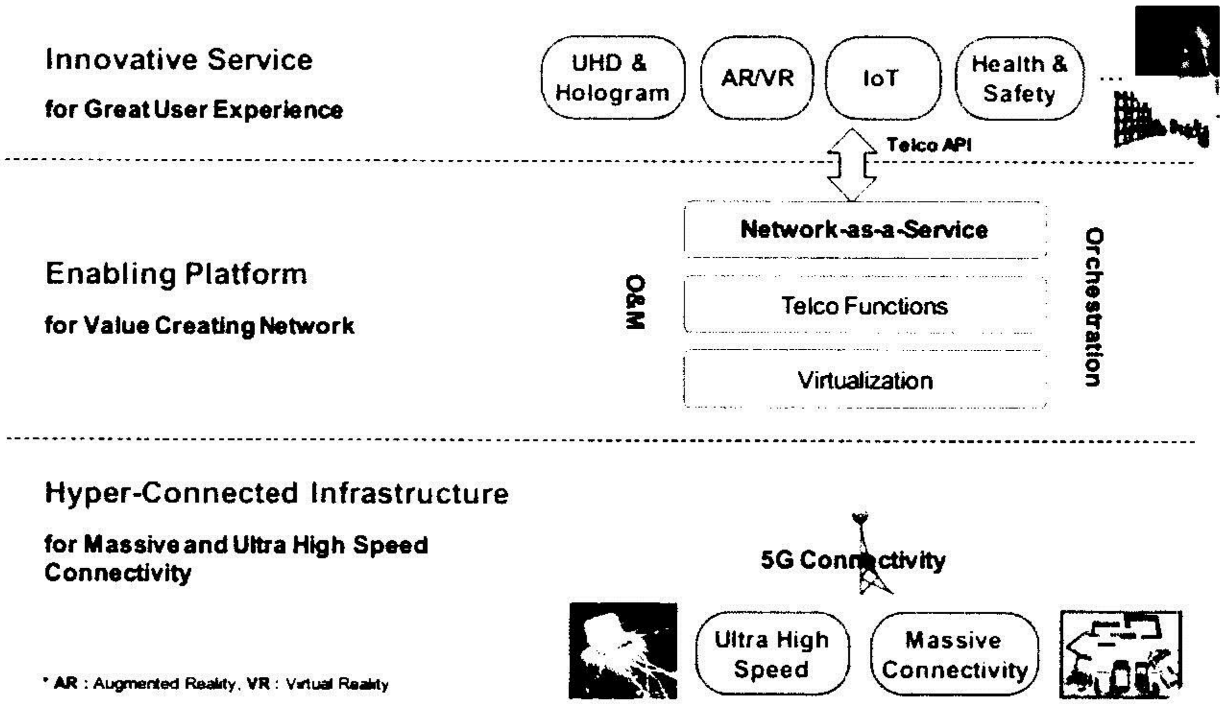

Fig 1. 4 5G Network Architecture by SK TELECOM [10]

1.3.1 Hyper Connected Infrastructure

Comprises the backhaul base edge clouding computing, which deals with virtualized Random-Access Network, BBU pool and edge cache for fast and reliable access for user. Edge cloud allows to access multi-RAT contains the Wi-Fi AP base network. It provides the coverage of big data through Centralized cloud base controlling which covers the wide variety of virtualized CN, EPC, DPI, IMS, MPTCP proxy CDN controlled easily elastic cell and ultra-dense small cell, which is dual connectivity base cell, fulfill the concept of massive MIMO For beamforming which is foundation requirement of 5G networks [10]. Ultra-wideband contain cmWave and mmWave depends on their application which covers IOT's base Platform covers ultra-high speed and massive connectivity of devices.

1.3.2 Innovation service

Involves "Ultra high definition" UHD and Hologram application base services for user, AR add real work setting, VR as a completely virtualized base network, Covers IOT application, 5th generation vehicle technology for safety parameters fulfil now a days, Health services is very help full for patients,3rd party services application covers.

1.3.3 Enabling platform

Includes Network as a service Which is cloud base service, Telco functions, Abstraction and Middleware, covers wide variety of SDN Controller [11], PCRF, SON, OSS, etc. Network as a services authorization of users to activate their individual links without providing their individual networking fundamental infrastructure, corresponding all other cloud services, Naas user operate their network by using software without superior hardware platform, basically many corporations allow to set their individual networks completely without any kind of hardware. Benefit of more resources, accessible across the cloud services as cloud computing more efficient towards end users, as illustrated in Fig. 1. 5.

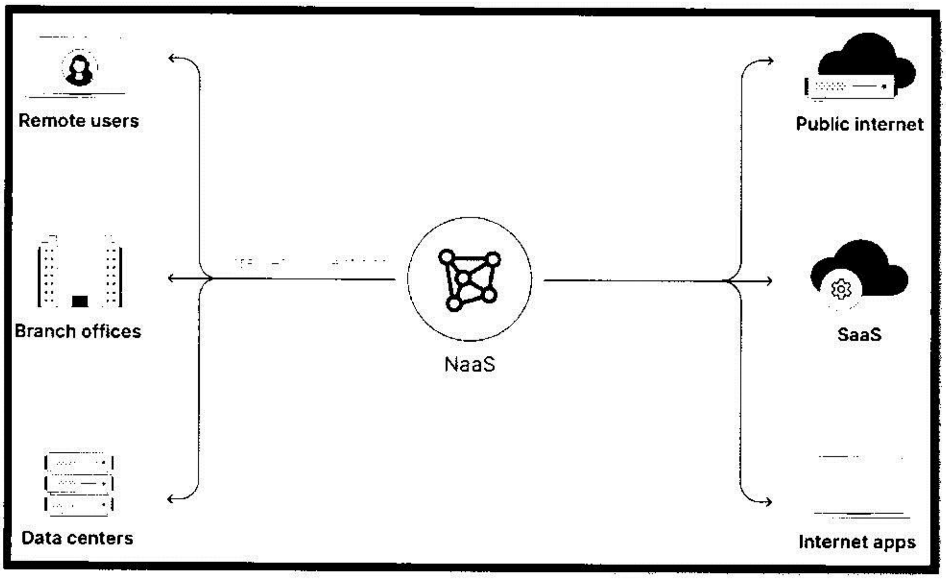

***Fig 1. 5** Network as a service [12]*

1.4 Spectrum Availability

Spectrum Availability International Telecommunication union (ITU) has publicized the list of specific frequency band between 24 - 86 GHz that are highly suitable for communication applications after consideration of different factors like mandatory services, channel propagation characteristics and contiguous bandwidth availability at World Radiocommunication Conference of 2015 [13].

Name	Specific Bands	Remarks
26 GHz band	26.5 - 27.5 GHz, 24.25 - 26.5 GHz	Incumbent services: fixed link services, satellite Earth station services, and short-range de vices. Earth exploration satellites and space research expeditions, inter-satellites, backhaul, TV broadcast distribution, fixed satellite Earth-to-space services and high-altitude platform station (HAPS) applications.
28 GHz band	27.5 - 29.5 GHz, 26.5 - 27.5 GHz	Proposed mobile communication. Incumbent services: Local multi-point distribution ser vice (LMDS), Earth-to-space fixed-satellite service and Earth stations in motion (ESIM) application
32 GHz band	31.0 - 31.3 GHz, 31.8 - 33.4 GHz	Highlighted as a promising band. Incumbent services: HAPS applications, Inter-satellite service (ISS) allocation.
40 GHz lower band	37.0 - 39.5 GHz, 39.5 - 40.5 GHz	Incumbent services: Fixed and mobile satellite (space-to-Earth) and Earth exploration and space research satellite (space-to-Earth and Earth-to-space) services, HAPS applications.
40 GHz upper band	40.5 - 43.5 GHz	Incumbent services: Fixed and mobile satellite (space-to-Earth), broadcasting satellite services, mobile services, and radio astronomy.
50 GHz	45.5 - 50.2 GHz, 47.2 - 47.5 GHz, 47.9 - 48.2 GHz, 50.4 - 52.6 GHz	Incumbent services: Fixed non-geostationary satellite and international mobile telecommunication (IMT) services, HAPS applications.
60 GHz lower band	57.0 – 64.0 GHz	Unlicensed operation for personal indoor services, device to device communication via access and backhaul links in the ultra-dense network scenario.
60 GHz upper band	64.0 - 71.0 GHz	Upcoming generations of mobile standards with unlicensed status in UK and USA. Incumbent services: The aeronautical and land mobile services.
70/80/90 GHz band	71.0 - 76.0 GHz, 81.0 - 86.0 GHz, 92.0 - 95.0 GHz	Fixed and broadcasting satellite services (space-to-Earth) services. Unlicensed operation for wireless device to device and backhaul communication services in the ultra-dense network scenario in the USA.
252 - 296 GHz band	252 - 275 GHz, 275 - 296 GHz	Early proposal for land mobile and fixed service. Suitable for outdoor usage.
306 - 450 GHz band	306 - 313 GHz, 318 - 333 GHz, 356 - 450 GHz	Early proposal for land mobile and fixed service. Suitable for short range indoor communication.

Table 2:*Band accessibility at diverse Wavelength [14],[15],[16]*

Spectrum Management creates a variety of opportunities for spectrum management as a large portion is still unacquainted. Different unconventional schemes, novel spectrum reusing, high capacity backhaul and multi-connectivity etc., must be deployed for network enhancement besides the conventional way of large bandwidth allocation to the Table 2. Bands Availability at mm Waves [14], [15] and THz Spectrum [16] radio access. Along with the challenges in the mm Wave and THz spectrum, Variation of atmospheric absorption in the frequency band of 10GHz-1000THz.

However, the focus areas of WRC 2015 were on allocation of mm-Waves band dedicated to 5G systems and 17.25 GHz spectrum has been identified [14]. Similarly, 160 GHz spectrum is also being identified in WRC 2015 in the terahertz band 252 – 450 GHz for the deployment of future THz communication systems. The brief discussions on mm Wave and THz bands are provided as illustrated in Table 2. Variability of frequencies can be custom-made selected applications reflecting the advanced frequencies are categorized by higher bandwidth, although millimeter wave short range frequencies are preferred for compactly occupied zones, but unproductive for extended for long range, distance communication for user. Higher and lower frequency bands consider to 5th generation, respectively carrier has commenced to pare out their own separate shares of the 5th generation band.

1.5 Collision probability 5G Networks

Packet Delivery Ratio (PDR) openly depends on system performs on behalf of packet is generated by source to destination it arrives at the end under whatever type of condition involved during transmission. It can be found in term of percentage total packets created by device to the total packets sent by resource point to destination joint in the network. Packet loss probability evaluated in term of PDR. PL is packet loss probability by recommended as in equations

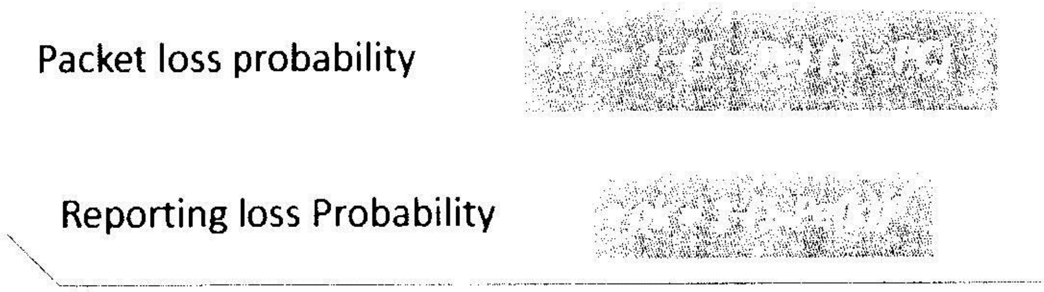

Fig 1. 6 *Equation of Packet loss probability and reporting loss Probability [17]*

Pe is Probability of channel error, Probability of collision Pc throughout broadcasting. Pe depends on numerous platforms which includes operating factors during channel operation and depends on type of digital modulation. Relationship of PL and PC is direct, individual way to diminish PL is by minimizing PC. at this time, inflate radio hardware is used to measure PL. Respective many algorithms involve but most common is use adaptive algorithms are accessible to reduce PC. Reproduction base outcomes an accuracy of 95% and overhead.

Constructed on our analytical prototypical, once the delivery of PC and PL are known, one can exactly fix the allotting of Pe. Block error rate (BLER) which increases the throughput and increase in energy efficiency and system performs. *d* is the bit length of reporting frame, *pk (rho)* is reporting loss probability, *K* is number of reporting terminals, *Pe(k)* is probability of bit error [18].

The relationship between number of cognitive terminals (K) increasing as a result the reporting loss probability (rho) increasing till the probability range from 0 to 1. When the value of bit length (d) increases as a result the reporting loss probability decreases, as illustrated in Fig. 1. 7.

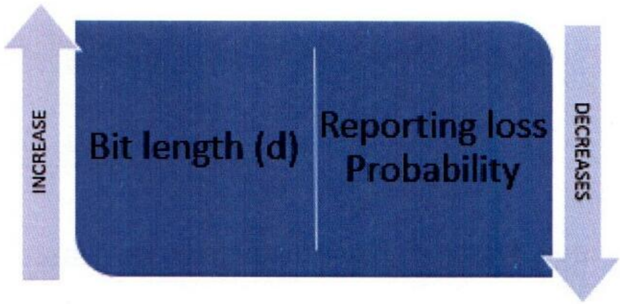

Fig 1. 7 *Relationship between Packet loss probability and reporting loss Probability [17]*

Quality Base Activation involved actively sensing of radio, which involves radio sensing and quality report of system.

$$QBA=Radio\ Sensing+\ Quality\ Reports$$

Equation 2 Quality Base Activation

Many users are active, it increases the reporting loss probability, limited total number of reporting users improve the capability with (Quality base reporting) QBR, Node selection approach works on Active and sleep mode of cognitive terminals may improve system performs which may degrades in reporting loss probability. Active cognitive terminals well-known as Quality base activation (QBA) [18]. Average energy consumption *done* by CTs during function as demonstrated in equation 3.

$$E = N*(Pc* tc) + L*(Ps* ts + Pr* tr + P p*tp) + [\varphi 1(1 - Pd (L, \lambda)) + \varphi 0(1 - P f (L, \lambda))] Pa\ td$$

Equation 3 Average energy consumption

Energy efficiency (η) convey in below equation (4).

$$\eta = C/E/T,\ bit/Hz/Joule$$

Equation 4 Energy efficiency (η)

1.6 Machine Learning Approaches

ML such as machine learning which contain broad three categories supervised learning, unsupervised learning, reinforcement learning, all categories have its own pro and cons.one of the vast challenge in machine learning model is process of feature extraction, Machine learning (ML), Generally three categories of machine learning which make more comfort and flexible environment to enhancement in technology. support vector machine (SVM) is a supervised learning will generate estimates that are more accurate results as compared to other algorithms of machine learning. By means of machine learning techniques, a reliable, affordable, and efficient system that can use for future training for their technology or their product. Which degrades the model performs, Deep learning is subdivision of machine learning where machine learning is subdivision of Artificial intelligence.

Supervised machine learning involves label data including regression and classification problems, unsupervised learning involves the no label data which deals with association and classification, reinforcement learning no predefined data require. Nonlinear SVM, data cannot be separated using straight line, by using Kernel function to fulfill the nonlinear data, its change 1D plane to 2D,3D to justify the data in visualization [20], as illustrate below in Fig. 1. 8.

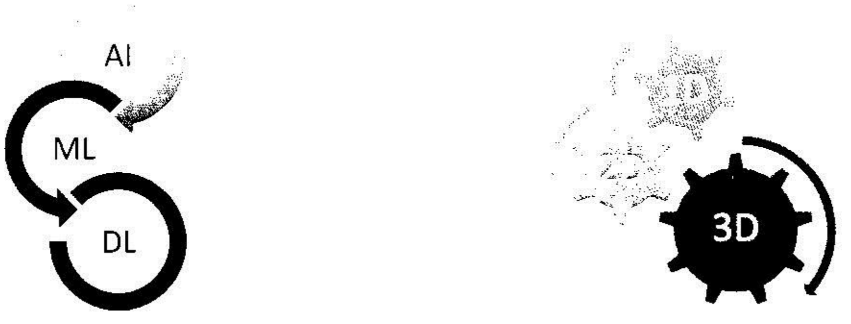

Fig 1. 8 AI, ML, DL subdivision and Kernel data vicissitude [20].

In this thesis able to link with SVM which is based on discrete and continuous base result which covers the supervised machine learning category which gives reliable and best result in term of SVM. The capacity given to machine by human to think and to take decision and learn from it.AI promises four features which covers computer vision, robotics, NLP, and autonomous vehicles.

1.7 Matlab and Google Colab

Google Colaboratory name as "Google Colab" is invention of google, given to researcher to continue do research forthrightly. it allows anyone to write and execute python code easily and it totally permitted, and easily access by google platform. its specifically design for innovative equipment and techniques', well suited to machine learning, Python code is implemented as a visualized platform provided by google and easily import their library online don't need to download in system, don't need any kind of decent hardware platform for user. Idea use of Colab for python implementation in which MATLAB data file is imported and implemented on machine learning algorithms on python visualization base execution on Colab which is helpful to reliable and accurate outcome.

1.8 Problem Description

Primary issue with 5G networks which degrades the preforms of networks is collision probability during propagation, if the number of nodes increases, probability of collision perspective is rapid rises with respect to number of nodes. Factor affecting preforms of 5G networks, includes white spaces, energy, and power losses, increase in fading, reporting loss probability etc. When transmission time is limited in real time system the information or reporting data is not full delivered by transmitter to receiver which may loss due to limited time. All the collisions in the system originate from the new UEs that eventually arrive at the system.5G provides different services for different user, Collision probability is a one of the key challenges in 5G networks which degrades the preforms of network. Reporting time and Packet length must be synchronous with transmitter and receiver time span may improve preforms.

1.9 Thesis Objectives

Recognize the factors involving collision probability in 5G Networks, Offers the solution how reduces collision probability in 5G networks, Optimum threshold between terminals and reporting loss probability, Reducing the block error rate (BLER) which increase the throughput and increase in energy efficiency and system performs. *d* is the bit length of reporting frame, *pk (rho)* is reporting loss probability, *K* is number of reporting terminals, *Pe(k)* is probability of bit error.The relationship between number of cognitive terminals (K) increasing as a result the reporting loss probability (rho) increasing till the probability range from 0 to 1. When the value of bit length (d) increases as the result the reporting loss probability decreases. When increasing the value of spreading gain (G) as result the reporting loss probability (rho) decreases. Software such as MATLAB and (Google Colabatory name as colab) determine the result. Machine learning method such as SVM named as "Support Vector Machine" prototypical is used to find threshold value of cognitive terminal for optimal result of reporting loss probability for effective system.

1.10 Organization of Thesis

The **Thesis is distributed** into four chapters.

- Starting with the first chapter as an Introduction.
- 5G Network and collision probability literature review will be covered as a Chapter 2. The key components of the system bit length, reporting loss probability, reporting terminals, probability of bit error, will also be explained and analyzed.
- Third chapter focuses the implementation of collision probability equation or algorithms, focuses on optimal results which is "MATLAB" and "Google Colabatory" base.
- The four chapter concludes the entire Thesis.

CHAPTER 2

2 LITERTURE REVIEW

2.1 VARIOUS SYSTEM

First generation such as 1G, Cellular base networks which is analog base technology introduce in 70's, the operation frequency is approximately 30khz, 2kbps is require bandwidth, Access system is FDMA and core network is used as a PSTN such as public switching telephone networks, maximum speed of 2.4 kbps. Cellular base networks which is digital base technology introduce in 80's, second generation such as 2G, the radio signal network is digital base. Main feature of 2G is secure and reliable which uses on the bases of CDMA and GSM base, they also provide data services which is initial as a low service.2G Networks also multiple users on single channel which make more user on the same time and channel,[21]. The operating frequency is 1.8Ghz and the Bandwidth is 14 to 64 kbps is considered of 2G, the access system and core network are PSTN base which is like to 1G.

Cellular base networks which is digital base and more efficient network technology introduce in 2000's which is 3G. The goal of 3G make coverage of wide range of user and application.3G uses new technology which is UMTS as a core network, features and protocol which makes more significant in data rate [22]. Technology uses in 3G is WCDMA base and the operating frequency is considered 1.6 to 2Ghz, the allow bandwidth is 2Mbps and the access system is CDMA, and the core network is Packet base Network.

The emerging technology, which is more efficient and secure than previous technology, which is 4G LTE base, the bandwidth considers 2000 Mbps to 1Gbps, operating frequency 2Ghz to 8Ghz which is CDMA base. Key features of 4G contain Turbo principle error for correcting codes, Frequency domain equalization, Link adaptation ,Adaptive modulation and Mobile IP base feature which make more efficient and fast, as shown blow table 3.

Start/Devlopment	1970/1984	1980/1999	1990/2002	2000/2010	2010/2015
Technology	AMPS, NMT, TACS	GSM	WCDMA	LTE, WiMax	MIMO, mm Waves
Frequency	30 KHz	1.8 Ghz	1.6 - 2 GHz	2 - 8 GHz	3 - 30 Ghz
Bandwidth	2 kbps	14.4 - 64 kbps	2 Mbps	2000 Mbps to 1 Gbps	1 Gbps and higher
AccessSystem	FDMA	TDMA/CDMA	CDMA	CDMA	OFDM/BDMA
Core Network	PSTN	PSTN	Packet Network	Internet	Internet

Table 3: Comparison among Generation

5G will be a combination of traditional technologies. Requirements of 5G fixed by the International Telecommunication Union Radiocommunication (ITU-R), 5G involved three different cases, *Enhanced mobile broadband (eMBB), massive machine type communication (mMTC),* and ultra-reliable low-latency communication (URLLC) [23]. multi-Giga bit per second (Gbps) consider as an extreme data rate, peak data rate 100 Mega bit per second client qualified trade, Deep awareness involve invention and optimization techniques in 5g network. Ultra-high reliability 0.00005 consider per 1 millisecond for Mission critical control,1milli second consider as an Ultra -low latency rate, 500 km/h consider as a user mobility factor. massive internet of things devices includes deep coverage platform of different networks,10 years of battery life consider ultra-low energy, 10s of bits per second consider as an Ultra-low complexity, 1 million nodes per km square consider Ultra-high density.

Energy Efficiency is key challenge in all previous technology, to understand the simpler viewpoint of upcoming 5G networks.Multiple frequency range provides the flexibly to 5G new radio [24], radio frequency range regarding 30 Giga Hz and 300 Giga Hz is recognized as the mm wave, wavelengths variety from 1 to 10 millimeter. 24 Giga Hz and 100 Giga Hz concerning Frequencies currently being distributed to 5^{th} generation networks in several counties globally. Addition part in millimeter wave, below-operated Ultra high frequency (UHF) variety between 300 Mega Hz and 3 Giga Hz are being purposed for 5^{th} generation networks.

2.1.2 RELATED WORK

A comprehensive agenda defines by some authors on collision, reporting loss probability of reporting channel (RCH) is responsible for loss probability with no of terminals, briefly describe trends and challenges on steps random access networks (RAN) on 5G system. Examined the effect of collision probabilities in an 802.11 WLAN. Proposed a new state dependent model to reduce collision probabilities by Hai L. Vu. 5G Enabled Cooperative Collision Avoidance by Mohamed Gharba, Hanwen [25]. QBA Allowing CTs triggered to report and intellect, whereas additional CTs continue as a sleep mode, which upgrades the energy efficiency (EE) and degrades the loss probability.

2.2 Cognitive Radio System

Cognitive radio system (CRS) is a Cooperative radio system, as demonstrated blow fig 2.1 in which batteries power cognitive radio terminals (CTs) commonly practice to intellect and report the PU's activity during all procedure, Empty spaces such as Spectrum hole named as white spaces which is unused band during broadcasting, sensing a while space and acknowledge the result to a centralized fusion center standard as "Cognitive Base Station" (CBS) [26].Cognitive base station takes the result of empty holes whether the spectrum is utilized or unused [27], well when cognitive terminal is not operated properly, CBS takes choice cognitive terminal could actively do their trade. Active and sleep mode is helpful to fulfill the parameters of energy efficient solution as a cooperate radio system. Energy efficiency (EE) is a thought-provoking base issue for all new upcoming technology.

To improve energy, acknowledge efficiency actively, Cognitive terminals consist of two-fold channels named as Data channel (DCH) and Reporting channel (RCH). Cognitive terminals have good ability to sense channel attributes in a data channel (DCH) as known as a reporting channel (RCH), Reporting channel are actively recognized and efficiently. Reservation the sensing is efficient, CRS could attain the complete variety of improvement, so the quantity of CTs increases [28].

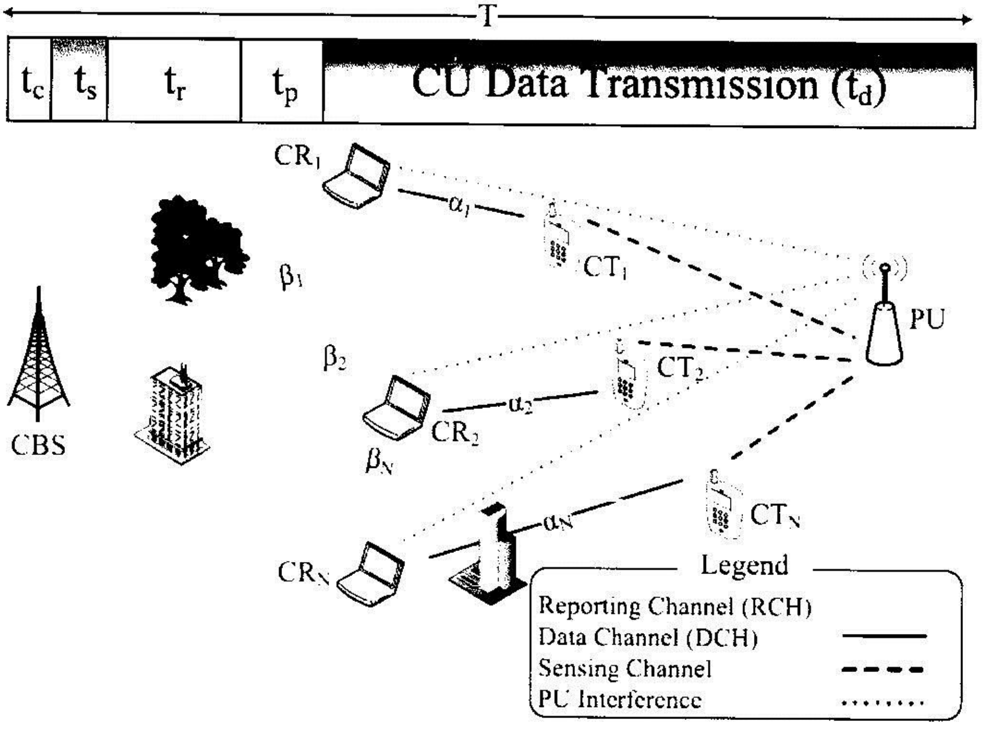

Fig 2. 1 CRS time frame (T) and system model of Cooperative Radio System.

2.3 Collision Probabilities

2.3.1 Random access

Random access process is the one of the furthermost and unique MAC-layer operations which originates with contention-based set up to conducive as an uplink transmission. Execution of a brand-new random-access technique is examined by presenting a "Adapted Backoff scheme" to diminish the collision probability [29]. Reducing the RA collision which creates the good impact on 5G network coverage, covers Massive narrow band devices requirement of the future technologies Network. Throughput of the Narrowest down Band-IoTs devices battery-operated but selecting QoS constraints such as promoting the Narrow Band-IoTs over denser traffic loads.

Probability of collision analysis to several efficient constraints, as fit with backoff countdown probability, amount of the NB-IoTs, queue range, and contention window size. System and link-level virtual reality are shown to evaluate the suggested ideas with up to thousands of narrow band-IoTs per cell. Quality of bandwidth with utilization, as shown below fig 2.2.

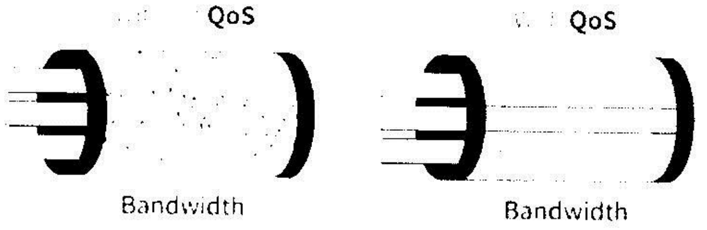

Fig 2. 2 Quality of Bandwidth Utilization.

2.3.2 Quality of Service (QoS)

Facets of Quality of services includes parameters and management functions, parament's comprise Applications and Transportation, Application work further include Frame rate, startup delay, image QoS, Transportation involves Bandwidth, Delay, Jitter, Error rate. Management function involves Tunning mechanism, Negotiation mechanism, Reservation Based Mech, Service classed based Mesh. The wide variety of traffic QoS includes Bandwidth, Delay, losses, Jitter etc. [30], as shown below fig 2.3.

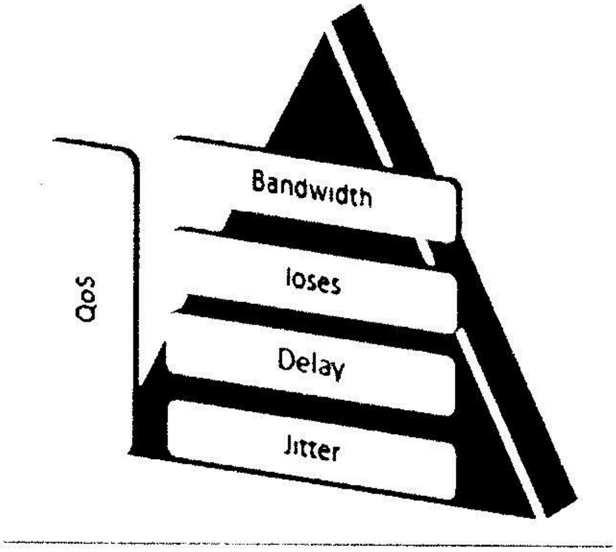

Fig 2. 3 Quality of service [30]

When the bitrates are rapidly increases as shown in fig 2.4 operational with selected constrains using No INTERF, DCF and FNAV broadcasting during interference activity, see the collision probabilities with bitrates the inverse relation, increases the bitrates lowering the collision perfective of probabilities [31].

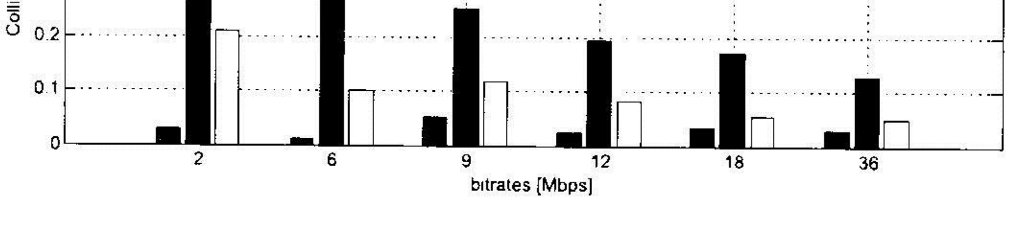

Fig 2. 4 Collision probability VS Bitrates [Mbps]

2.4 Quality Base Activation (QBA)

Quality base activation (QBA) for cooperative cognitive user (CU) consist of Cognitive terminals (CTs) and Cognitive receiver (CRs) [32], Cognitive terminals consist of two-wrinkle channels named as Data channel (DCH) and reporting channel (RCH), linked channel values CBS take decision for to threshold value, as demonstrated blow fig 2.5.

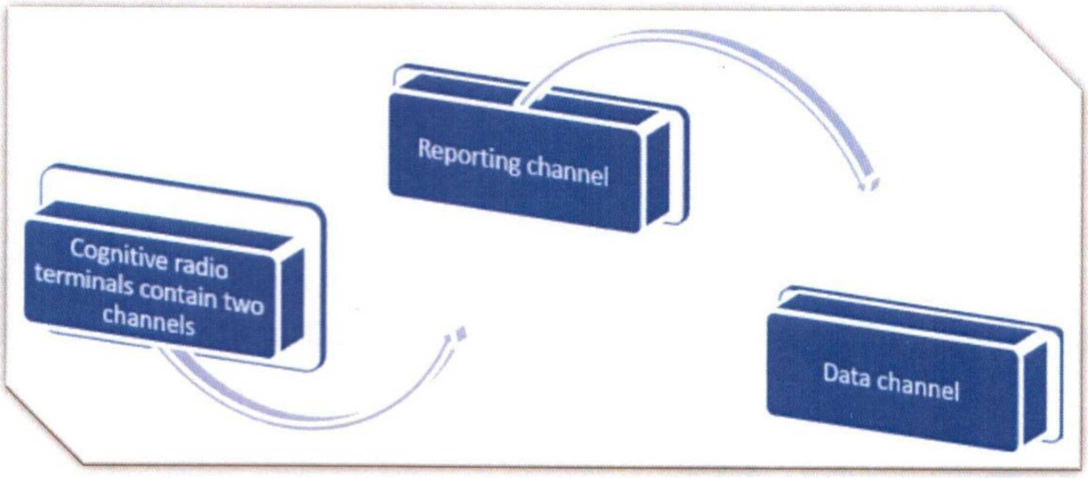

Fig 2. 5 *Channels of Cognitive Radio*

Cognitive radio terminals which work actively and sensing the radio efficiently are likely as QBA, as demonstrated blow fig 2.6. improving Energy Efficiency in two setups, CTs attempt to a sleep mode for protect the energy, At the same time, it decreases process of reporting channel RCH and recompenses to growing throughput the way to cultivating energy. Throughput and EE of CRS with the strategic QBA are initiate in conditions of the thresholds. QBA is very efficient and flexible technique to reaches additional than 50 percent improvement in EE. Furthermore, QBA also rises the throughput other than 30 percent later it avoids CTs from missing their reports by lowering traffic flow load in Reporting channel.

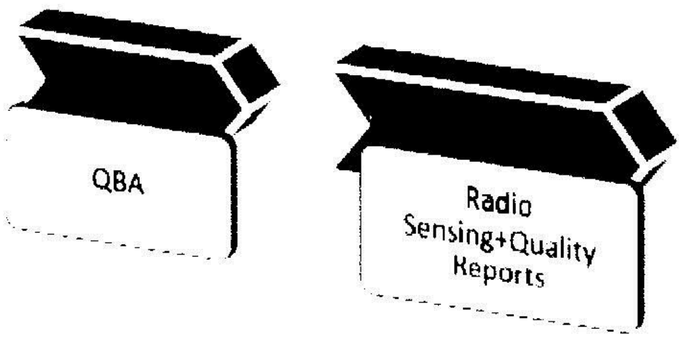

Fig 2. 6 Quality Base Activation [32]

A likely disadvantage of restricted base activation it could be bond the contributor of Cognitive terminals in a scheduling process. Throughput and Energy efficiency of Cognitive radio system, Quality Base Activation, decrease the throughput and offers significant improvement in Energy Efficiency.

2.5 CBS Decision Base Probabilities

Quality base results depends generally, consider for the detection probability during propagation, detection probability $Pd(L, \lambda)$, false alarm probability $Pf(L, \lambda)$ is also accountable for their outcome. Sharing is advised to the cognitive user linked by CBS, during time tp Control channel is linked. well-known probability of choosing a cognitive user couple is $\phi 1(1-Pd(L, \lambda))$ and $\phi 0(1-Pf(L, \lambda))$. Initial signals generate which known as beacon, signal produced by CBS, Reporting channel and data Channel are supposed ideally, to use a self-leading and non-covering spectrum that does not restrict between the PU networks [17], as demonstrated blow fig 2.7.

$\phi 1(1-Pd(L, \lambda))$ and $\phi 0(1-Pf(L, \lambda))=1$

Equation 5 Detection probability and the false alarm probability

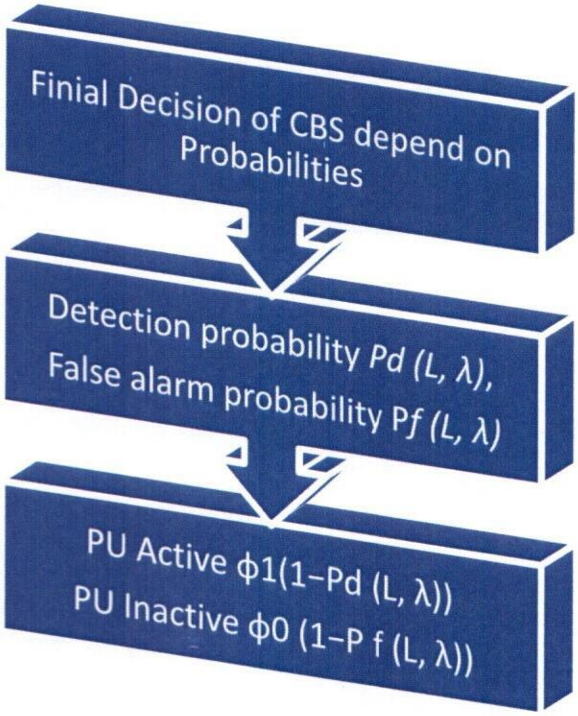

Fig 2. 7 *CBS Decision probabilities for Active and Inactive PU*

2.6 Coordinated Scheduling of Nodes Operation

Intelligent Program consist of two main unique block which contain the Monitoring library, Global power manager which is linked with each other for updated status of node activity, Scheduling appeal and Clustering of node involves in global scheduler. Node operation contain two main blocks involve nodes and local power manager controls the nodes and worked with on/off configuration between global manager and local power manager. Where nodes are liked with Monitoring library for node status and scheduling appeal as shown below fig 2.8.

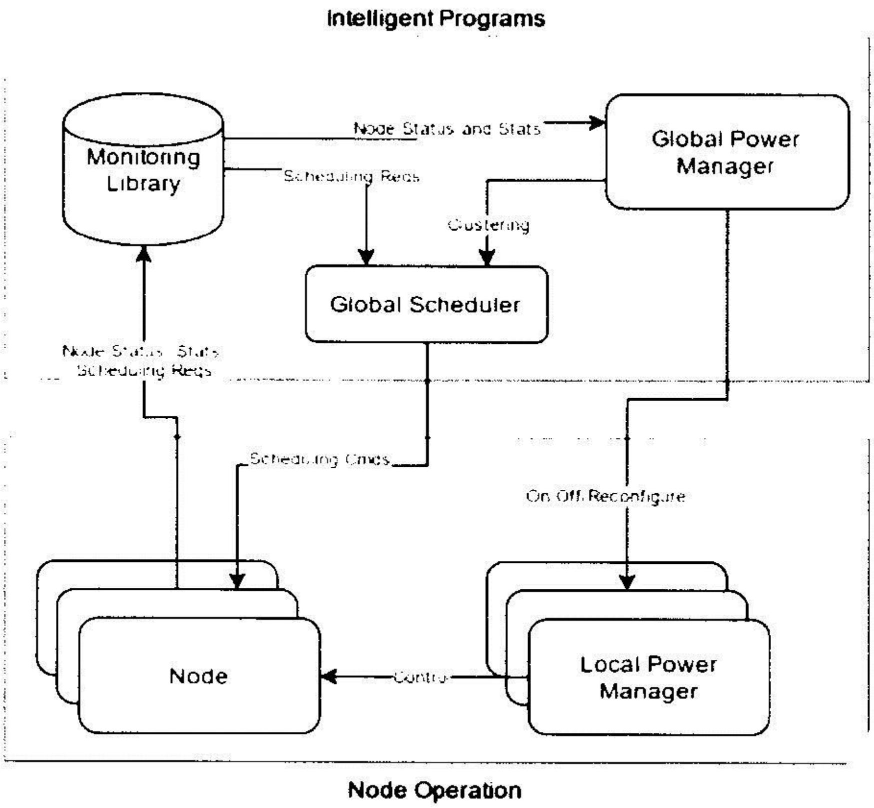

***Fig 2. 8** Coordinated Scheduling of Nodes operation, ON/OFF configuration [18]*

2.7 SYSTEM MODEL:

Number of Cognitive terminals interlinked to Cognitive base station, N is cognitive user. Sensing node term as CTi, Data transmitter term as CRi, its starts from i = 1, 2,3,4,5 . . ., N. Primary user (PU) spreading power P during transmission, Active and inactive probability $\phi 1$ and $\phi 0$, $\phi 1$ is active probability and $\phi 0$ is inactive probability, ($\phi 1 + \phi 0 = 1$) sum of all probability is equal to 1 not more than 1. Time span T is considered, corresponding. Fig. 1 displays the system architype a CRS time frame with configuration. Originally, tc is duration time, CBS generates beacon or initial signals for active position for sensing and reporting, period harmonization of CTs and demanding CTs to start sensing.

Cognitive Terminals detect the primary user actions throughout time span Ts, report the sensing result to CBS, data channel gives the data report to CBS, tr is reporting time during reportage to CBS. CBS chooses whether Primary User is existing or not. Our assumption that the judgment is established as a soft-scheme fusion rule [33].

For soft scheme CBS compares an average value of signal to noise element (SNR) and got from the description and defined threshold to take a finishing decision for active and sleep mode for cognitive terminals for energy efficient and remarkable throughput of system. Generally, 20db or more than 20db is good SNR for data networks, for voice application 25db is standard better for their effective outcomes, SNR is too important for sensing channel which includes the reporting and data channels. Quality base results depends generally, consider for the detection probability during propagation, detection probability *Pd (L, λ)*, false alarm probability *f (L, λ)* is also accountable for their outcome. Sharing is advised to the cognitive user linked by CBS, during time tp Control channel is linked. well-known probability of choosing a cognitive user couple is $\phi 1(1-Pd\ (L, \lambda))$ and $\phi 0\ (1-P\ f\ (L, \lambda))$. Initial signals generate which are known as beacon, signal produced by CBS, Reporting channel and data Channel are supposed ideally, to use a self-leading and non-covering spectrum that does not restrict between the PU networks [32].

Effective time: • $T=\frac{T-(tc+ts+tr+tp)}{T}$

Time frame: • $T=tc+ts+tr+tp$

Fig 2. 9 *Equation of effective time and time frame of CRS*

CT conveys data in data channel on primary user spectrum duration of time td. Thus, Effective time designed for the CRS to involve the PU's spectrum is provided by. The total time CRS Time frame (T) during all process which includes tc, ts, tr, tp and td which is equal to time.

2.7.1 KEY COMPONENT

ρk (rho) is reporting loss probability, The loss probability rate is measure in one of two behaviors containing random loss probability of individual packet and average size of torrent loss during transmission. Combination of data comprehend videos, voice and other data, data traffic is a creating a traffic stream during transmission, such a service is exhibited by a basic ON, OFF model of nodes terminals with" Markov Additive Process" (MAP).

k is number of reporting terminals, main functionality of reporting terminal is to generates the reports of nodes which is actively functioned or not, Pe(k) is probability of bit error well recognized as "BER" is number of bit error distributed by the total number of transferred bits during process at single interval, its measure in term of percentage [28].

The relationship between reporting loss probability Pe(k) with no of terminals k is unswerving, when number of cognitive terminals (K) increasing as a result the reporting loss probability (rho) increasing till the probability range from 0 to 1. When the value of bit length (d) increases as the result the reporting loss probability decreases. When increasing the value of spreading gain (G) as result the reporting probability (rho) decreases [19].

2.7.2 Energy Efficiency:

For Energy efficiency the Cognitive terminals changes into active and sleep mode to lesser energy consumption during all process but on the same scenario the throughput decrease because of less diversity gain occurs.

1. Energy-efficient data transmission in full flag scenario.
2. Low energy feeding in idle situations, consider active and sleep mode of nodes for energy efficient solution.

2.7.3 Important component of structure model

Circuit power (Pc), consider a single cognitive terminal (CT) hearing the beacon indication from CBS, for all the cognitive terminals is represented by N*CT, Cognitive terminal hear the first beacon signal duration is consider tc, time duration of consumption of total energy of initial stage which is equal to N*Pc*tc , Circuit power (Ps) consumption by detection the PU channel, Pr be transmittal power consumption by sending the sensed result to CBS by an separate cognitive terminals. Processing power (*Pp*) consumption by Cognitive terminals while received judgement on spectrum sharing by CBS . *L(≤ N)* ,CTs for single where all cognitive terminals inc(*N** CTs) sense and report the result duration is *ts* and *tr*, correspondingly, therefore predicting the CBS's decision during *tp* , the total energy feasting is *ts +tr +tp* is equal to *L(Ps *ts + Pr* tr + P p*tp)*.Idle case is consider for data transmission for selecting cognitive terminal for primary user. *Pa is a* transmitting power of the chosen CT in its own data channel. Therefore, the entire Average energy consumption Which is *done* by CTs during function.

$$E = N^*(Pc^*\, tc) + L^*(Ps^*\, ts + Pr^*\, tr + P\,p^*tp) + [\varphi 1(1 - Pd\,(L, \lambda)) - \varphi 0(1 - P\,f\,(L, \lambda))]Pa\; td$$

Equation 6 Average energy consumption

Energy Efficiency of a communication platform is definite as a ratio of reachable system throughput is to the energy consumption during communication [5], [8], [13]. For a given CRS throughput *C which is bit per second per hertz* (bps/Hz) is defined in the subsequent segment.

Energy efficiency (η) is express through

$\eta = C/E/T.\ bit/Hz/Joule$

2.8 MATHEMATICAL MODELLING AND PERFORMANCE ANALYSIS

ρk (rho) is reporting loss probability, k is number of reporting terminals, Pe(k) is probability of bit error [4]. The relationship between reporting loss probability Pe(k) with no of terminals k.

when number of cognitive terminals (K) increasing as a result the reporting loss probability (rho) increasing till the probability range from 0 to 1. When the value of bit length (d) increases as the result the reporting loss probability decreases. When increasing the value of spreading gain (G) as result the reporting probability (rho) decreases.

$$\rho k = 1-(1-Pe(k))^{d}$$

Equation 7 Reporting loss probability

$$Pe(k)= \sqrt{\frac{3G}{k-1}} + 1/6Q\sqrt{\frac{3G}{\sqrt{\frac{(k-1)*G}{3}+\sqrt{3\sigma}}}} + 1/6Q\sqrt{\frac{3G}{\sqrt{\frac{(k-1)*G}{3}-\sqrt{3\sigma}}}}$$

Equation 8 Pe(k) is probability of bit error

$$\sigma 2=(k-1) + G^{2} *23/360+(G-1)\ [1/20+[(K-2)/36]]$$

Equation 9 variance

2.8.1 Energy Efficiency With QBA

consider *Pact(L)* equation, the average feeding energy at CTs with QBA during time *T, EQBA*, is assumed by

$$EQBA = NPc\ tc + [NL=1]\ Pact(L)L(Ps\ ts + Pr\ tr + P\ ptp) + [\varphi 1(1 - Pd\ (L, \lambda)) + \varphi 0(1 - P\ f\ (L, \lambda))]Pa\ td]]$$

EE for CRS with QBA, ηQBA, is then obtained by

$$\eta QBA = CQBA/(EQBA/T), \text{ bit/Hz/Joule.}$$

CHAPTER 3

3 Analytical analyses of for collision

For computation Reporting loss Probability ρk with bit length d, we estimate number of cognitive terminals K from 0 to 50 with spreading Gain factor 1 in Reporting channel [9]. Power standards consider as P is 0.8W, Power value of Cognitive Base station is considered PCBS is 0.25W, power value of power processing is Pp is 0.01W, power value of power sensing is Ps is 0.01 w, power value of initial startup consumption is Pc is0.01W, Pa is 0.5W,And respectively time of whole processing T is 3ms, sensing time is consider ts is 0.15ms, Reporting time tr is 0.2ms,initial time tc is 0.002ms is consider, transmission power time is tp is 0.002ms for time values.

3.1 NUMERICAL CALCULATIONS AND RESULTS

SYSTEM PARAMETERS

Using the numerical, calculation to compute the results of Reporting probability loss with Number of cognitive terminals.

K=0 to 50---No of Cognitive Terminals

G=1---Spreading gain

d--Bit length

PCBS--Power value of Cognitive Base station.

Pp-- Processing power

Ps---Sensing power

Pc-- *initial startup consumption*

T=ts+tr+tc+tp--whole processing *T*

3ms=0.15ms+0.2ms+0.002ms+0.002ms----------Time(T)

P=PCBS+Pp+Ps+Pc+Pa--------------------------------Power Consumption

0.8w=0.25w+0.01w+0.01w+0.5w-------------------Power (P)

$pk = 1-(1-Pe(k))^d$ --.----*Reporting loss Probability*

$$Pe(k)= \sqrt{\frac{3G}{k-1}} + 1/6Q\sqrt{\frac{3G}{\sqrt{\frac{(k-1)*G}{3}+\sqrt{3\sigma}}}} + 1/6Q\sqrt{\frac{3G}{\sqrt{\frac{(k-1)*G}{3}-\sqrt{3\sigma}}}}$$ ----Probability of bit error

$\sigma 2=(k-1) + G^2 *23/360+(G-1)\ [1/20+[(K-2)/36]]$------------variance

Computing Reporting Probability loss with Cognitive Terminals.

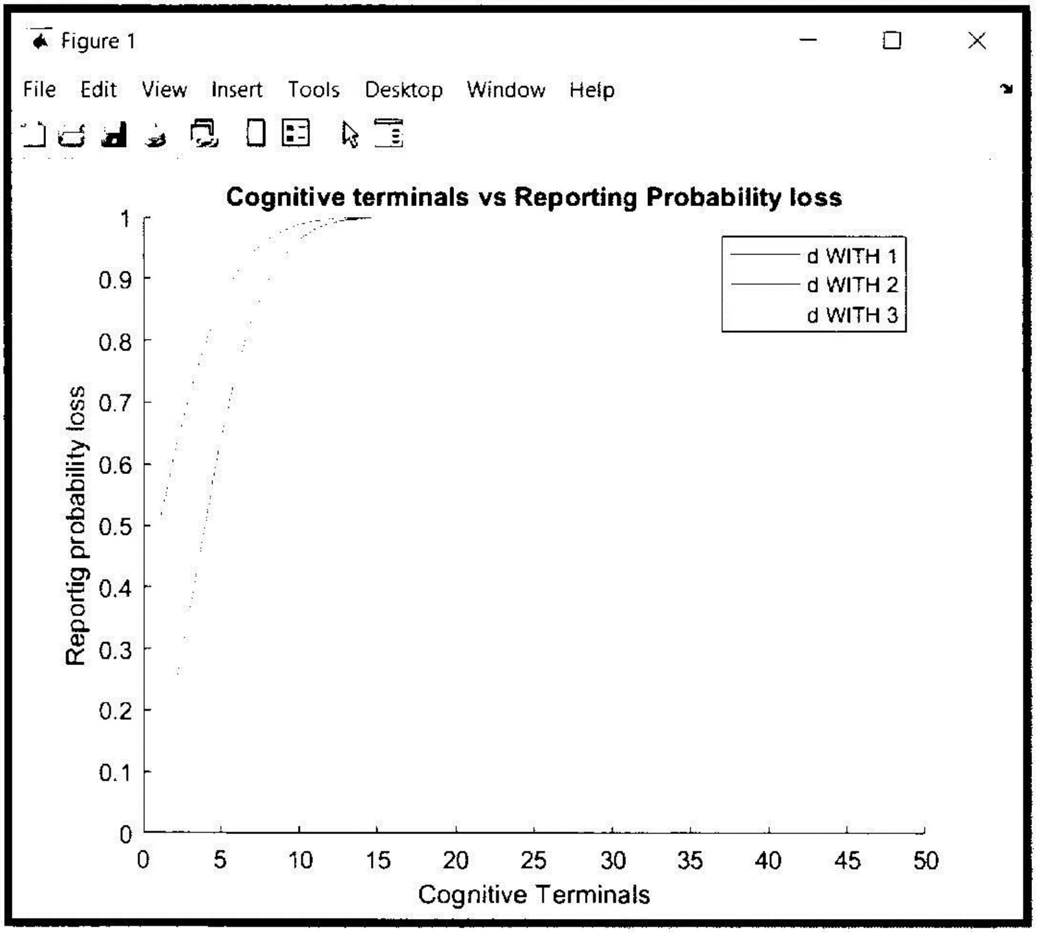

Fig 3. 1 *Reporting loss Probability verse Cognitive Terminals with 3 different bit length*

In this simulation base figure 3.1 shows when the cognitive terminals increase the Reporting loss probability is increase from 0 to 1, where the length of data or bit length also make impact on growing curve, with cognitive terminals and reporting loss during transmission, simulation clear shows if bit length increases the reporting loss probability is decrease with number of terminals.

If Reporting probability increase with terminals on the same behalf the throughput also decreases with cognitive terminals. no doubt bit length d is great impact on collision, and no of cognitive terminal have great impact on reporting losses, furthermore impact regarding to throughput, energy efficiency.

MATLAB code with different parameters Estimation base.

```
clc;
clear all;
close all;
K=1:1:50;%cognitive termials
G=1;%spreadig gain)
%d=4;
for d=1:2:5
s=((K-1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36).^(1/2));
S=real((K-1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36)).^(1/2);
a1=qfunc((3*G)\(K-1));
a2=qfunc(G\(K-1)*(G/3)+(3).^(1/2)*(real(((K-
1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36)).^(1/2))).^(1/2));
a3=qfunc(G\(K-1)*(G/3)-(3).^(1/2)*(real(((K-
1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36))).^(1/2)).^(1/2));
%P=(2/3)(qfunc((3*G)\(K-1)))+(1/6)(qfunc(G\(K-
1)(G/3)+(3).^(1/2)(real(((K-1)((G.^2)(23/360))+(G-
1)((1/20)-(K-2)/36)).^(1/2))))).^(1/2))+(1/6)(qfunc(G\(K-
1)(G/3)-(3).^(1/2)(real(((K-1)((G.^2)(23/360))+(G-
1)*((1/20)+(K-2)/36)).^(1/2))))).^(1/2));
P=(2/3)*(a1)+(1/6)*(a2)+(1/6)*(a3);
R=((1-P).^d);
hold on
plot(K,R,'-');
%stem(K,R);
title('Cognitive terminals vs Reporting Probability
loss')
xlabel('Cognitive Terminals')
ylabel('Reportig probability loss')
legend('d WITH 1','d WITH 2','d WITH 3')
end
```

Fig 3. 2 Matlab code with 3 unique bit length of d,G=1

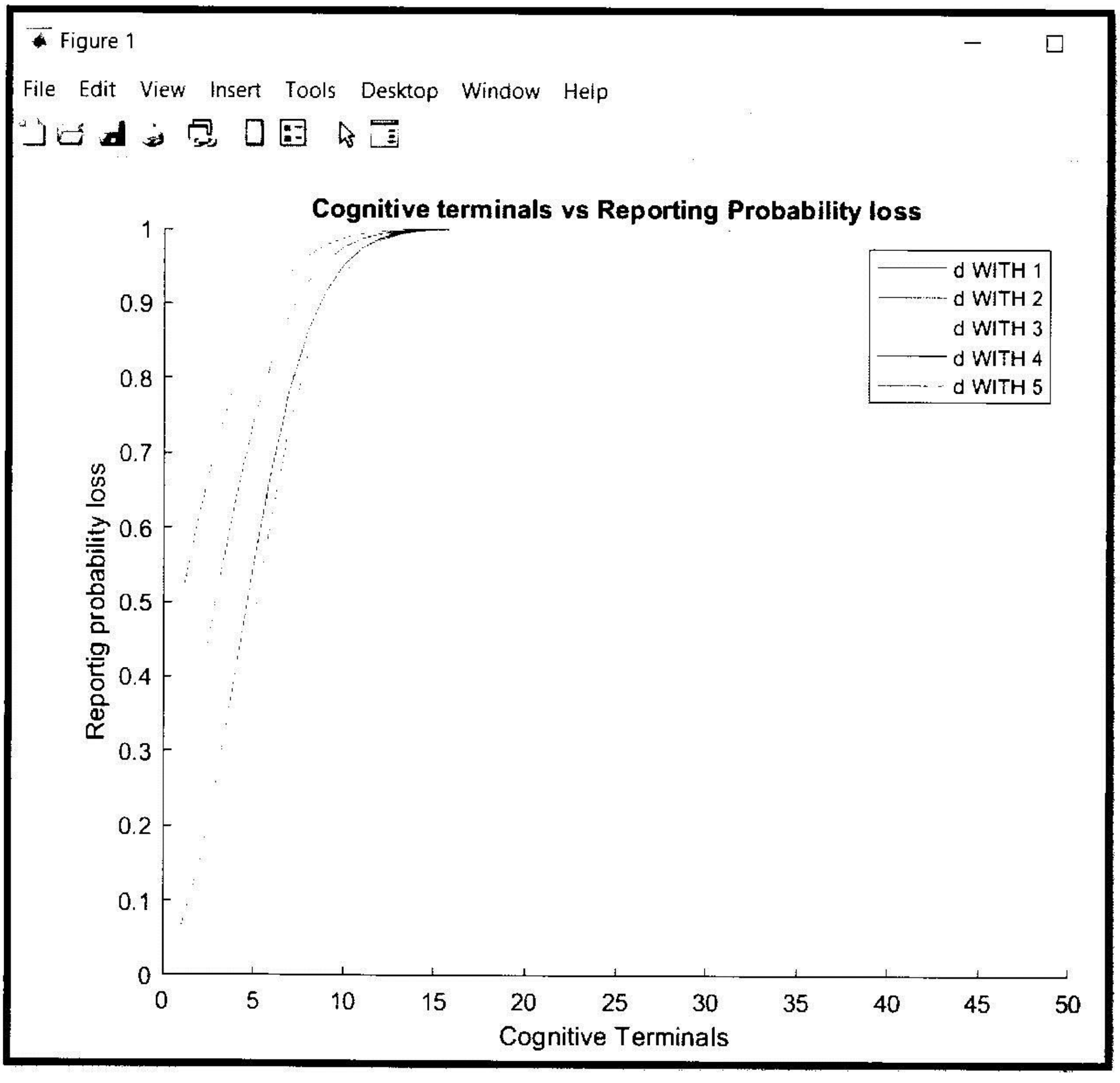

Fig 3. 3 *Reporting loss Probability verse Cognitive Terminals with 5 various bit length*

In this simulation base figure 3.3 shows when the cognitive terminals increase the Reporting loss probability is increase from 0 to 1, it is clear visible the relationship between bit length and reporting loss is inverse in nature, so bit length increases on the same behalf the reporting loss is decrease and other all parameters like throughput and energy efficiency is well suit of efficient system

```
clc;
clear all;
close all;
K=1:1:50;%cognitive termials
G=1;%spreadig gain)
%d=4;
for d=1:1:5
s=((K-1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-2)/36).^(1/2));
S=real((K-1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36)).^(1/2);
a1=qfunc((3*G)\(K-1));
a2=qfunc(G\(K-1)*(G/3)+(3).^(1/2)*(real(((K-
1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36)).^(1/2))).^(1/2));
a3=qfunc(G\(K-1)*(G/3)-(3).^(1/2)*(real(((K-
1)*((G.^2)*(23/360))+(G-1)*((1/20)+(K-
2)/36))).^(1/2)).^(1/2));
%P=(2/3)(qfunc((3*G)\(K-1)))+(1/6)(qfunc(G\(K-
1)(G/3)+(3).^(1/2)(real(((K-1)((G.^2)(23/360))+(G-
1)((1/20)+(K-2)/36)).^(1/2))))).^(1/2))+(1/6)(qfunc(G\(K-
1)(G/3)-(3).^(1/2)(real(((K-1)((G.^2)(23/360))+(G-
1)*((1/20)+(K-2)/36)).^(1/2))))).^(1/2));
P=(2/3)*(a1)+(1/6)*(a2)+(1/6)*(a3);
R=((1-P).^d);
hold on
plot(K,R,'-');
%stem(K,R);
title('Cognitive terminals vs Reporting Probability loss')
xlabel('Cognitive Terminals')
ylabel('Reportig probability loss')
legend('d WITH 1','d WITH 2','d WITH 3','d WITH 4','d WITH 5')
end
```

Fig 3. 4 Matlab code with 5 different bit length of d

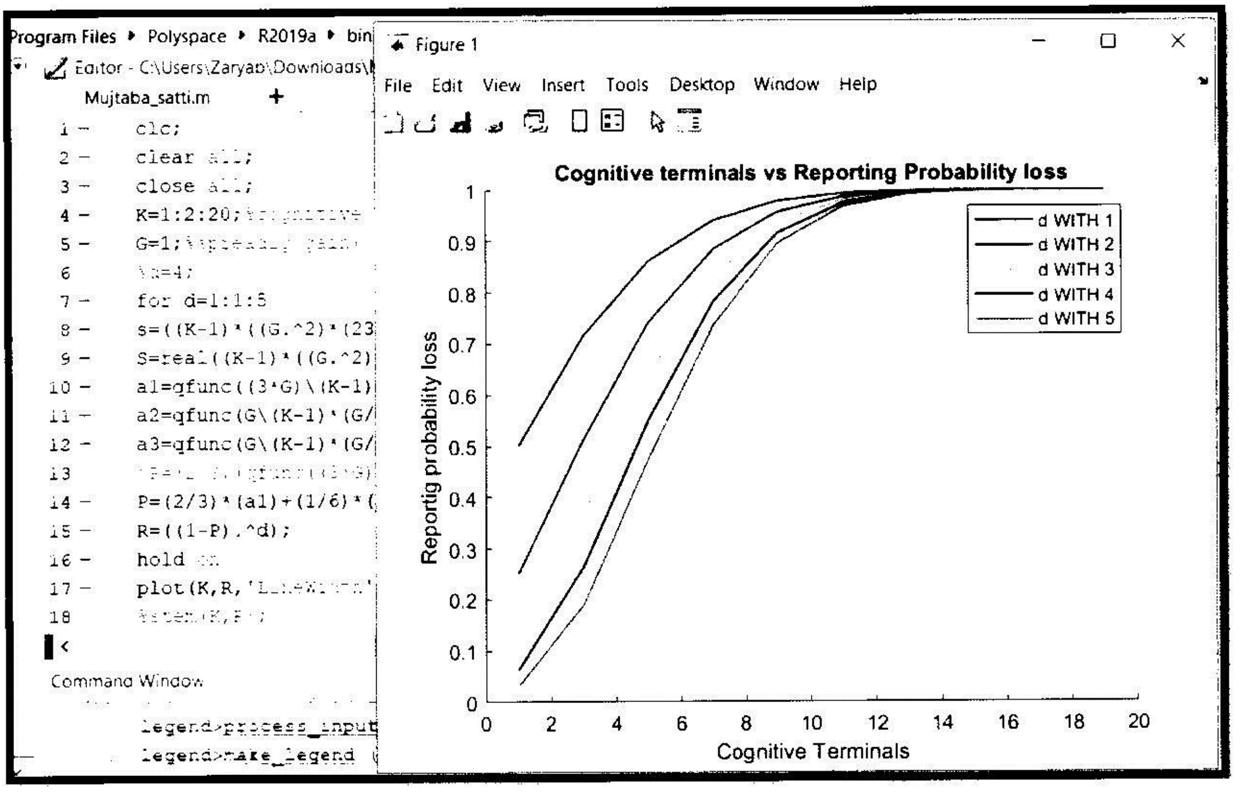

Fig 3. 5 Reporting loss Probability verse Cognitive Terminals with 5 various bit length, G=1

In this figure 3.5 shows if the value of Spreading gain G=1 rapid enhancement is occurred on reporting loss probabilities. where the length of data or bit length also make impact on growing curve, with cognitive terminals and reporting loss during transmission, simulation clear shows if bit length increases the reporting loss probability is decrease with number of terminals. If Reporting probability increase with terminals on the same behalf the throughput also decreases with cognitive terminals.

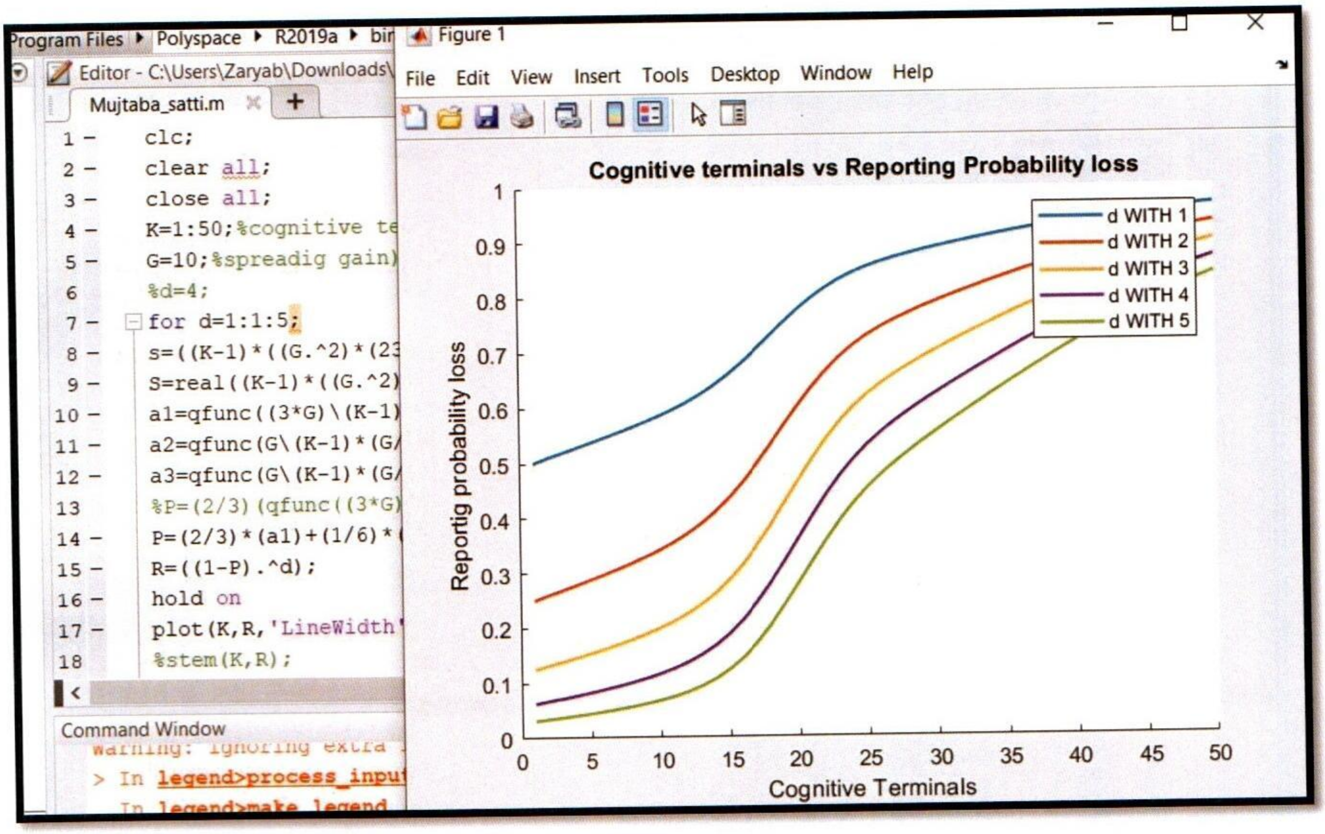

Fig 3. 6 *Reporting loss Probability verse Cognitive Terminals with 5 various bit length, G=10*

In this figure 3.6 shows if the value of Spreading gain G=10 smooth enhancement is occurred on reporting loss probabilities, value of spreading gain also relate with loss, the curve clearly shows the relation of gain, which great impact on system outcomes.

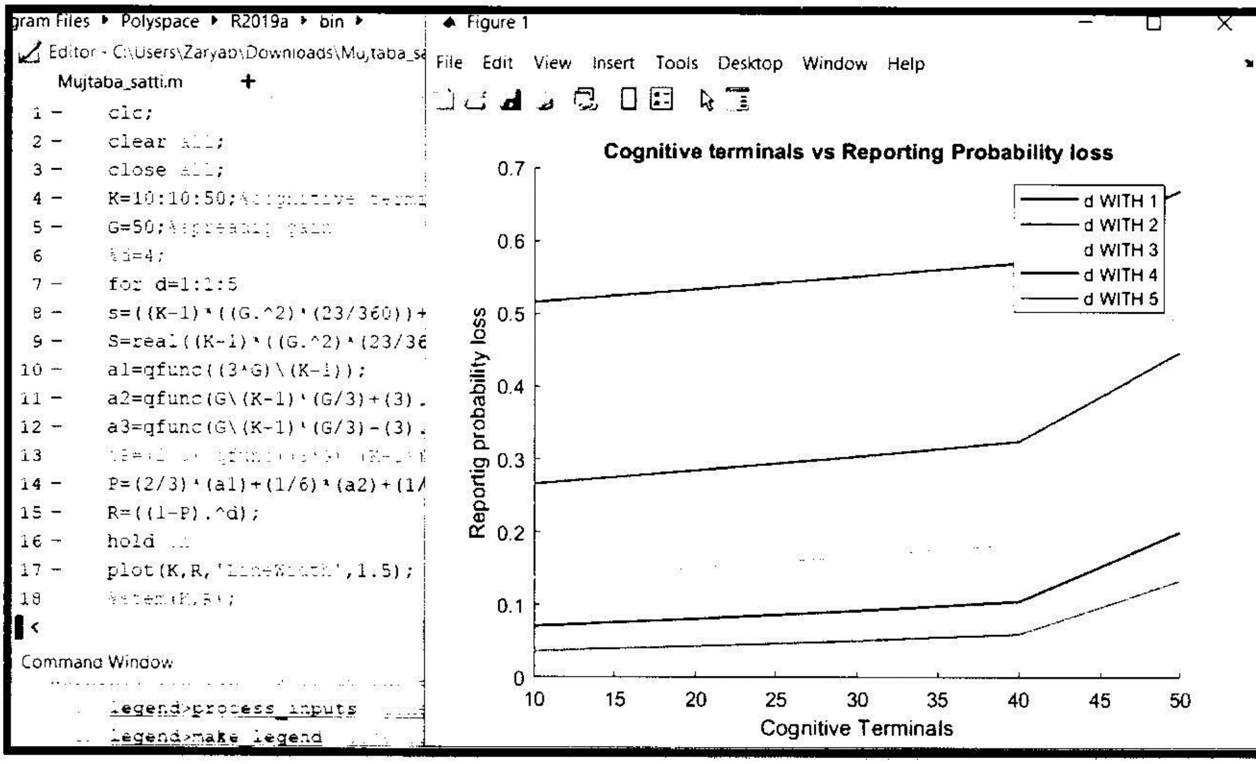

Fig 3. 7 Reporting loss Probability verse Cognitive Terminals with 5 various bit length G=50

Here is MATLAB code for simulation which is between with number of cognitive terminals K and Reporting loss probabilities with different bit length of d. where the length of data or bit length also make impact on growing curve, with cognitive terminals and reporting loss during transmission, simulation clear shows if bit length increases the reporting loss probability is decrease with number of terminals. In this figure 3.5 shows if the value of Spreading gain G=1 rapid enhancement is occurred on reporting loss probabilities. If we vary the value of Spreading gain it will have great impact on reporting loss probability smoothly change, not rapidly, it diminishes the reporting loss probabilities and increase throughput and Energy efficiency of Cognitive base system. In this figure 3.7 shows if the value of Spreading gain G=50 minor change occurs on reporting loss probabilities. Here we decide if the value of gain is increased the reporting loss probability decreases, which impacts on throughput of system with Energy efficient.

CHAPTER 4

Conclusion and Future work

Cognitive Radio enables to improves spectrum efficiency for broadcasting systems for efficient use. It is no doubt that these enabling technologies will revolutionize the world. We have seen in the literature review as well in which researchers are trying hard to overcome their collision and make it possible to bring this technology in to real world as well. There are many use cases like Virtual reality, ultra-low latency and terabits level of speed. In this document, uses of Cooperative radio system, node selection approach is use for cognitive quality base outcome, which is activity use, for deep analysis of the cooperate procedure has been considered. This learning also takes some valuable opinions into the progression of CRS for sensing efficiency view related to Cognitive channel.no doubt bit length d is great impact on collision, and no of cognitive terminal have great impact on reporting losses, furthermore impact regarding to throughput, energy efficiency. Outcomes demonstrating the strategic proposals achieve improved implementation at a similar instant as the probability of reporting losses is considered. Upcoming work consists of adjustment of the length which includes bit length, Throughput, Energy efficiency for justification of simulation base code in case of a cognitive radio terminals plan as to make system energy efficient. QBA diminishes the quantity of active CTs by determining the data channel and Reporting channel efficiency, sizing of CBS to conserve the multi-user diversity and the CRS throughput. For future working Numerical analysis base recommends that QBA offers considerable enhancement in EE, more than 50 percent as well as throughput further than 30 percent, combined with the all-time through with "sensing and reporting" approach. Many batteries operated CTs are engaged in communication like in Internet-of-Things applications, QBA is a gifted method. simulation clear shows if bit length increases the reporting loss probability is decrease with number of terminals, here we decide if the value of gain is increased the reporting loss probability decreases, which impacts on throughput of system with Energy efficient. Machine learning approach is used which analyzes the data and automate the development of analytical models. It learns from the dataset, recognizing patterns providing correct results.

REFERENCES

[1] Mishra, Ajay K. "Fundamentals of Cellular Network Planning and Optimization,2G/2.5G/3G...Evolution of 4G", John Wiley and Sons, 2004.

[2] Commission of the European Communities, Staff Working Document, "Exploiting the Employment Potential ofICTs," Apr. 2012.

[3] E. Dahlman, G. Mildh, S. Parkvall, J. Peisa, J. Sachs, Y. Selen, et al., "5G Wireless Access: Requirements and Realization", *IEEE Commun. Magazine*, vol. 52, no. 12, pp. 42-47, Dec. 2014.

[4] K. C. Huang and Z. Wang, *Millimeter Wave Communication Systems: Wiley*, pp.1-29, 2011.

[5] K. Cicho´n, A. Kliks, and H. Bogucka, "Energy-efficient cooperative spectrum sensing: A survey," *IEEE Commun. Surveys Tuts.*, vol. 18, no. 3,pp. 1861–1886, 3rd Quart., 2016.

[6] Frank Rayal, „Cloud RAN vs. Small cells: Trading processing for transport cost"Available: http: frankrayal.com cloud-ranvs-smallcells-trading process-for-transport-

[7] "Network Functions Virtualisation An Introduction Benefits Enablers Challenges & Call for Action", *ETSI white paper*, no. 1, pp. 1-16, 2012.

[8] Q.-V. Pham, F. Fang, V. N. Ha, M. J. Piran, M. Le, L. B. Le, et al., "A survey of multi-access edge computing in 5G and beyond: Fundamentals technology integration and state-of-the-art", *arXiv:1906.08452*, 2019, [online] Available: http://arxiv.org/abs/1906.08452.

[9] *ETSI Multi-Access Edge Computing*, Oct. 2019, [online] Available: https://www.etsi.org/technologies/multi-access-edge-computing.

[10] *https://www.sktelecom.com/img/pds/press/SKT_5G%20White%20Paper_V1.0_Eng.pdf*

[11] O. Salman, I. H. Elhajj, A. Kayssi and A. Chehab, "SDN controllers: A comparative study," *2016 18th Mediterranean Electrotechnical Conference (MELECON)*, 2016, pp. 1-6, doi: 10.1109/MELCON.2016.7495430.

[12] Y. Ran, E. Yang, Y. Shi, S. Chen and J. Yang, "A NaaS-enabled for service composition in software defined networking environment," *2014 IEEE Globecom Workshops (GC Wkshps)*, 2014, pp. 188-193, doi: 10.1109/GLOCOMW.2014.7063429.

[13] Series, M. "Future technology trends of terrestrial IMT systems." *Int. Telecommun. Union, Geneva, Switzerland, Rep. ITU* (2015): 2320-0.

[14] ITU, J. "Provisional final acts." *World Radiocommunication Conference 2019*. ITU Publications, 2019.

[15] Gupta, Abhishek K., and Adrish Banerjee. "Spectrum above radio bands." *Spectrum Sharing: The Next Frontier in Wireless Networks* (2020): 75-96.

[16] Kürner, Thomas, and Akihiko Hirata. "On the Impact of the Results of WRC 2019 on THz Communications." *2020 Third International Workshop on Mobile Terahertz Systems (IWMTS)*. IEEE, 2020.

[17] E. C. Y. Peh, Y. -C. Liang, Y. L. Guan and Y. Pei, "Energy-Efficient Cooperative Spectrum Sensing in Cognitive Radio Networks," *2011 IEEE Global Telecommunications Conference - GLOBECOM 2011*, 2011, pp. 1- 5, doi: 10.1109/GLOCOM.2011.6134342.

[18] S. Chaudhari, J. Lunden, V. Koivunen, and H. V. Poor, "Cooperative sensing with imperfect reporting channels: Hard decisions or soft decisions?" *IEEE Trans. Signal Process.*, vol. 60, no. 1, pp. 18–28, Jan. 2012.

[19] S. Bayhan and F. Alagoz, "Scheduling in centralized cognitive radio networks for energy efficiency," *IEEE Trans. Veh. Technol.*, vol. 62, no. 2, pp. 582–595, Feb. 2013

[20] A. Patle and D. S. Chouhan, "SVM kernel functions for classification," *2013 International Conference on Advances in Technology and Engineering (ICATE)*, 2013, pp. 1-9

[21] Sheikh Bilal Zahid, "Evolution of Next Generation Intelligent Networks with re-using existing Networks," *2010 Seventh International Conference on Wireless and Optical Communications Networks – (WOCN)*, 2010, pp. 1-4, doi: 10.1109/WOCN.2010.5587320.

[22] YANG Menghui et al., "Performance flexibility architecture of Core service platform for Next-Generation Network", *Tsinghua Science and Technology*, vol. 13, no. 1, February 2008.

[23] Q. K. Ud Din Arshad, A. U. Kashif and I. M. Quershi, "A Review on the Evolution of Cellular Technologies," *2019 16th International Bhurban Conference on Applied Sciences and Technology (IBCAST)*, 2019, pp. 989-993, doi: 10.1109/IBCAST.2019.8667173.

[24] Nidhi, A. Mihovska and R. Prasad, "Overview of 5G New Radio and Carrier Aggregation: 5G and Beyond Networks," *2020 23rd International Symposium on Wireless Personal Multimedia Communications (WPMC)*, 2020, pp. 1-6, doi: 10.1109/WPMC50192.2020.9309496.

[25] M. Gharba *et al.*, "5G enabled cooperative collision avoidance: System design and field test," *2017 IEEE 18th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM)*, 2017, pp. 1-6, doi: 10.1109/WoWMoM.2017.7974355.

[26] S. Chaudhari, J. Lunden, V. Koivunen, and H. V. Poor, "Cooperative sensing with imperfect reporting channels: Hard decisions or soft decisions?" *IEEE Trans. Signal Process.*, vol. 60, no. 1, pp. 18–28, Jan.2012.

[27] J. N. Reddy, S. Racharla, B. S. Rajesh, K. Jyothsna and G. Narayanan, "Effective Spectrum Utilization using Peak Detection and CSMA/CA," *2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA)*, 2020, pp. 808-813, doi: 10.1109/ICIRCA48905.2020.9182817.

[28] A. Sendonaris, E. Erkip, and B. Aazhang, "User cooperation diversity.Part II. Implementation aspects and performance analysis," *IEEE Trans.Commun.*, vol. 51, no. 11, pp. 1939–1948, Nov. 2003.

[29] J. Fan, F. Gao, W. -S. Wang and G. -F. Dong, "Performance analysis of an adaptive backoff scheme for Ad Hoc networks," *2008 8th IEEE International Conference on Computer and Information Technology*, 2008, pp. 624-629, doi: 10.1109/CIT.2008.4594747.

[30] Z. Shu and T. Taleb, "A Novel QoS Framework for Network Slicing in 5G and Beyond Networks Based on SDN and NFV," in *IEEE Network*, vol. 34, no. 3, pp. 256-263, May/June 2020, doi: 10.1109/MNET.001.1900423.

[31] Amr Abdelfattah and Naceur Malouch Modeling and Performance Analysis of Wi-Fi Networks Coexisting with LTE-U file:///C:/Users/Hp/Downloads/SecondpaprFirstedition.pdf

[32] C. Cormio and K. R. Chowdhury, "Common control channel design for cognitive radio wireless ad hoc networks using adaptive frequency hopping," *Ad Hoc Netw.*, vol. 8, no. 4, pp. 430–438, Jun. 2010.

[33] J. Ma, G. Zhao, and Y. Li, "Soft combination and detection for cooperative spectrum sensing in cognitive radio networks," *IEEE Trans. Wireless Commun.*, vol. 7, no. 11, pp. 4502–4507, Nov. 2008.