AN INTELLIGENT QUAD BAND USER EQUIPMENT BLOCKING COMMUNICATION SYSTEM

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***Abstract*— In this paper we present a quad band selective mobile phone communication blocking system for mobile phone restricted areas. The design works on 2G, 3G, 4G and 5G network systems. Mobile phone jammers function by blocking the entire communication spectrum, as a result in the case of emergencies no mobile can either make or receive calls. Therefore, we present a system where, access to mobile phone communication would be given to privileged users and a signaling control channel jammer to attenuate the control channel of network operators in the restricted area. Mobile phones always connect to the base station (BS) with the strongest cell reception, attenuating the operators control channel will as a result leave our system as the "BS" with the strongest cell reception in the restricted area. It grants access to mobile phones in the restricted area to connect to our system. Thereby having full control of the entire restricted area. This will allow mobile phones in the restricted area to connect to our system and selective blocking of communication would be performed, where privileged users would be given access to communication. The results show that when the system is implemented mobile phone communication can be prioritized to suit privileged users within a mobile phone restricted area.**

Keywords

Mobile Phone Jammer, Privileged User, Intelligent Selective System, Mobile Phone Restricted Areas

INTRODUCTION

Due to the growing popularity of telecommunications, mobile phones are becoming a necessary component of almost every human existence. Mobile phones have evolved into a necessary but specific tool in our daily lives. Users are now able to use other multi-media chat apps, make calls, and send texts. The ability to get in touch with anyone at any time is remarkable. However, there are a number of places where mobile phone activities are restricted. These locations include banks, movie theatres, libraries, mosques, halls of worship, and any other setting where stillness is essential. It ends up noticeably irritating and upsetting when a mobile phone rings or somebody gets a call amid parties (tuning in to a sermon or lecturing, asking at the mosque), official gatherings and social affairs that requires silence. An engaged region where phones are limited is in schools particularly senior secondary schools (motel) and exams corridors of tertiary establishments (preparing universities, Polytechnics and colleges).

With this as an issue, mobile phone jammers are utilized to keep phone clients from making and accepting calls inside that specific limited range. [1]. Therefore, the elementary determination of the mobile jammers is to block communications between a mobile phone and base stations. [2]. This discourages mobile phone utilization in the confined range. Since there are distinctive, frequency bands that the mobile phone system use. The jammers would need to jam mobiles by crossing over those bands successfully. [3], such as GSM, WCDMA,4G and 5G [4].

Unfortunately, the use of mobile phone jammers would probably meddle with or bother public mobile services, and in turn have serious consequences on the users such as [5]

- Jeopardising the quality of the service (QoS).
- May affect the contact to emergency services.
- Bring about inconvenience and loss of business for mobile service provider
- Distressing the total income of mobile service providers.

The following are some benefits of a mobile phone jammer. [6];

- One of the underlying advantages of utilizing mobile phone jammer is that, the device can impede any mobile phone signal from base station. In the event that a jammer is utilized, it can block out the signals from the mobile phone from reaching the base station. Apart from this, it likewise enables save critical information by hindering the signals so employees are not able to send trade information to others in the form of pictures or videos.

- The jamming devices help prevent phone interruption during important meetings.

The use of a mobile phone jammer has some limitations. Once activated no mobile phone can be able to function within the restricted area. For that reason, in the case of emergencies no mobile phone can either make or receive phone calls.

Therefore, there is a need for a system, which can allow certain mobile phones to exclusively make communication within the restricted area. The system should selectively allow mobile phone communication within the restricted area. The system should effectively control communication in the restricted area. All mobile phones in the restricted area should connect to the system without interference from external operators. To ensure this another system is needed to attenuate the signalling control channel of network operators in the restricted area. This will allow mobile phones in the restricted area to fully connect to our system.

BACKGROUND

Over the past, few years' different types of mobile phone jammers have been manufactured for the commercial market. However, the evolution of the generation of communication networks has developed the interest of researchers to come up with different ways of jamming communications in a network for security reasons. [7] [8] [9] [10]. In 2008, a group of students designed an intelligent jamming system, which can block only the controller channels in the Global system for mobile communication (GSM) and digital cellular network (DCS) and operate only if the jammer senses an active mobile in the restricted area. [11]. In 2013, another group designed a jammer, which works at GSM 900MHz and GSM 1800MHz simultaneously and thus jams the four well-known network carriers (MTN, GLO, Etisalat, and Zain) in Nigeria. [12].

A group in 2002 developed a real-time interception system for the GSM protocol. [13]. In the paper, they exhibited three new capture attempt frameworks for security purposes. The first one (detector) powers all idle Mobile phones close by to generate action, which can be utilized to actuate a caution of mobile phones' presence. The second one screens information exchange between mobile phones and BS. The third system syndicates the previous two systems to improve obstructive performance. These interceptors monitor GSM transactions and, if necessary, block nonprivileged calls.

In a paper presented on new GSM/UMTS jamming, a pseudo base station was built to attempt connecting with mobile devices. [14]. While the devices are trying to connect, the system will get a unique identity, such as IMSI and IMEI. The system cannot perform selective blocking of communication of these mobile terminals.

The above works can all block phone calls in a certain way. However, with external operator influence in a restricted area full communication control would not be accomplished. Mobile phones always connect to the BTS with the strongest cell reception. Therefore, with this concept, we can attenuate external operators signalling control channels. As a result, our system is a "BTS" with the strongest cell reception in the restricted area. This will obviously allow mobile phones in the restricted area to connect to our system. Thereby having full control of the entire restricted area. We present scenarios of this case in the next section III.

An approach scenario of how the system will connect to mobile phones and perform selective blocking of communication in the restricted area

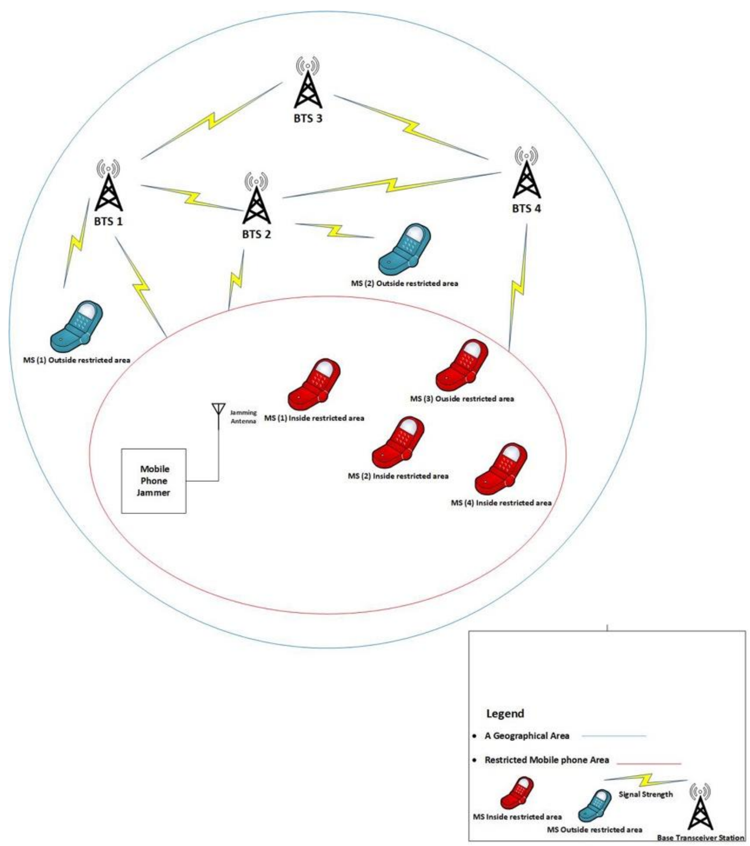


Fig. 1: A mobile phone jammer blocking the signal from the base station to the mobile phone

In this scenario, mobile phones in the restricted are completely cut off from the operators' BTS by the mobile phone jammer. Therefore, in emergency contact situations (fire, police, and ambulance services) communication cannot be established in the restricted area.

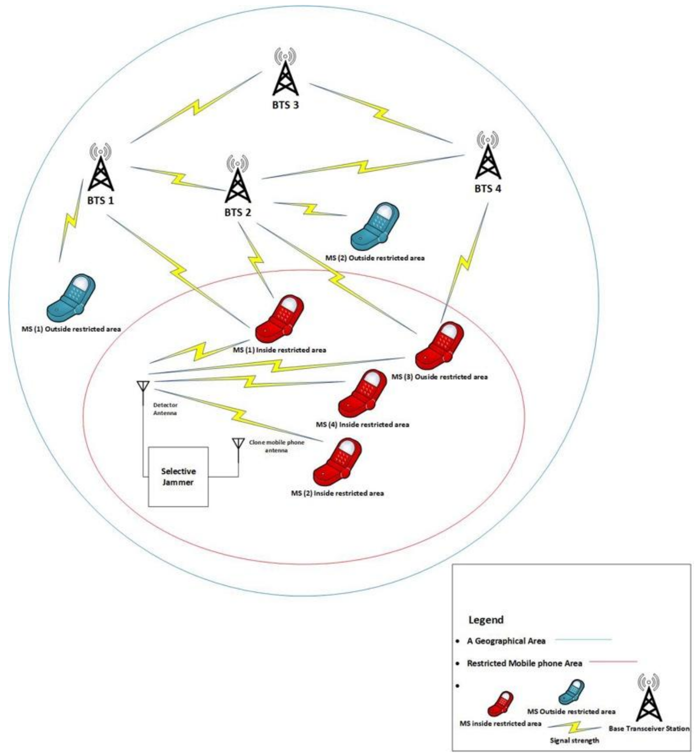


Fig. 2: Selective blocking system activated in the restricted area

Fig. 2. shows the selective mobile phone communication blocking system activated in the restricted. The mobile phones labelled in red are those in the restricted area and those in blue are those outside the restricted area. The restricted area is labelled with a red oval and the entire geographical area is labelled with a blue circle. The BTS's represent the operators' base stations. Once the selective mobile phone communication blocking system is activated, it broadcasts its radio frequency as a base station. As a result, the mobile phones in the restricted area can see the broadcast frequency and may attempt to connect to it depending on the signal strength. Thus, it will compare the signal strength of the available base stations and connect to the strongest.

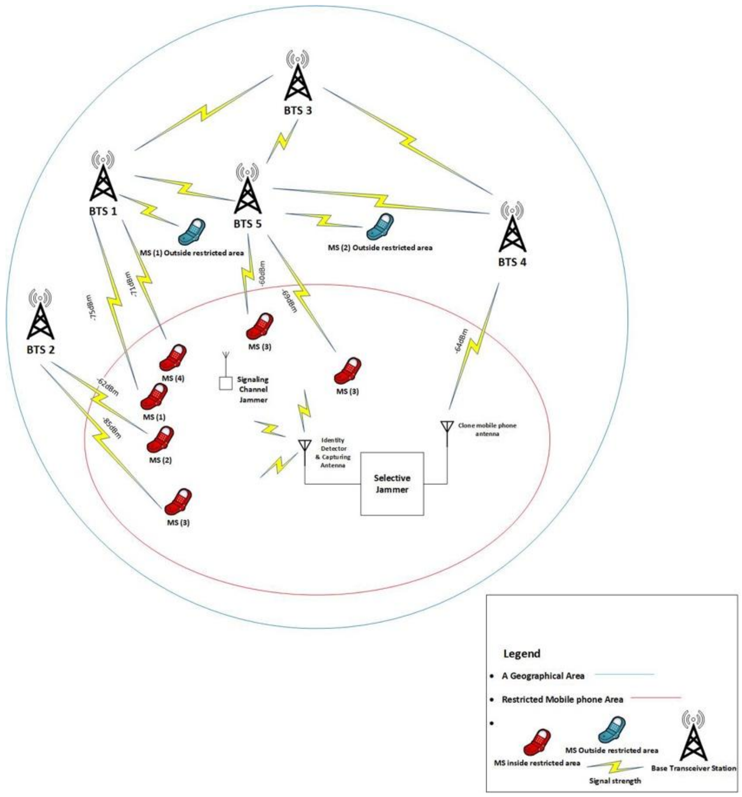


Fig. 3: Selective blocking system with a signalling control channel jammer in the restricted area

Fig. 3. shows the selective mobile phone communication blocking system activated and a signalling channel jammer deactivated with mobile phones having active connections with base stations outside the restricted area. The mobile phones labelled in red are those in the restricted area and those in blue are those outside the restricted area. The restricted area is labelled with a red oval and the entire geographical area is labelled with a blue circle. The BTSs represent the operators' base stations. In the scenario where mobile phones in the restricted choose to connect to base stations out of the restricted area according to cell selection criterion. The purpose of implementing the system in the mobile phone restricted will not be achieved. Therefore, a need arises to force all mobile phones that enter the restricted area to connect to the proposed system. This can be achieved by placing a signalling channel jammer in the restricted area to disrupt the signalling control channel of base stations outside the restricted area (the operators' BTS). Because of this disruption, the mobile phones in the restricted will not be able to connect to the operators' network. Therefore, the only available system to connect with will be the proposed system.

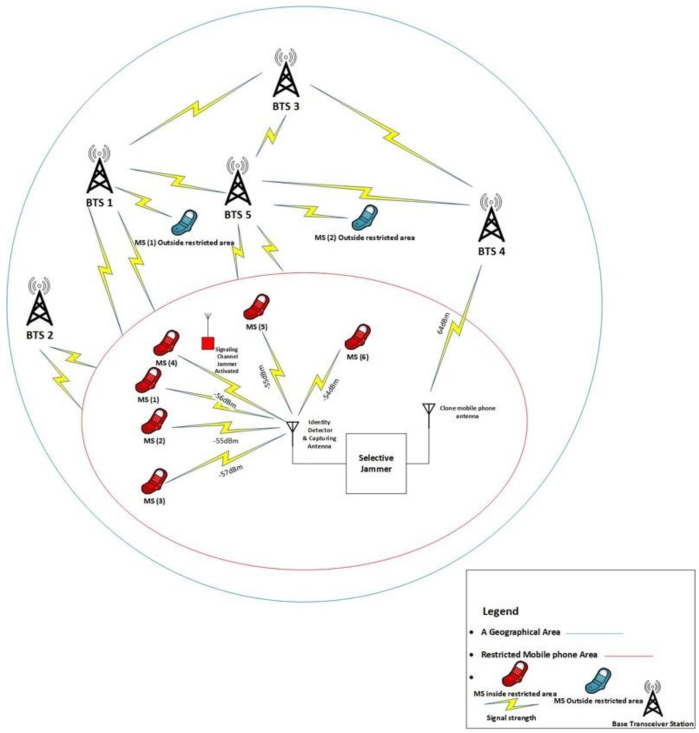


Fig. 4. Selective blocking system with mobile phones connected to it in the restricted area

Fig. 4. Shows the selective mobile phone communication blocking system activated with a signalling channel jammer activated and mobile phones in the restricted area connected to the mobile phone selective blocking system. The mobile phones labelled in red are those in the restricted area and those in blue are those outside the restricted area. The restricted area is labelled with a red oval and the entire geographical area is labelled with a blue circle. The BTS's represent the operators' base stations.

In this scenario, mobile phones do not have an option to connect to the operator's network but are forced to connect to the proposed system due to the introduction of the signalling channel jammer.

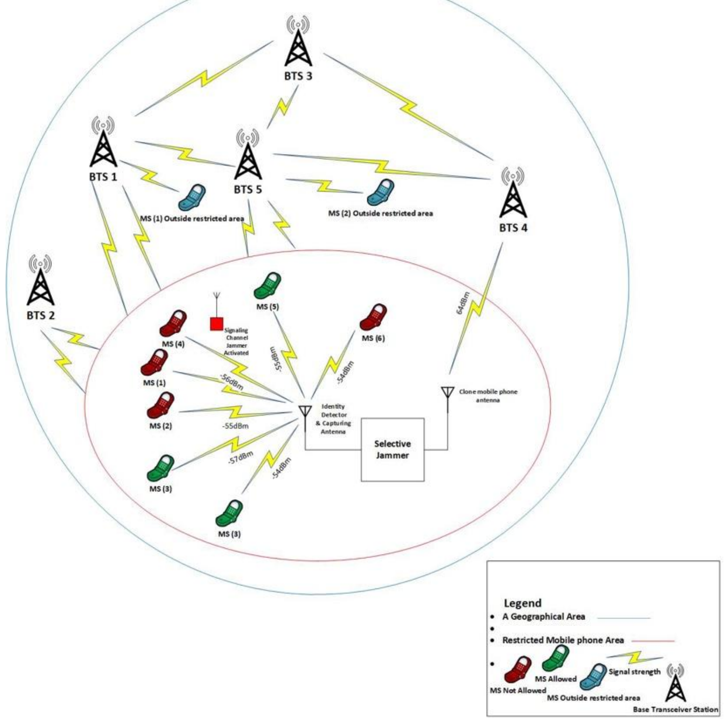


Fig. 5. Selective blocking system performing selective blocking in the restricted area

Fig. 5. Shows a scenario where mobile phones connected to the proposed system (selective jammer) are selectively blocked. The mobile phones labelled in red are those connected to the proposed system but have been denied a communication service, the green labels are the ones who have been granted communication service and the blue are those outside the restricted area. The restricted area is labelled with a red oval and the entire geographical area is labelled with a blue circle. The BTS's represent the operators' base stations. With the proposed system connected to a mobile phone, when the mobile phone wants to perform a communication service, the proposed system would check its database of eligible mobile phones allowed in the restricted area. If a mobile phone is found eligible then that mobile phone would be allowed else would be blocked. All allowed mobile phones would be connected to the operators' network by the proposed system. The proposed system is like a filter that determines who can establish communication with the operators' network.

EXPERIMENTAL DETAIL & METHODS

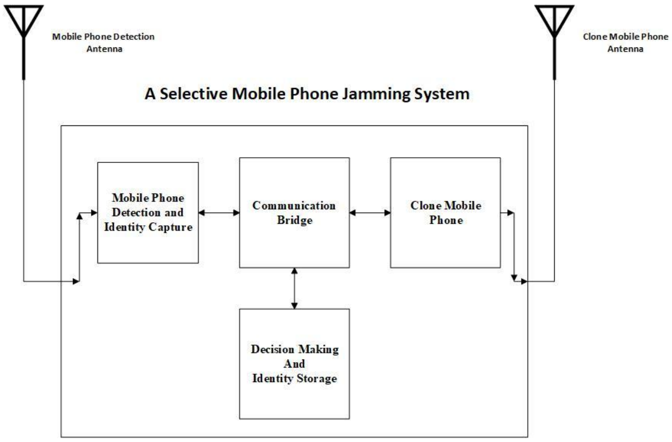


Fig. 6: System Model

The system model looks at connecting mobile phones in the restricted area to the true operator's network. The system acts as a filter, which determines which mobile phone can enjoy communication in the restricted area. Within the identity and decision-making unit is a register containing the eligibility of mobile phone identities, that can enjoy communication in the restricted area. If a mobile phone that is connected to the system wants to enjoy communication, the system will check its identity storage to find out if that mobile phone is permitted to enjoy the requested service or not. If permitted then the mobile phone will be allowed, if not then it will be rejected. When a mobile phone requests for the service and is permitted, the system would connect the mobile phone to the operator's network.

The mobile phone detection and identity capture unit is responsible for capturing a user's IMSI number and connecting users to the system. If a mobile phone user is granted access, the user's IMSI number will be imprinted on the clone mobile phone. Then connected to the operator's network. When communication is established between the clone mobile phone and the operator's network, then the communication bridge forwards the communication from the clone mobile phone and the operator network to the user in the restricted area. This forwarding by the communication bridge is done through the mobile phone detection and identity capture unit. This form of communication can be established for both GSM, UMTS, 4G, and 5G networks.

System Modelling in MATLAB Simulink

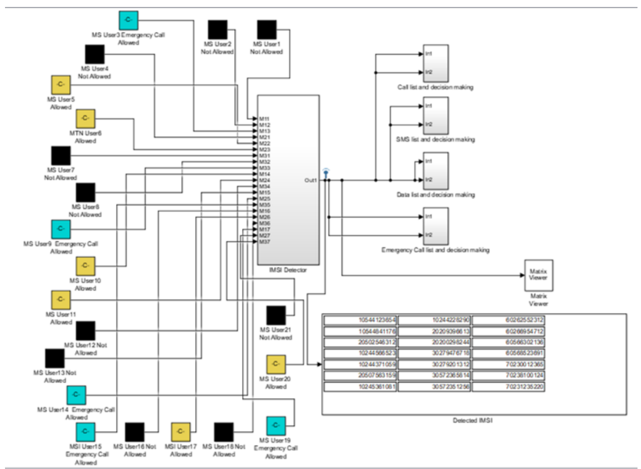
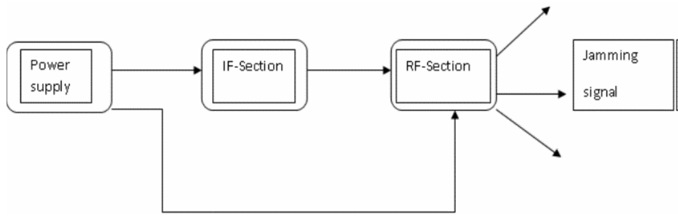


Fig. 7: System design in Simulink

In fig. 7 is the system design in the Matlab Simulink environment. There are twenty-one nodes representing mobile stations. The black-labeled nodes represent mobile stations, that are not privileged to perform communications, and the yellow-labeled nodes are privileged mobile stations permitted to perform communication. The light blue nodes represent privileged mobile stations permitted to only perform emergency calls. The decision-making registers for calls, sms, data connection, and emergency calls can be programmed to block all nodes labeled in black and allow light blue nodes to only perform emergency calls. It can also selectively allow the yellow-labeled nodes to perform communications based on the decision-making registry for calls, sms, data, and emergency calls. The decision-making registers are found at the output of the IMSI detector. The IMSI detector functions to detect available mobile stations. The output display of this design is a matrix viewer. The matrix viewer displays the output decision-making for each detected mobile station. However, the matrix viewer can display the decision for allowing MS for only one MS at a time. Meaning it cannot display multiple “allowed” MS per view.

Design structure of the signaling control jammer



The power supply unit offers the necessary power to control the IF and RF area. The intermediate Frequency (IF) unit is the segment where the signal is produced to the Radio Frequency section (RF). IF unit is responsible for frequency tuning by producing a triangular wave, which is mixed with a noise signal to sweep the Voltage Controlled Oscillator (VCO). The IF unit comprises of four main parts which are:

a) Triangular Wave Generator: To set the exact frequency band in the VCO in the RF unit. b) Noise Generator: To produce output noise.

c) Mixer: To mix the triangular wave signal with the noise signal.

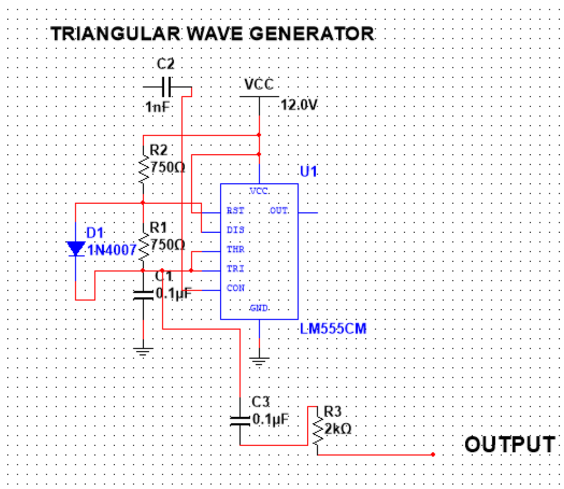


Fig. 8: Triangular wave generator circuit

A triangular wave generator is used to adjust the frequency band in the Voltage Controlled Oscillator (VCO). This will sweep the desired frequency range to cover the downlink frequency, which is 935 to 960 MHz, 806 MHz to 821 MHz, 1805 to 1880 MHz, and 2110 MHz to 2170 MHz. Where these are, the frequency ranges that are needed to block the transmission for GSM/UMTS/4G/5G band frequencies. The 555 timer IC was utilized and works in a steady mode to produce the broad signal to the VCO.

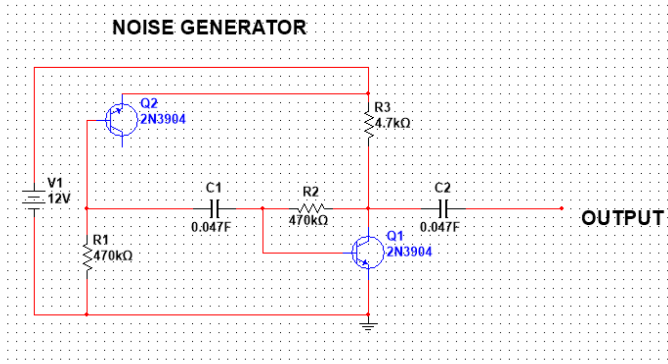


Fig. 9: Noise generator

In this paper, the jamming system needs a specific kind of noise to cover a portion band of the spectrum, so the most applicable type of noise in this case is white noise. When all is said in done can be characterized as a Random development of charges or charge transporters in an electronic device creating current and voltage that fluctuate arbitrarily with time. Without noise, the yield of the VCO is only an un-adjusted sweeping RF carrier. Due to this, it is compulsory to mix the triangular wave signal and noise.

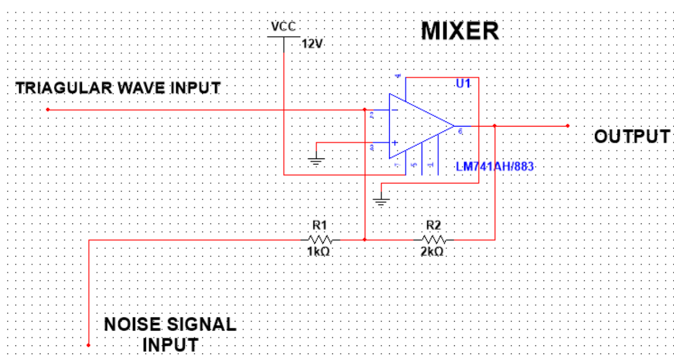


Fig. 10: Mixer circuit

The mixer is an amplifier, which functions as a summer. The triangular wave signal and noise will be added together in the mixer before inflowing into the VCO.

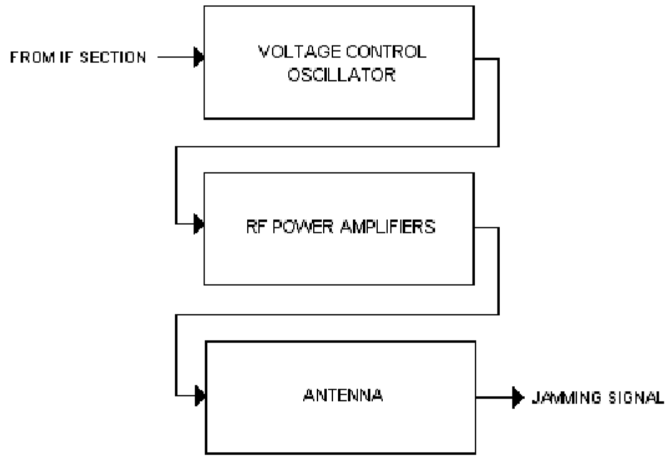


Fig. 11: Block diagram of RF section

To effectively jam a specific area we have to think about an essential parameter, the signal-to-noise ratio, denoted as the SNR. Each device working on radio communication principles can only endure noise in a signal up to a specific level. This is termed as SNR management capability of the device. Most cellular devices have an SNR dealing with a capacity of around 12dB. A very good device may have an estimation of 9dB, in spite of the fact that it is exceptionally improbable. To guarantee the jamming of these devices, we have to lessen the SNR of the carrier signal to below the 9dB threshold.

For this, we consider the direst outcome imaginable from a jammers perspective. This would mean the most extreme transmitted power S max from the tower, alongside the least estimation of the SNR management capability of a mobile device. Precisely,

J = -24dBm

since SNR min = S/J

where J is the power of the jamming signal.

So we need to have a jamming signal strength of -24dBm at the mobile device's reception to effectively jam it. Be that as it may, our emanated signal will experience some attenuation when conveyed from the antenna of the jammer to the antenna of the mobile phone. This path loss can be considered utilizing the straightforward free space path loss estimation:

$L_P = 32.45 + 20\log_{10}(fD)$-------- Equation (1)

At this juncture, f is the frequency in MHz, and D is the distance traveled in kilometers. By means of the GSM downlink center frequency (947.5MHz) and a jamming radius of 20m, we get the value of path loss to be 58dBm. This ideal path loss is for free space only, and the path losses in air will be significantly more prominent. This implies that the jamming range will be not as much as the 20m used to ascertain this value. Along these lines, incorporating the power lost in path loss, we need to transmit a signal with the strength of:

$J_T = 58 - 24 = 34dBm$ -----------Equation (2)

SIMULATION AND RESULTS

simulation result for the selective blocking system

10544123654	16	10244228290	4	60262552312	2
10544841176	15	20209396613	5	60266954712	19
20502546312	14	20200298244	6	60566302136	9
10244566523	13	30279476771	7	60568523691	20
10244371059	3	30279201312	18	70230012365	10
20575631159	12	30572365814	17	70238100124	21
10245361081	1	30572351256	8	70231235220	11

Fig. 12: A 7x3 view of detected IMSI numbers with eleven eligible IMSI numbers

Fig. 12 shows the stored mobile phone numbers (IMSI numbers) in the decision-making and identity storage unit found in Fig. 6. The black highlighted IMSI numbers in Fig. 12 are considered privileged users. The special numbers tagged on the individual IMSI numbers are linked to the matrix viewer to indicate the position of that IMSI number or mobile phone on the matrix viewer. The entire structure of Fig. 12 is in a matrix form. There are two main colors in the matrix viewer which signifies if a mobile phone is allowed or not allowed. That is the color white indicates when a mobile phone is allowed and orange when a mobile phone is not allowed. The Z-axis in Fig. 8 represents color coding between -1 and 1. The number, 1 on the z-axis represents "true" or "allowed" which stands for the color white. The number, 0 also in the z-axis represents "false" or "not allowed" which corresponds to the color orange.

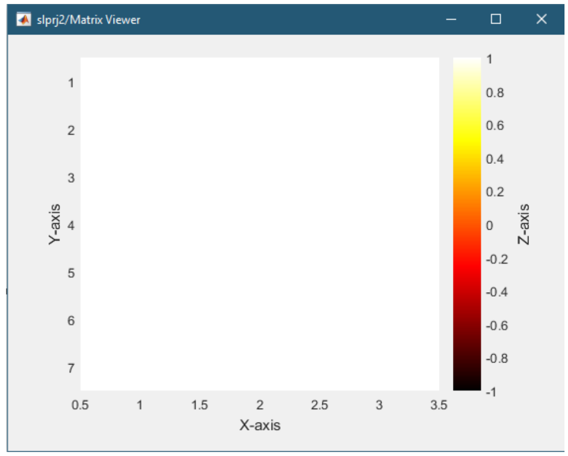


Fig. 8: Matrix viewer of all mobile phones allowed

Fig. 8 shows a complete white matrix graph. In this scenario, all mobile phones have been allowed to operate within the restricted area.

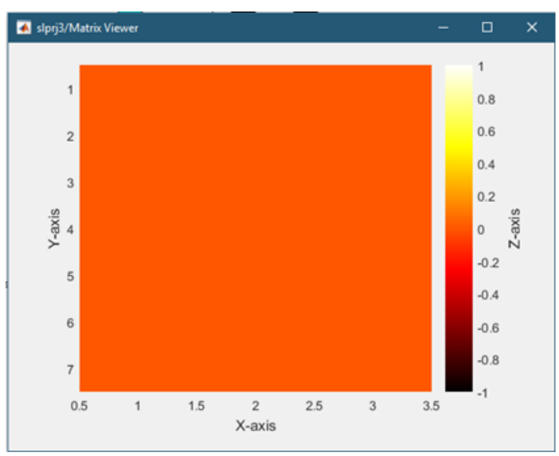


Fig. 9: Matrix viewer of all mobile phones blocked

Fig. 9 shows a complete orange matrix graph. In this scenario, all mobile phones have been blocked operation within the restricted area. Therefore no communication in that region.

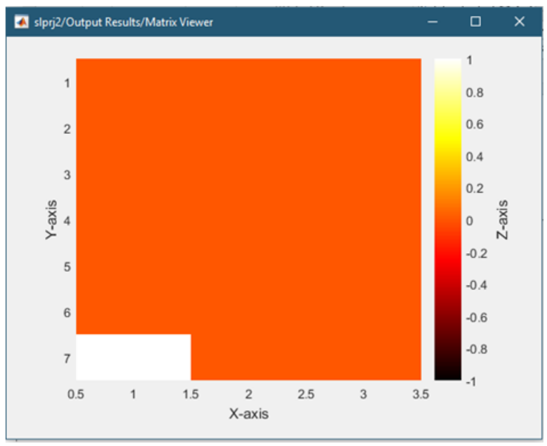


Fig. 10: Matrix viewer of IMSI number tag 1 allowed

Fig. 10 shows a portion of the entire graph in white. That is the graph shows the intersection of row number 7 on the y-axis against the column numbers 0.5 and 1.5 on the x-axis. This indicates that the IMSI number tagged number 1 in Fig. 12 is allowed for communication service.

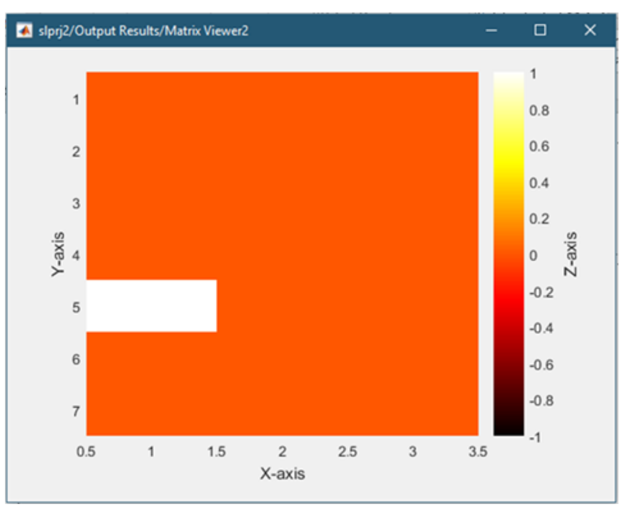


Fig. 11: Matrix viewer of IMSI number tag 3 allowed

Fig. 11 shows a portion of the entire graph in white. That is the graph shows the intersection of row number 5 on the y-axis against the column numbers 0.5 and 1.5 on the x-axis. This indicates that the IMSI number tagged number 3 in Fig. 12 is allowed for communication service.

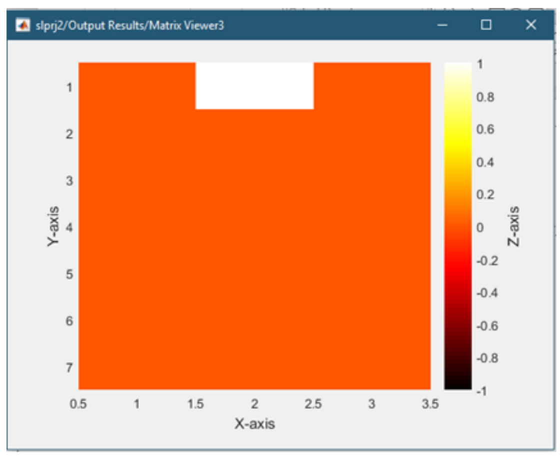


Fig. 12: Matrix viewer of IMSI number tag 4 allowed

Fig. 12 shows a portion of the entire graph in white. That is the graph shows the intersection of row number 1 on the y-axis against column numbers 1.5 and 2.5 on the x-axis. This indicates that the IMSI number tagged number 4 in Fig. 12 is allowed for communication service.

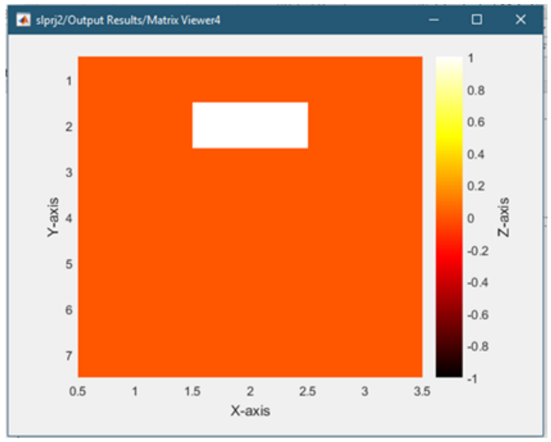


Fig. 13: Matrix viewer of IMSI number tag 5 allowed

Fig. 13 shows a portion of the entire graph in white. That is the graph shows the intersection of row number 2 on the y-axis against column numbers 1.5 and 2.5 on the x-axis. This indicates that the IMSI number tagged number 5 in Fig. 12 is allowed for communication service.

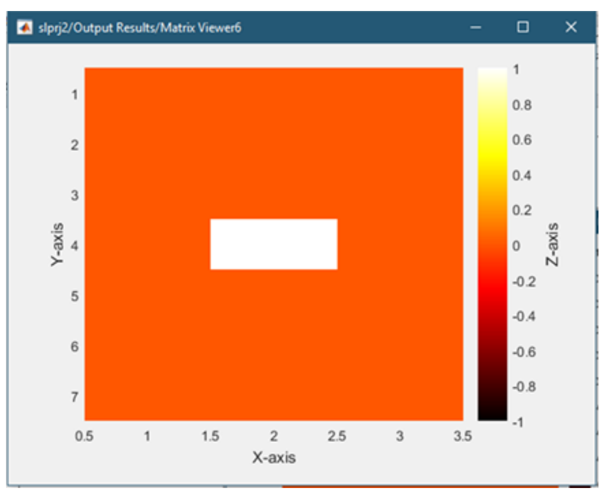


Fig. 14: Matrix viewer of IMSI number tag 7 allowed

Fig. 14 shows a portion of the entire graph in white. That is the graph shows the intersection of row number 4 on the y-axis against column numbers 1.5 and 2.5 on the x-axis. This indicates that the IMSI number tagged number 7 in Fig. 12 is allowed for communication service.

Simulation results for signaling control channel jammer

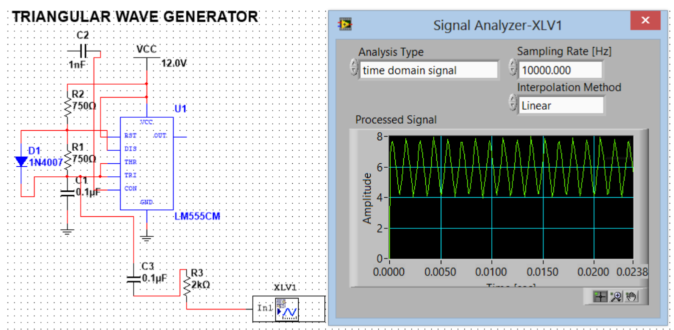


Fig. 15: Triangular wave generator simulation

Fig. 15 shows the results of the triangular wave generator producing a triangular wave, which will tune VCOs in the RF section to the following range of downlink frequencies; 935-960MHz and 1805-1880.

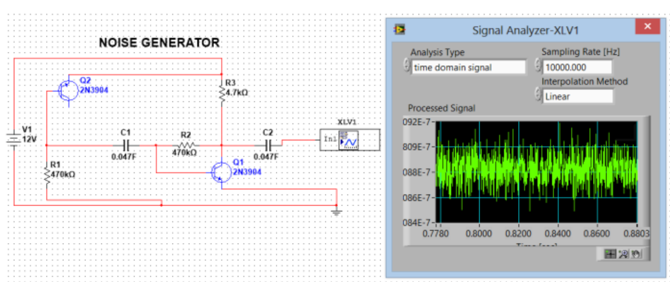


Fig. 16: Noise generator simulation

Fig. 16 shows the results of the noise generator which generates the noise that will be mixed with the triangular wave at the mixer stage. Noise is the actual element that is going to disturb the frequency spectrum between the mobile phone and the base station.

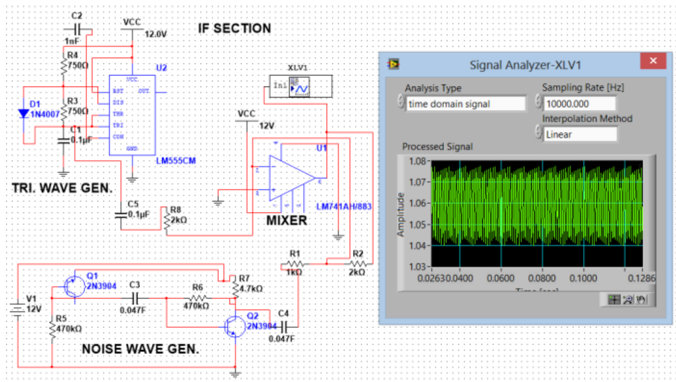


Fig. 17: IF section simulation

At the IF stage, the triangular wave is mixed with the noise wave before entering the VCOs. Fig. 17 shows the results of the mixer.

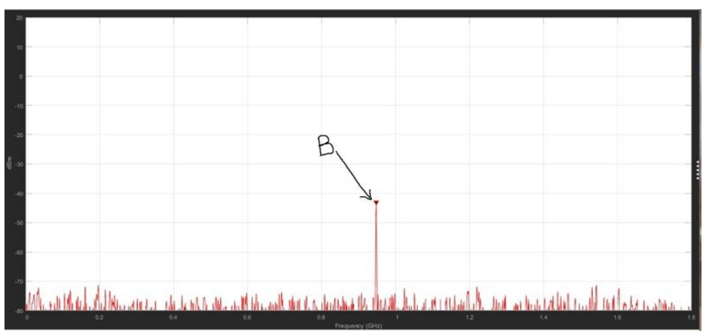


Fig. 18: When the signaling control channel jammer is deactivated for 900MHZ band frequency control channel

Fig. 18 shows the spectrum results when the control channel jammer does not distort the frequency spectrum of the GSM 900 signaling control channel. The peak labeled B represents the signal power of the control channel in the frequency spectrum when the jammer is disabled. B= -41dbm.

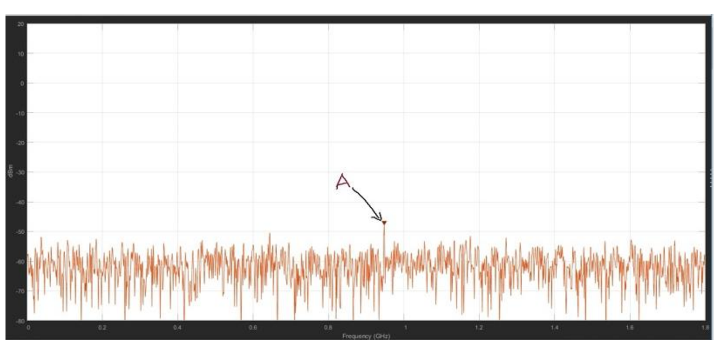


Fig. 19: When the signaling control channel jammer is activated for 900MHZ band frequency

Fig. 19 shows the spectrum results when the control channel jammer distorts the frequency spectrum of the GSM 900 signaling control channel. The peak labeled A represents the signal power of the control channel in the frequency spectrum when the jammer is enabled. A= -48.8dbm.

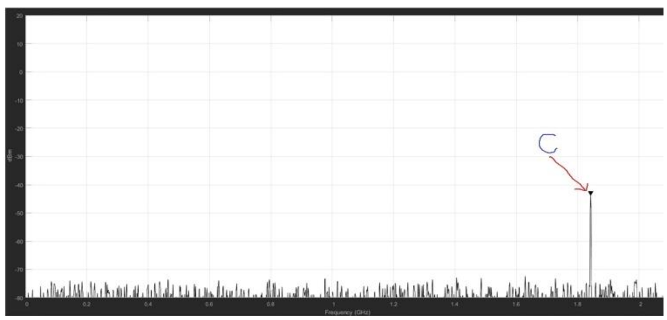


Fig. 20: When the signaling control channel jammer is deactivated for 5G 1800MHZ band frequency

Fig. 20 shows the spectrum results when the control channel jammer does not distort the frequency spectrum of the 5G signaling control channel. The peak labeled C represents the signal power of the control channel in the frequency spectrum when the jammer is disabled. C= -40.98dbm.

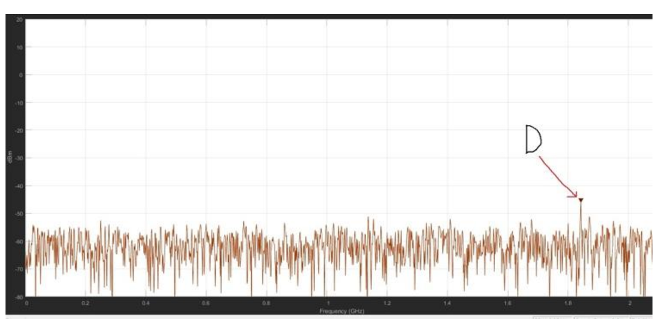


Fig. 21: When the signaling control channel jammer is activated for 5G 1800MHZ band frequency

Fig. 21 shows the spectrum results when the control channel jammer distorts the frequency spectrum of the 5G signaling control channel. The peak labeled D represents the signal power of the control channel in the frequency spectrum when the jammer is enabled. D= -49.20dbm.

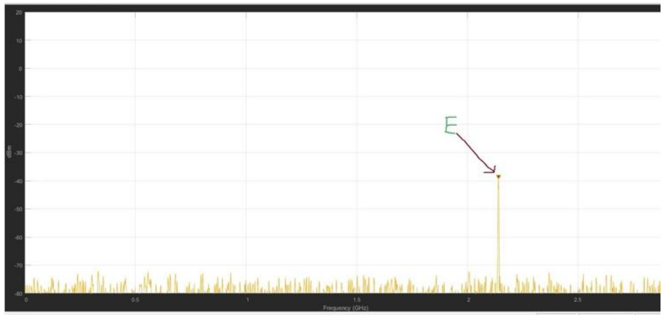


Fig. 22: When the signaling control channel jammer is deactivated for 3G 2100MHZ band frequency

Fig. 22 shows the spectrum results when the control channel jammer does not distort the frequency spectrum of the 3G signaling control channel. The peak labeled E represents the signal power of the control channel in the frequency spectrum when the jammer is disabled. E= -39.88dbm.

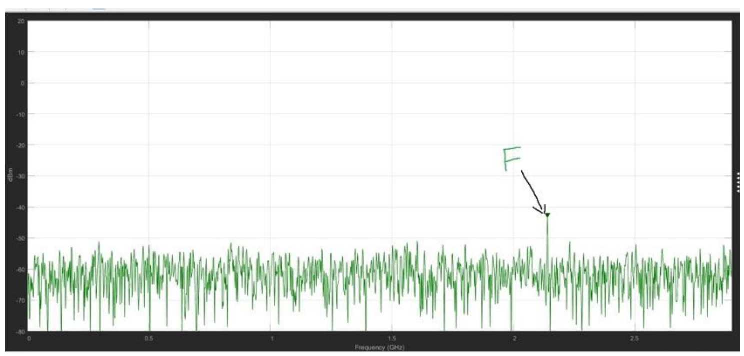


Fig. 23: When the signaling control channel jammer is activated for 3G 2100MHZ band frequency

Fig. 23 shows the spectrum results when the control channel jammer distorts the frequency spectrum of the 3G signaling control channel. The peak labeled F represents the signal power of the control channel in the frequency spectrum when the jammer is enabled. F= -42.70dbm.

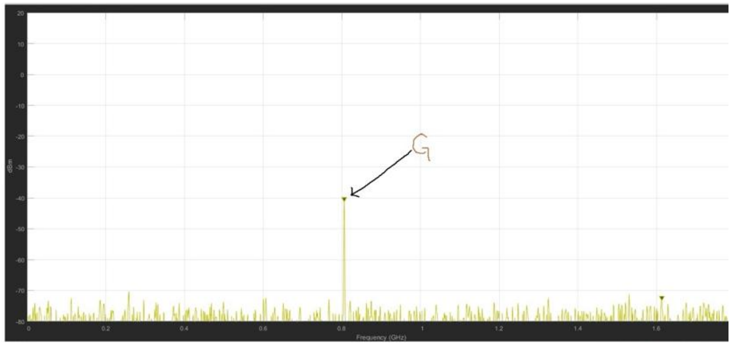


Fig. 24: When the signaling control channel jammer is deactivated for 4G 800MHZ band frequency

Fig. 24 shows the spectrum results when the control channel jammer does not distort the frequency spectrum of the 4G signaling control channel. The peak labeled G represents the signal power of the control channel in the frequency spectrum when the jammer is disabled. G= -40.21dbm.

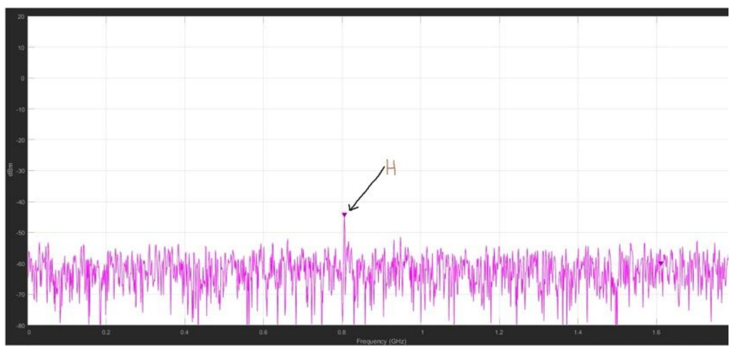


Fig. 25: When the signaling control channel jammer is activated for 4G 800MHZ band frequency

Fig. 25 shows the spectrum results when the control channel jammer distorts the frequency spectrum of the 4G signaling control channel. The peak labeled H represents the signal power of the control channel in the frequency spectrum when the jammer is enabled. H= -44.16dbm.

CONCLUSION

The results of this work show that when the system is implemented mobile phone communication services can be prioritized to suit privileged users within the mobile phone-restricted area. The above spectrum results also demonstrate that all mobile phones in the restricted area would effectively connect to our system without external network operators' interference in the restricted area.

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