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Influence of Jammers on GSM Mobile Network

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***Abstract*—Cell phone is a device that transmit signal with same frequency at which the GSM works, the jamming is achievement when the mobile in the area where jamming is placed is not working. These places comprise holy places, class rooms, libraries, performance halls, meeting rooms, and other places where silence is required. In this paper, we analyze the effect that a jammer can have on the outage probability of users based on the calculation of the effective jamming to signal ratio (JSR). This will be used to estimate how much mobile provider's companies; such as Almadar Aljadid Co.; will financially loss due to jamming effect. Simulation results show that the outage probability increased as the JSR increased, and it reaches to approximately 7.5% when the powers of both the BTS and the jammer have equal power. Same results have also been obtained for the shadowing case in which show more than 8% of the users will be out of coverage when $JSR = 0\ dB$. Simulations show also the maximum distance that the jammer can affect.**

Keywords: GSM, Jamming, Jamming Model, Shadowing Model..

I. INTRODUCTION

A basic function of the mobile jammers is to block communications between mobile and base stations [1]. Since there are different frequency bands that the mobile system use the jammers would need to jam mobiles cross over those bands successfully[4],such as GSM,WCDM and DCS[2].
Jammers may classified according to their ability to older and advanced jammers. Older jammers are limited to jam only analog or older digital mobile system. On the other band advanced jammers can work with different mobile system that work with multibit and such as GSM and CDMA[4].

Unfortunately, the use of mobile jammers would be likely to substantially interfere with or disturb public mobile services, and inturn have serious consequences on the users such as [3]

- risking the quality of the service (QoS).
- May affect the access to emergency services.
- Causing inconvenience and loss of business for mobile provider, and
- Affecting the total income of mobile service providers.

Coverage range of jammers depends on many factors: its power level, operating frequency, type of phone that wanted to be blocked and physical surrounding of jammer[4].

Many works have been introduced to study the mobile circuits as well as the jammer's effect on the mobile and communication networks. In[2] the author proposes a low cost radio frequency (RF)amplifier with less complexity using IC number Max2235 to provides same coverage as using z-RF amplifier. The problems caused by mobile jammers have studied in [4]. In this paper ,the interference of GSM and WLAN systems are analyzed with respect to the effective jamming to noise ratios[4] .

In this paper, the effect of jammers on the QoS of the mobile system, particularly GSM system is analyzed. This has been evaluated by calculating the users outage probability as shown in fig.1. Based on the free space model the effect of jammer's transmitted power on the network is analyzed for different cases such as shadowing and shadowing free channel. A 7-cell cluster is used to simulate the effect, with one jammer placed randomly inside this cluster. The received signal power from the base station is compared to that received from the jammer. In this case, the user is said to be out of coverage as long as the received power from the jammer is larger than that received from the base station. Different scenarios are simulated using Matlab and from which results are obtained for these scenarios.

The rest of the paper is organized as follows. In section II, the communication in non-jamming area is studied in the case of no-shadowing is applied. This is then followed by an analysis of the coverage range and the signal model of a mobile system with one jammer is discussed in section III. Working under shadowing model is presented in Section IV. Results obtained from computer simulations for an one jammer in a cluster of 7-cells are presented in Section V. Finally, Section VI concludes the paper.

II. COMMUNICATION IN NON JAMMING AREA

Before analyzing the impact of jamming on the communication range, we briefly review the key factors that affect packet deliveries. Essentially, signal power to jammer power ratio (SJR) associated with the bit error rate (BER) which depends on the probability that a receiver can detect and process the signal correctly. To process a signal and derive the associated bit information with high probability, the signal has to exceed the noise *i.e* the jamming signal by certain amount. Given the same hardware design of wireless devices, the minimum required surplus of signals over ambient noise is roughly the same. We use γ_o to denote the minimum SNR, the threshold required to decode a signal successfully. The communication range defines a user's ability to communicate with others, and it can be divided into two components; the hearing range and the sending range [5]

- The hearing range is the area within which the users can communicate together in any time where the jammer device working.
- The sending range is the area within which the users communicate together in any time where the jammer device not working.

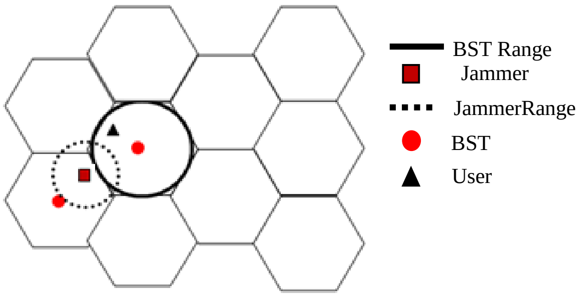

Fig.1 The sending range equal the BST range but the perfect range it difference between BST range and perfect range.

III. JAMMING MODEL

There are many different attack strategies that a jammer can perform in order to disrupt wireless communications. In this work, we focus on a representative jammer with the following characteristics.

Constant jammer: We use a constant jammer that continually emits a radio signal, regardless whether the channel is idle or not.
Omnidirectional: Each jammer is equipped with an omnidirectional antenna and transmits at the same power level. Thus, every jammer has the same jamming range in all directions.
Non-overlapping: We assume there are one or more jammers in the network, but none of their jamming regions overlap.

IV. EFFECT OFJAMMING ON THE COMMUNICATION RANGE

By applying the free-space model to a jammer, the jamming signals will also attenuate as function with the distance, similar to (BTS)signal. The place of the jammer has been chosen to be inside the cell under test, and might make its outstanding ability equal to the capacity of the base station(BTS). There for, we will examine the users within the cell under test. In this case, the power received from the jammer will be calculated and compared with that calculated from the BTS and the user will be out of service if the received power of the JTS is greater than the received power of BTS [4].

Referring to Fig.2 the effects of jamming mainly depend on JSR which can be calculated from

$$JSR = \frac{P_j G_{jr} G_{rj} R_{BU}^2 L_r B_r}{P_t G_{tr} G_{rt} R_{JU}^2 L_j B_j} \qquad (1)$$

where
P_j is the jammer power.
P_t is the transmitter power.
G_{jr} is the antenna gain from jammer to receiver.
G_{rj} is the antenna gain from receiverto jammer.
G_{tr} is the antenna gain from transmitter to receiver.
G_{rt} is the antenna gain from receiver to transmitter.
B_r is the communications receiver bandwidth.
B_j is the jamming transmitter bandwidth.
R_{BU} is the range between transmitter and receiver.
R_{JU} is the range between jammer and receiver.
L_j is jammer signal loss including polarization mismatch.
L_r is the communication signal loss.

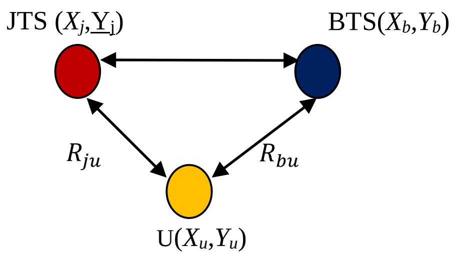

Fig.2 System Model

From Fig.2 and based on the Cartesian coordinates, distances defined as

$$R^2{}_{bu} = (X_{bn} - X_{um})^2 + (Y_{bn} - Y_{um})^2 \qquad (2)$$

$$R^2{}_{ju} = (X_{ji} - X_{um})^2 + (Y_{ji} - Y_{um})^2 \qquad (3)$$

where (X_b,Y_b), (X_u,Y_u) and (X_j,Y_j) are the cartesian coordinates of the BTS, User, and the jammer respectively. n=1,2…, m=1,2…. and i=1,2…are the identification numbers associated with BTS, user and jammer respectively.

V. COMPUTER SIMULATIONS

The effect of jammers on the performance of the mobile networks has been evaluated by means of computer simulations. The simulations are obtained for two different cases; with and without shadowing. The measured parameters that used to evaluate the performance are jammer to signal ratio (JSR) and user's outage probability.

For simulations, the following parameters are used

- Only one jammer in used.
- Signal dipole antennas with the same gains are used for all base stations, jammer and the user handset.
- A binary phase shift keying (BPSK) signal are used.
- 7 cells- cluster in employed.
- Maximum output power of each user is fixed to 2 W.
- Noise and interference free channel.
- For shadowing case model (7) is used with$\eta = 2$ and three different values of standard deviations (σ); 0,1 and 2 [6].

A. Influence Under No-Shadowing Case

In this case two measurements have been obtained by means of simulations; JSR and outage probability.

1) JSR against power of the jammer

First the JSR is measured while changing the jammer's power for four different $R_{ju}$and R_{bu}ratios based on Fig.1. Results are shown in Fig.4, and from which we can observe that as the jammer's power increased, the JSR is increased as expected. Moreover, From Fig.4 it is observed that under the given conditions, the JSR is highly decreased as jammer becomes further away than the base station from the user. The influence of jamming is likely to be more effective as the jammer becomes closer to the user.

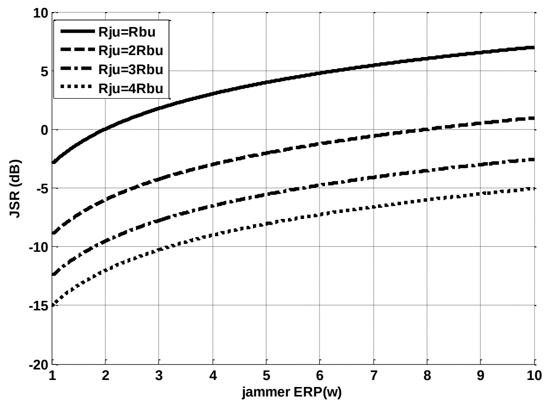

Fig. 3.The relation between the Pj(W) and JSR as (1).

2) Effect of Jammer's Position on the Coverage Area.

The effect of the position of the jammer on the outage probability will be considered in this part. Two positions for the jammer are chosen; at the border and close to the base station (within 10 meters). At each position the power of the jammer is changed while keeping the power of BTS constant to obtain JSR in the range of [-40,0]while measuring the outage probability, as well as, measuring the maximum distance (R) that the jammer can affect.

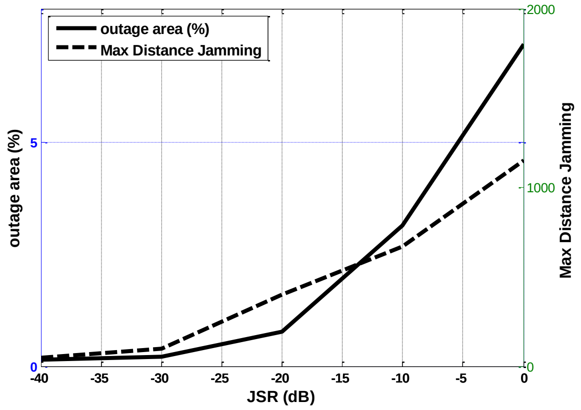

Fig. 4.The influence of the jammer's power on both the outage probability and the maximum coverage distance in a cluster that have one jammer when the jammer is fixed on the boarder of the cell.

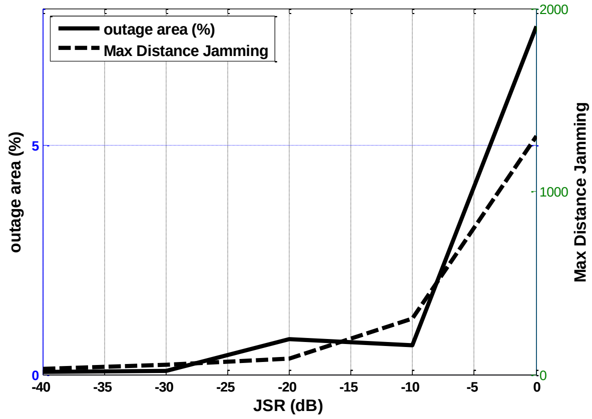

Fig. 5. The influence of the jammer's power on both the outage probability and the maximum coverage distance in a cluster that have one jammer when the jammer is close to the center of the cell.

Figs.4 and 5 show the resultant outage probability and maximum distance obtained when the jammer is fixed on the boarder once and close to the cell center in other time respectively. As shown in Figs.4 and 5, the outage probability and the maximum distance are increased, as expected, as the jammer's power in increased.

As shown in Fig. 3 that, the outage probability will gradually increase when the power of the jammer is bigger than -30 dB. However, in Fig. 4, this increase will start beyond -10 dB. The results are approximately similar for the case of measuring the maximum distance that the jammer can cover.

Focusing on the losses due to jammers, we can notice from Fig.3 that the outage probability will be around 5% when the jammer's power is equal to half of the base station's power.

Therefore, we expect that for each jammer in a cell, 5% of the users in side this cell will lose their communication.

A. Performance under shadowing

In this case, the influence of the jamming has been evaluated in terms of the outage probability under the shadowing channel as a function of the standard deviation (σ). This has been evaluated when the jammer is fixed at the boarder once, and close to the base station next time.Fig.6 shows the resultant of the outage probability and as expected, we can notice as σ increased the outage probability will increase too. For example, when $\sigma = 1$,the outage probability reaches to 7.7% for center position and 7.5% for corner position.

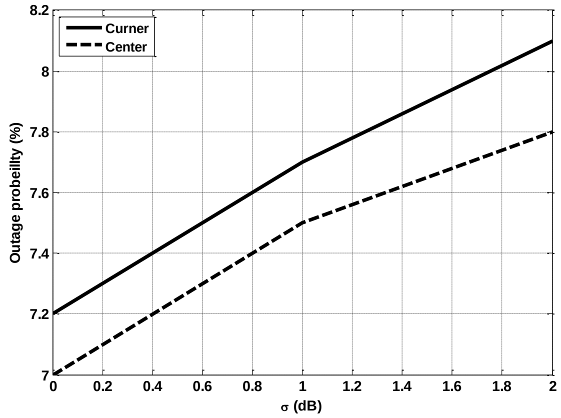

Fig.6effect of shadowing on the coverage area

VI. CONCLUSION

As it well known, the performance of the mobile networks is decayed in the presence of mobile jammers because of the interference with the normal operation of the network. In this paper, the effect of jamming on the mobile network was studied by monitoring the outage probability of users as well as the maximum distance that the jammer can affect. The outage probability was studied to emphasis the losses that the mobile provider such as Almadar Aljadid Co. may face. This effect has been mathematically analyzed for shadowing and no shadowing cases.

Simulations have shown this effect as a function of the jammer's power and jammer's position for the two cases. The results show that the outage probability depends on the jammer's power more than on the position of the jammer for both shadowing and no-shadowing cases.

More research has to be clone to evaluate the effect of the jammers on the mobile network when more than one jammer in used, as well as, for noisy and interfere channel.

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