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Boosting Network Functionality of a communication System Using Smart Antenna

[1]Ngang Bassey Ngang, Department of Electronic and Computer Engineering, Veritas University, Abuja, Nigeria.

[2]Bakare Kazeem, Department of Electrical and Electronic Engineering, Enugu State University of Science and Technology, (ESUT), Nigeria

[3]Anthony Lordson Amana, Department of Electronic and Computer Engineering, Veritas University, Abuja, Nigeria.

[4]Fidelis I. Onah, Department of Electronic and Computer Engineering, Veritas University, Abuja, Nigeria.

Abstract

Consumer and customer discontent as a result of poor and uneven network performance in some multimedia networks and applications has resulted in low consumption of those services. This has resulted in the closure of several of these businesses because their subscribers are no longer prepared to pay for them. This necessitates an increase in network performance through the deployment of smart antennas, as this will improve the network quality observed in these businesses. The network understudy must be characterized, the congestion, fading, and interference components must be analyzed, and the bit error rate and attenuation from the characterized network must be determined in order to accomplish this general increase in network performance. The network results are utilized to develop an optimized smart antenna rule base that will improve network performance, as well as a Simulink model that will be used to justify and validate network performance with and without Smart Antenna. The maximum conventional congestion was 3.996, and the Smart Antenna congestion was 0.6434. When Smart Antenna is included in the system, however, the percentage improvement is 59.87 percent. With these findings, it will be demonstrated that, in contrast to the typical approach, deploying Smart Antenna in a Multimedia Network System improves network quality.

Keyword: Improving, Network Performance, Multimedia, Application, Smart Antenna

Introduction

The transfer of information or power between two or more nodes that are not connected by an electrical conductor or wire is known as wireless communication. Wireless communications enable services and capabilities that would be impossible or prohibitive to implement using electrical cables, such as long-range communication. Cellular networks have been designed and optimized to handle ever-increasing amounts of mobile data, but a new class of machine-centric communications applications has emerged in recent years. [1] They all work by broadcasting or transmitting electromagnetic signals through the physical environment or atmosphere by an enabled device. When all appliances are connected to a common Wi-Fi network, improvement in signal propagation is also necessary. Wireless technology is gaining traction and is used in small areas or constrained premises when all appliances are connected to a common Wi-Fi network. [2]

Signals in wireless communication travel along multiple pathways to reach the receiver, which is known as multipath. The signal propagation process that results in the receiver receiving radio signals via two or more paths or ways is known as multipath. According to the research, the number of internet-enabled devices is steadily expanding [3]. The huge amounts of data generated by these devices are becoming increasingly challenging to collect and analyze. The edge computing paradigm is gaining traction, allowing data to be processed close to the point of origin. Ionospheric reflection, atmospheric scattering, reflection from aquatic bodies, and reflection from terrestrial objects such as buildings and mountains are all causes of multipath.

Wireless communication technology sends data over the air using electromagnetic waves like infrared and radio. When considering frequency, the frequency and satellite of the term come to mind. It's important to remember that GPS, Wi-Fi, and other related technologies are all available. Wireless computers, satellite television components, and 3G and 4G cellular phones A network, such as Bluetooth, is a good example [4]. Worldwide, wireless cellular networks are quickly expanding, and this trend is expected to continue for several years. Radio technology advancements enable new and improved services. Wireless services now include phone, fax, and low-speed data transmission. In the future, more bandwidth-intensive interactive multimedia services such as video-on-demand and internet access will be supported.

Aim of the work

This paper is about improving network performance in telecommunication company network using smart antenna.

The study objectives the objectives are stated in behavioural terms and when followed sequentially can lead to the successful realisation of the aim; hence, specifically the purpose is to

- Collect the network parameters and tabulate and characterize. Evaluate the congestion, interference, bit error rate and attenuation from the characterized network that caused the network failure.
- Determine the throughput and signal to noise ratio from the characterized network that reduces network performance
- Optimize the results obtained for network performance
- Design a Simulink model that will be used to justify and validate network performance with and without Smart Antenna.

A closer look at previous related works

Wireless network transmission applications have seen a surge in popularity. The demand for high-speed wireless communication continues to rise. Antenna technology is an important part of wireless communication progress [5]. One proposed solution is to apply artificial learning approaches to help enhance antenna technology, which is currently limited. It's based on a learning antenna that adapts as it travels. It paved the way for signal intensity adjustment to improve wireless transmission efficiency [6]. Although there are a variety of adaptive antenna structures available, such as diversity antennas, phased array antennas, and beamforming specialized learning methods, this study focuses on smart antenna characteristics to improve performance. Antenna diversity is a technique for reducing the effects of channel fading in wireless networks.[7] Wireless communication technology uses electromagnetic waves such as infrared, radio frequency, and satellite to send data over the air. GPS, Wi-Fi, satellite television, wireless computer parts, wireless phones with 3G and 4G networks, and Bluetooth are just a few examples

The underlying notion behind space diversity is that if many replicas of the same information-carrying signal are received via several branches with equal intensities and independent fading, there is a good chance that at least one (or more) of them will not fade at any one time. Diversity branches are useful when a receiver has two or more antennas that are suitably spaced (usually several wavelengths). Because diversity branches tend to fade individually, correct branch selection or combining improves connection reliability. To secure link margins without diversity, more transmit power is required to prevent against deep channel fades. As a result, at the user terminal, diversity at the base can be exchanged for lower power consumption and longer battery life. Most telecommunication companies are unable to guarantee complete free and high-quality communication network service; in recent years, there have been instances of unsatisfactory service delivery; this problem can be traced to a lack of a free and high-quality network, which arose as a result of a failure to monitor when the bit error rate is high. [8] Reduced transmit power also reduces co-channel interference while increasing system capacity. When radio waves impinge on the antenna array with enough angle spread, independent fading across antennas is conceivable. [[9], stated that wireless networks must be able to provide these services in a variety of settings, including densely populated urban, suburban, and rural locations. Various mobility requirements must also be met. Fixed subscribers are served by wireless local loop networks. Pedestrians and slow-moving users are served by microcellular networks, whereas high-speed vehicle-borne users are served by macro cellular networks. For terrestrial networks, several competing standards have been created. A first-generation frequency division multiple access analog cellular system is the AMPS (advanced mobile phone system). GSM (Global System for Mobile) and IS-136, which use Time Division Multiple Access (TDMA), and IS-95, which uses Code Division Multiple Access (CDMA), are examples of second-generation standards (CDMA). The third generation standard, IMT-2000, is expected to use either wide-band CDMA or TDMA technology.

Materials And Methods

The methodology to implement the stated objectives starts with the evaluation of the following:

The congestion, interference, bit error rate and attenuation from the characterized network that cause network failure.

The mathematical model for congestion control in improving network performance in multimedia application using smart antenna is as shown in equation 2

$L = 8/\ 3W^2$ 1

Where L is packet loss

W is the network congestion

Then, make W the subject formula in equation 1

The mathematical model for congestion in the network is as shown in equation .2

W = Square root of 8/3L .2

To find the network congestion in 12.00 AM

W1 = square root 8/ 3 x 0.8

W1 = square root 8 /2.4

W1 =$\sqrt{}$ 3.33

W1 =1.82

To find the network congestion in 1.00 AM

W2 = square root 8/3 x 0.833

W2 = 8 / 3 x 0.833 = 8/2.499

W2 =√ 3.20

W2 = 1.79

To find the network congestion in 2.00 AM

W3 = Square root of 8/ 3 x 0.7

W3 = square root of 8/ 2.1

W3 = √3.81

W3 = 1.95

To find the network congestion in 3.00 AM

W4 = Square root of 8/ 3 x0.556

W4 = square root of 8/ 1.668

W4 = √4.796

W4 = 2.19

To find the network congestion in 4.00 AM

W5 = square root of 8/3 x 0.5

W5 = Square root of 8/ 1.5

W5 = √5.33

W5 = 2.31

To evaluate the bit error rate in 12 A.M when the packet loss is 0.8.

Make BER the subject formula in equation 3.3

BER1 = PER/8 × MTU × 1.03125 3

BER1 = 0.8/8 x 12000 x1.03125

BER1 = 0.8/9900

BER1 = 0.000081bits

To evaluate the bit error rate in 1.00 AM when the packet loss is 0.833.

BER2 = 0.833/9900

BER2 = 0.000084bits

To evaluate the bit error rate in 2.00 AM when the packet loss is 0.7.

BER3 = 0.7/9900

BER3 = 0.000071bits

To evaluate the bit error rate in 3.00 AM when the packet loss is 0.556.

BER4 = 0.556/9900

BER4 = 0.0000562bits

To evaluate the bit error rate in 4.00 AM when the packet loss is 0.5.

BER5 = 0.5/9900

BER5 = 0.000051 bits

To determine the throughput and signal to noise ratio that reduces the network performance from the characterized network

To evaluate the throughput

Throughput1 = file size/ transmitted time 4

Throughput 1 = 12/2 = 6bps

Throughput 2 = 14/3 = 4.7bps

Throughput 3 = 16/2 = 8bps

Throughput 4 =18/4 = 4.5bps

Throughput 5 = 14/3 = 4.7bps

Designing of an optimized smart antenna rule base that would enhance the network performance.

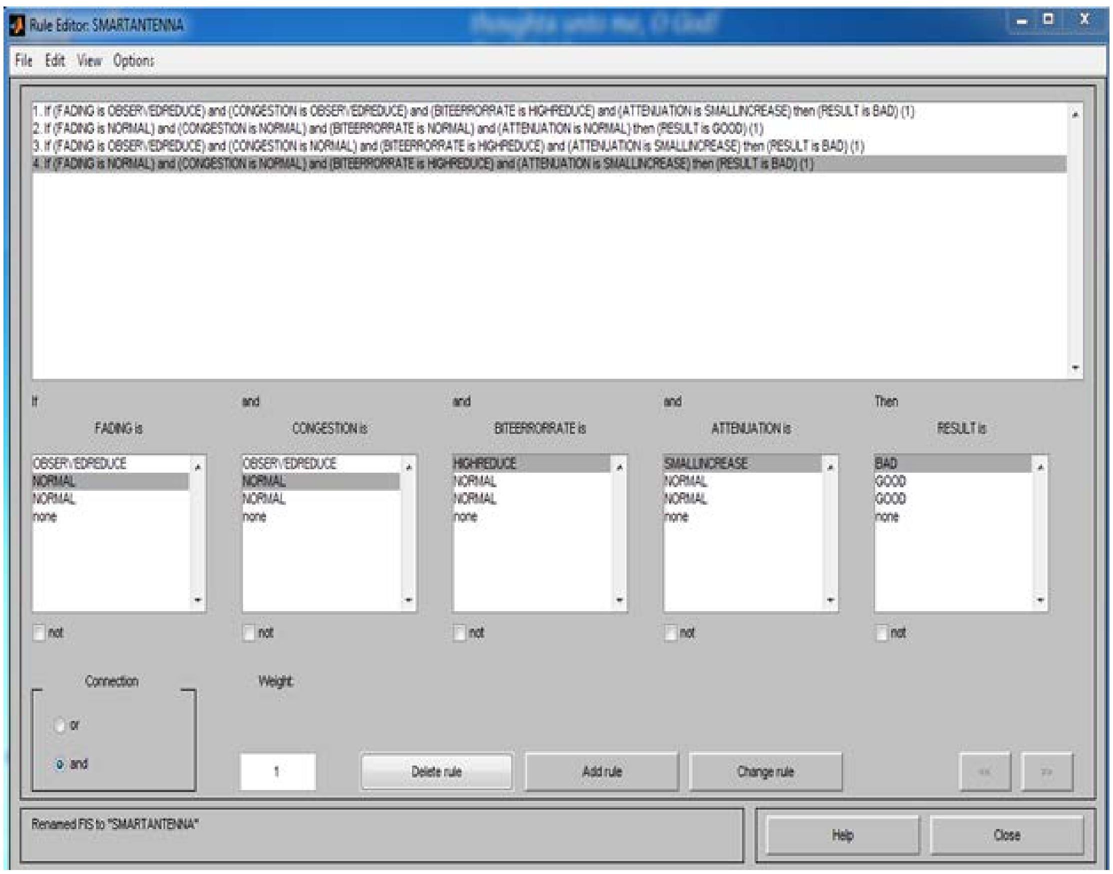


Fig 1 Designed optimized smart antenna rule base that would enhance the network performance. The rule bases are four in number.

Table 1: Optimized smart antenna rule base

If fading is observed reduce	And congestion is observed reduce	And bit error rate is high reduce	And attenuation is small increase	Then result is bad
If fading is normal	And congestion is normal	And bit error rate is normal	And attenuation is normal	Then result is good
If fading is observed	And congestion is normal	And bit error rate is high reduce	And attenuation is small increase	Then result is bad
If fading is normal	And congestion is normal	And bit error rate is high reduce	And attenuation is small increase	Then, result is bad

Designing a SIMULINK model for improving network performance in multimedia application using smart antenna.

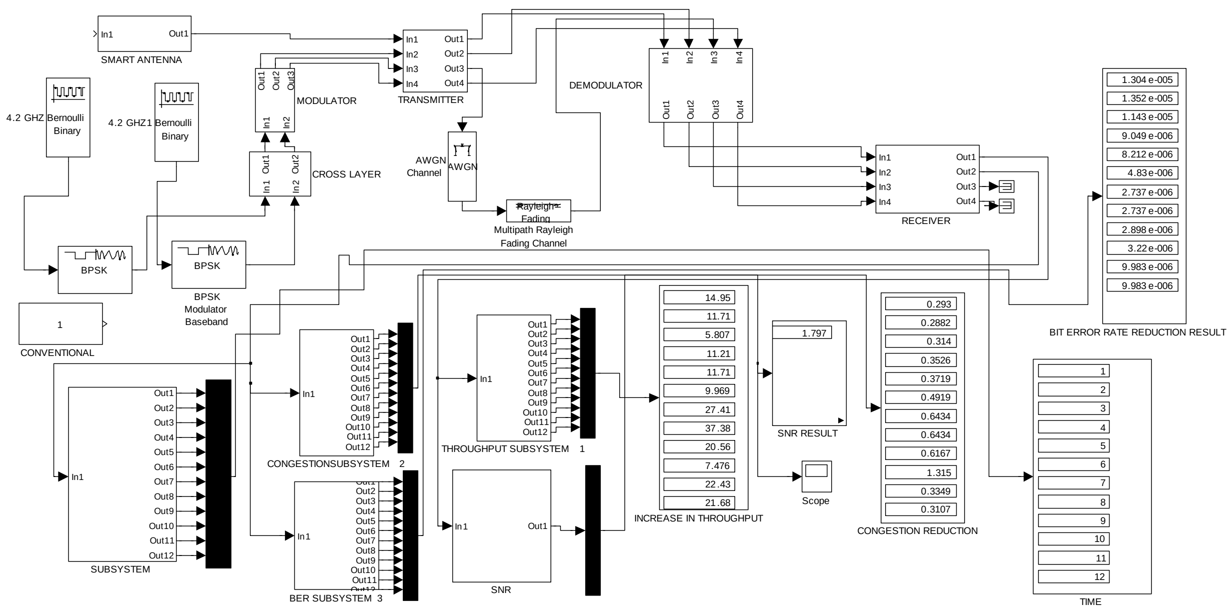


Fig.2: Designed SIMULINK model for improving network performance in multimedia application using smart antenna.

Discussion of Result

The following are the simulated outcomes from the task conducted in the technique section:

Figure 1 shows a smart antenna rule base that has been built to improve network performance there are four different rule bases. A SIMULINK model for increasing network performance in multimedia applications utilizing smart antenna is shown in Fig 2. Figures 3, 4, and 5 show a complete study of the simulated findings, accordingly. Figure 3 illustrates that the largest conventional congestion occurred at (3.996, 7) whereas the smart antenna congestion occurred at (3.996, 7). (1.316, 10). As a result of these findings, the smart antenna technology has less congestion than the traditional way.

Table 2: Comparing conventional and smart antenna congestion

Time(S)	Conventional Congestion	Smart Antenna Congestion
1	1.82	0.293
2	1.79	0.2882
3	1.95	0.314
4	2.19	0.3526
5	2.31	0.3719
6	3.055	0.4919
7	3.996	0.6434
8	3.996	0.6434
9	3.83	0.6167
10	3.65	1.316
11	2.08	0.3349
12	1.93	0.3107

Fig 3: Comparing conventional and smart antenna congestion

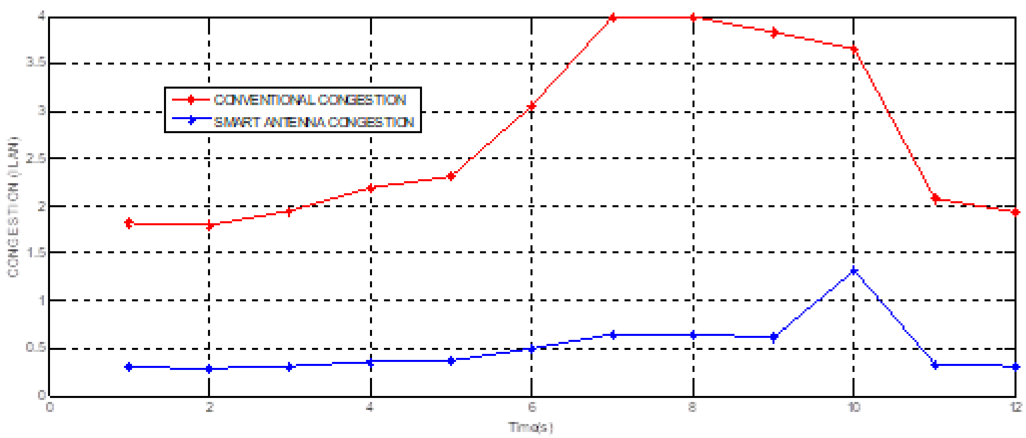


Table 3: Comparing conventional and smart antenna bit error rate

Time(S)	Conventional Bit Error Rate	Smart Antenna Bit Error Rate
1	0.000081	0.00001304
2	0.000084	0.00001352
3	0.000071	0.00001143
4	0.0000562	0.000009049
5	0.000051	0.00008212
6	0.00003	0.0000483

7	0.000017	0.000002737
8	0.000017	0.000002737
9	0.000018	0.000002898
10	0.00002	0.00000322
11	0.000062	0.00009983
12	0.000062	0.00009983

Fig 4: Comparing conventional and smart antenna bit error rate

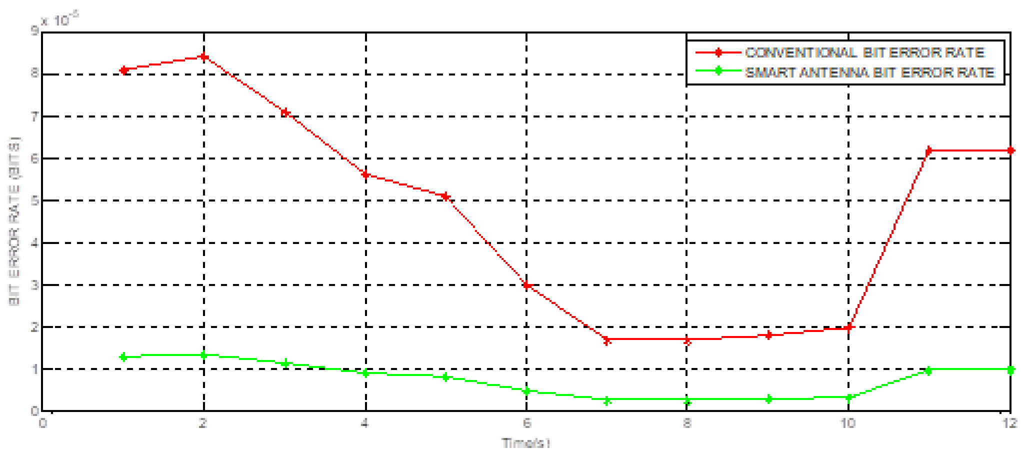
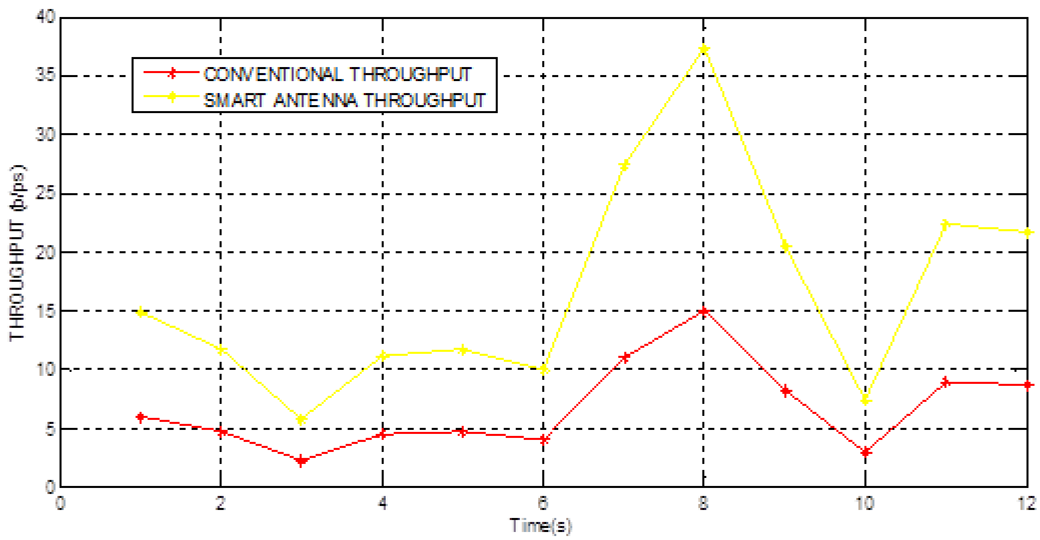


Table 4 Comparing conventional and smart antenna throughput

Time(s)	Conventional Throughput	Smart antenna throughput
1	6	14.95
2	4.7	11.71
3	2.33	5.807
4	4.5	11.21
5	4.7	11.71
6	4	9.969
7	11	27.41
8	15	37.38
9	8.25	20.56
10	3	7.478
11	9	22.43
12	8.7	21.68

Fig 5: Comparing conventional and smart antenna throughput



Conclusion

The problem of not having a quality network in our communication network has become a very big problem in our society and the country at large. This work has presented a systematic approach to achieving improvement in the quality of information transmission using Smart Antenna; the use of smart antenna in the network could help to reduce this endemic complexity. It can be accomplished by following the stated objectives, which include characterizing the network under study, evaluating the congestion, interference, bit error rate, and attenuation from the characterized network that caused the network failure, determining the throughput and signal to noise ratio from the characterized network that reduces network performance, optimizing the results obtained for network performance, and designing a SIMULINK model.

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