Performance Comparison of Centralized and Distributed Antenna System in 5G

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Abstract. The usage range of nowadays wireless communications become wide, all of the develop applications uses wireless communication which improve the mobility and improve the mobility of the network subscribers. As known that the antenna diversity scheme developed from “SISO” to “MIMO” that has a maximum capacity and ability to improve the communication quality with a good shields among the fading effects and other impairments. In this research work study and analysis to the antenna systems and antenna schemes was done taking into consideration the central antenna system and the distributed antenna system “CAS” and “DAS”. A Matlab simulation was developed to test antenna configuration system in term of effeteness of fading channel while using different modulation order.

1. Introduction

As known that the wireless networks handle considerable growth of data broadcast cause of the number of developing applications that includes machine-to-machine (M2M) communications systems and video streaming over network [1]- [4]. Due to the very huge volume of data exchanged is likely to continue and increase in the next period or so, presenting a very important task to inventors of “5G” systems [4]. In particular, “MIMO” signal processing will have a vital role in dealing with the impairments of the physical medium and in providing cost-effective tools for processing information.

Problem Definition

The Massive “MIMO” technology was designed for reducing the effects of fading among the communication channel, two main techniques used in massive “MIMO” technology “CAS” and “DAS”, the problem is the efficiency of the two techniques among the antenna configuration while using the fading channel and also the optimal required power to enhance the performance of the network with the reliable power and “QoS” parameters. The objective of this paper focus on simulating the antenna systems “CAS” and “DAS” and evaluate the performance while using different modulation order and applying fading Rayleigh channel. “QAM” modulation was chosen because it is one of the modulation techniques that supported by the “5th” generation.

Methodology

The methodology starts from simulating of the system using Matlab simulation software cover a full study to the antenna systems including the centralized antenna system “CAS” and the Distributed Antenna System, and “DAS”.

In the following table a set of parameters that used to adjust the simulation environment including the number of element used, modulation type and the antenna system scheme used.

| Parameter          | Value/Description |
|--------------------|-------------------|
| Number of Elements | 64 elements       |
| Modulation Type    | 8-256 “QAM”      |
| Antenna Diversity  | “MIMO”            |
| Scheme          | Scenario Area 1k x 1k |
|----------------|----------------------|
| Noise AWGN     | 0 to 20 SNR adjusting |
| Fading Effects | Rayleigh Fading      |
| Antenna System | “CAS”                |

In the following table a set of parameters that used to adjust the simulation environment including the number of element used, modulation type and the antenna system scheme used.

**Table 2. Scenario (II) Parameters Used:**

| Parameter                  | Value/Description |
|----------------------------|-------------------|
| Number of Elements         | 64 elements       |
| Modulation Type            | 8-256 “QAM”       |
| Antenna Diversity Scheme   | “MIMO”            |
| Scenario Area              | 1k x 1k           |
| Noise AWGN                 | 0 to 20 SNR adjusting |
| Fading Effects             | Rayleigh Fading   |
| Antenna System             | “DAS”             |

**Mathematical Model**

**Fading Rayleigh**

The mobile antenna, instead of receiving the signal over one line-of-sight path, receives a number of reflected and scattered waves. The phases are random, and consequently, Because of varying path multi-length, the instant established power become an arbitrary number. However, signal that sent at frequency “ωc” connected to the source via a multi roads, the “ith” road that have an amplitude “ai”, as well as a phase “φi”. If presumed which there is no straight road of sight “LOS” element, the target signal “s(t)” may be expressed as

\[
s(t) = \sum_{i=1}^{N} a_i \cos(\omega_c t + \phi_i) \quad (1)
\]

where “N” is the number of roads. The cycle “φi” based on the difference path lengths, changing by “2π” when the road length variations by a wavelength. Therefore, the phases are consistently dispersed over “[0,2π]”. When there is virtual motion between the transmitters to receiver.

**Signal to Noise and Bit Error Rate**

\[
BER = \frac{\text{Number of Error Bits}}{\text{Total Transmitted Bits}} \quad (2)
\]

Fig1: system flowchart of antenna system
Computer Model
The flowchart of the simulation starts with generating random data and setting the number of transmitters and receiver elements. Then, a “16QAM” was used to modulate the data, and noise was inserted to simulate the real noise environment. The system was then evaluated in terms of required power after the simulation time was ended.

Simulation Results of Discussion
In Fig. 2, an analysis of the signal to noise ratio vs. the bit error rate was shown while using different modulation orders. It was found that increasing the signal to noise ratio decreases the bit error rate, and “CAS” requires less power compared to the Fig. 3, with a difference of 18% in power.

![Fig 2: “SNR” vs. “BER” in “CAS”](image)

In Fig. 3, an analysis of the signal to noise ratio vs. the bit error rate was shown while using different modulation orders. It was found that “DAS” requires high power and still has a high bit error rate compared to “CAS,” occurring due to the number of channels used in the distributed and centralized systems. The percentage is around 22%.

![Fig 3: “SNR” vs. “BER” in “DAS”](image)

It was found that as usual, increasing the signal to noise ratio decreases the bit error rate and increasing the modulation order increases the required power to achieve an ideal and optimal bit error rate. It was found that the centralized antenna system requires less power while the distributed requires high power.

Conclusion
As a conclusion, the centralized antenna system has a good performance in the communication system while meeting fading effects in the “CAS” by 11.5% not recovered and for the “DAS” is 24% not recovered. It was concluded that the “CAS” has an increased performance with 12% higher compared to the “DAS.” The distributed may have a problem of pathloss which affects the network performance and increases the bit error rate. Increasing the power is not an optimal solution since the antenna may have a maximum power gain limit that can be handled. A buffering stage can be used to collect information through a distributed antenna system but it will increase the delay time.
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