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A STUDY OF BANDWIDTH CONSUMPTION GAINS FOR IMPROVING SMART GRID QoS

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ABSTRACT

Recently, the smart network performance is great significance in quality of service. When the Energy server provider requires several types of information signals with different requirements from all nodes it manages. these signals will meet some interference when sent in view of the limitation of bandwidth for wireless technologies. To insure from receiving information signals its required suitable modulation schemas Proportional to hugging data signals whereas any wireless communication technology performance depends firstly on bandwidth factor and latency. This paper explains bandwidth consumption gains (BCG) to match the appropriate communication technologies that enhance the QoS of Smart Grid.

KEY WORDS: *Smart Grids, Different Communication Technologies,Bandwidth, Latency Factor, Different Nodes, Bandwidth Consumption Gain (BCG), Energy Service Provider (ESP).*

Article History

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1. INTRODUCTION

Contemporary issues, to get over problem of increasing demand in traditional power grid, that requires development of electrical network elements itself and using smarter technology's. Energy Service Provider (ESP) considers the main unit that control and manage all procedures performed in smart grid (Smart grid promotes the power reduction breakaway, customer's power transmission cost reduction, and trust reliance, reduce carbon dioxide spreading, using electrical vehicles, more security and reliability etc.). increasing nodes number in smart grid and resources demand and response time requirements are critical [1, 2]. In addition, insufficient spectrum is gaining great attention in new research due its exponential increasing demand each node with Smart Grid send a detailed report of its electrical power information to the Energy Service Provider (ESP) (requests / responses, such as command control and dynamic consumption costs.......etc). where (ESP) enables all nodes to connect, coordinate and manage all requests, needs, and demands in satisfactory manner. But during propagation process transmitted signals will meet some obstructions until they are received through different Communication channels. so smart grid ensures quality of service using various modulation schemes within the communication network. Modulation scheme over different channel effects on the received data rate, therefore the selection of modulation schemes with Smart Grid is more definitive. We note recently some of researchers try to recommend some solutions for QoS problems in different parts of Smart Grid. Most of them focus on proper communication infrastructure of network architecture, determining security problems and how to handle them, etc. Wireless network based on wireless technologies becomes an important issue [1], so we first take a brief of obstructions of signal propagation Which obscures the route of the main signals from transmitter to receiver and effects on modification schemes in Smart Grid during signal reception. Finally, a study of how bandwidth for each node effects on maximizing resources efficiency with respect Smart Grid requirements is performed.

studying Bandwidth Consumption Gain (BCG) helps to achieve this objective which considers the main item in the improving QoS of smart grid. This paper organized as following : background and associated works are viewed in Section II, but signal propagation and Channel Capacity are explored in Section III. In Section IV, demonstrates particular analysis of Bandwidth Consumption Gain. Finally, simulation finalize and conclusion will be advance in Section V and Section VI respectively.

II. Background and Associated Works

In [3] Referred to increasing capacity of wireless channel. Capacity is uttered as the maximu m rate of achievable data for an arbitrarily low error probability. Hence, the trend was to develop symbols and schemes that would enable systems to approach Shannon capacity limit. Where increasing the maximu m transmission rate as in [4], requires with small error probability and increases system capacity linearly. [5,6] Explores tradeoff of intensive bandwidth Antenna Relay Networks, based on formation of multi-antenna relay package, concentrating in the first place in enhancing spectral efficiency. The QoS mechanism for network communication system is recommend to smart grid for quality of service as time delay are explored. The greed routing algorithm of rapid routing with smart grid is represented on basis of QoS requirements and its performance by simulation. In [5] The delay and performance of smart network for wireless network protocols has been improved by providing variety of services to different priority directions, distribution network sends data collected to the sink by IEEE 802.15.4 protocol. Two types data are reported: operational and emergency data. Operational data and emergency data are included with top priority list. Emergency data interrupted the service belongs to operational data and get the same service. Given the defined access rate and the length list, a delay model proposed for improving QoS as a model for the channel time and packets sent successfully is suggested. In [6,7] by using this strict priority list, requirements of QoS are discussed. [8] Briefly reviews QoS requirements with Smart Grid then discusses problems in determining QoS requirements. [9]. It is believed that due to existence of various communication networks with the smart network, quality of service is required Therefore, it represents a queue form with some input queues and some output queues. Input queues consist of buffers that relate to smart network services with different QoS requirements, and output networks show different options for packet delivery. Finally, the optimization algorithm was used based on scheduling packages for queue and output status while trying to ensure QoS quality for input queues. The utility has charted Automatic Meter Management System (AMM) based on narrow-band PLC using frequency Shift key (FSK)and binary phase-shift keying (BPSK) modulation schemes [10,11]. This causes the non-accuracy, non-adjusted data rate and uncontrolled in real time of the information system due to relation between latency and bandwidth. Distributed power connection systems and a path that is theme to many additional QoS constraints in connection with intelligent network communication requirements [12-16].\

We will provide how to increase smart grid QoS by studying the propagation of signals on two different channels, and the spectrum has become a rare source due to increasing speed of demand, we use multicarrier to work around this problem, to increase capacity of channels and occupy entire bandwidth available. Finally, We study how bandwidth affects resource efficiency for each node while respecting smart grid requirements [17].

III. SIGNAL PROPAGATION AND CHANNEL CAPACITY

On account of bandwidth requirements and latency for smart grid are two very definitive items so quality of service with smart grid demonstrated essentially [18]. As shown with Fig. 1 Smart Grid contains several units which are connected together and supervised by ESP, where each node sends a detailed report of their electrical power information through wireless communication channels [18-19]. Wireless communication systems performance is greatly affected by wireless channel. Unlike the fixed and expected characteristics of a wired channel, wireless channel is rather dynamic and unpredictable, making accurate analysis of wireless system very difficult. Recently, the improvement in the wireless communication systems has become critical with rapid growth of telecommunications services and emerging broadband mobile access services. In fact, the understanding of wireless channels will dispose the organization for development of high-performance wirelesstransmission technology and band width. In radio communication, radio propagation refers to radio waves attitude when it is deployed from transmitters to receivers. In the context of propagation, they mainly influenced with different types of physical phenomena: reflection, diffraction and dispersion, which is called fading. When any node with Smart Grid send a massage to ESP these massages signal will meet some distortion and delay.

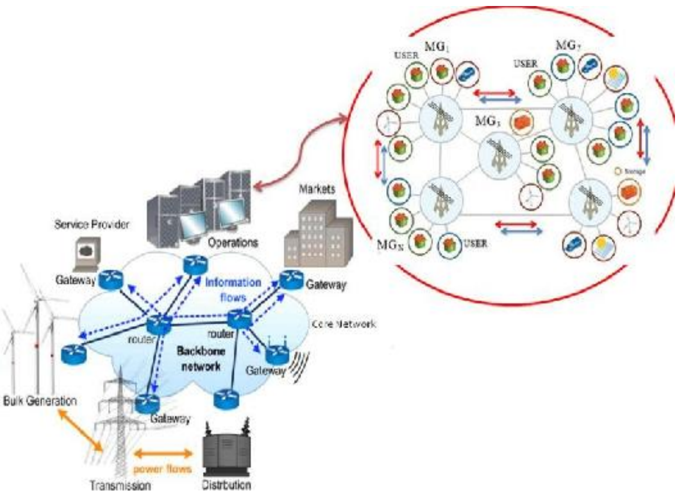

Figure 1: Smart Grid Constructions.

In general, propagation environments may be subject to any LOS (line of sight) or NLOS (non-line of sight) wireless channel. Therefore, the probability density function of received signals in LOS environment related to Rician distribution, whereas in NLOS environment related to Rayleigh distribution. Any received signal with propagation environment for wireless channel is the sum of received signals from infinite number of scatters. System capacity (bit/s/Hz) is defined by max transmission rate if a small error is possible. The system capacity linearized by setting up multiple sub-channels of space that is defined as per **Shannon's theorem**: by

$$C = B \log_2(1 + S/N) \text{ bps} \quad (1)$$

where C is capacity in (bps, B is channel bandwidth in Hertz, *(S/N)* is signal-to-noise ratio carried per unit time of a signal on the channel. The information rate finding we require the estimation of how many messages carried for each unit time with a signal on the channel that eatimatly equal $T= 0.5B$ when using LPF. Then the message rate is given as:

$$r = \frac{1}{T} = 2B \quad massage/sec.$$

Efficiency of the bandwidth distinguishes the efficiency of any system by specifying the allocated bandwidth which is defined as

$$\eta = \frac{\text{Transmission Rate}}{\text{Channel Bandwidth } (B)} \quad \text{Bit/ S/ Hz} \tag{2}$$

$$\eta_{max} = \log_2(1 + S/N) \tag{3}$$

Shannon's theory is not constructive proof - it's just a guide provides for such a coding method. Therefore, the demonstration not used for development coding method that reaches the channel capacity. Especially if $R > C$, where R is the transmission rate in bps and C channel capacity, then errors can not be avoided regardless of the coding technique used If the $S = RE_b$, Where E_b is energy per bit [18]. so

$$\frac{\text{no. bits transmitted / symbol}}{\text{symbol duration}}$$

And N is total noise power $= BN_o$ So

$$\eta_{max} = \log_2 \frac{(1+RE_b)}{(BN_o)} \tag{4}$$

$$\frac{E_b}{N_o} \geq \left(\frac{2^{\eta_{max}} - 1}{\eta_{max}} \right) \tag{5}$$

From the previous equation, the system has improved maxchannel capacity, which requires an increased transmission rate for information and improving communication systems reliability. This achieved by enhancing information redundancy in maintaining the rate of transmission of information and overcoming the fading problem by re-transmitting signals. When transmitted signals for each node arrives from the receiver (EPS) and vice versa, with multi paths, extracting original signals at receiving end becomes more difficult. Especially when the signal transmitted at time intervals T, then delayed by tm, because of their long path, this creates the signal fluctuation with the previous by tm/ T, so to overcome this signal fluctuation, the signal is transmitted with different frequency subcarrier (OFDM) is a special form of multi-carrier modulation : dividing available bandwidth to number of Sub-channels, each one is orthogonal to another and used for improving smart grid QoS and maximizing the system efficiency. From the above we note that the bandwidth is a critical factor with each node with smart grid studying Bandwidth Consumption Gain (BCG) helps to fulfillment this goal, where any wireless communication systems performance Bandwidth Consumption Gain (BCG) depends on two parameters: Required data rate, or BW, and delay factor. BCG is a comparison between two systems where B1 (taken as system indication, and B2 is the proposed system) [19,20].

$$\text{BCG} = \frac{B1}{B_2} \tag{6}$$

IV. BANDWIDTH CONSUMPTION GAIN

An evaluation method is needed to allocate appropriate communication resources for different nodes in smart grid that are used as a indication for QoS factor. To achieve this, a convenient (Bandwidth Consumption Gain (BCG)) is introduced for managing resources distribution policy for different nodes. To achieve this, several factors should be discussed using network bandwidth and their latency factors, then data rates required for all nodes is divided by each communication technologies data rate applied for wireless network, where bandwidth for each node is defined as

$$B_n = \frac{R_{ni}}{\max_m(R)} \tag{7}$$

where R_{ni} is data rate needed by node i, max(R) is the max required data rate from all Smart grid nodes? where the latencyfactor for node i is defined as:

$$f_n = 1 - \frac{\max(f_{ni})}{\max_m(f)} \tag{8}$$

Where max(f_{ni}) is maximum latency of node i and (max (f)) m is maximum value between all nodes. The communication technologies that support a certain type of smart grid nodes and achieve Max Bandwidth Consumption Gain (BCG) is the best choice. Therefore, the node with the highest difference between delay requirements and delay of custom communication technologies, has a higher value [21]. As aforementioned above, the nodes with lowest rate have the lowest appreciate, So the bandwidth value for the node i tonetwork bandwidth is:

$$B_{Net} = \frac{R_{ni}}{R_{Net}} \tag{9}$$

Where $RNet$ is the proportional rate for certain fixed of bandwidth. Where latency for node i, to network latency, can be defined as:

$$f_{Net} = 1 - \frac{\Sigma_m(f_n)}{\max(f_{ni})} \tag{10}$$

The communication networks that have the latency factor higher than maximu m delay factors for nodes are cancelled where eq. (9), its value is negative

$$\text{BCG} = \frac{(B_n * B_{Net}) + (f_n * f_{Net})}{(B_n + f_n)} \tag{11}$$

V. SIMULATION RESULTS

QoS is a gravity topic specially when using wireless communication technology to communicate all nodes with each other, so when all nodes send all reports to ESP the communication process is influenced by some factors (where transmitted signals distorted due to propagation environment that causes some fading with signal here we study signals under two type of fading channel, Rayleigh and Rician fading channel. Due to the fading process that blocked the signal from reaching. due result of huge signals intended to be confirmed on time with limitation in communication technologies bandwidth of smart grid we used OFDM as a modulation scheme that handle these huge data and enhance Smart Grid QoS. The other factors that evaluate the grid performance is max Bandwidth Consumption Gain (BCG). which explains relation between bandwidth and latency with each node at different communication technologies used with smart grid to insure each one is the best.

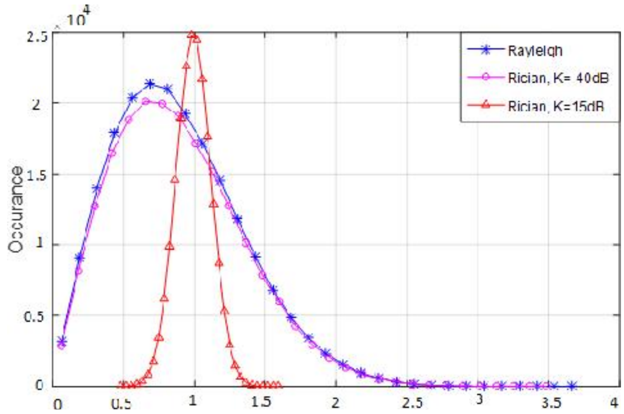

Figure 2: Rician and Rayleigh Fading Comparison

Figure 2 demonstrates that Rician distribution approaches Rayleigh distribution and Gaussian distribution when k= -40d B and k=-15dB, respectively. In case existing an LOS component (i.e., k=0), and with decrease the K factor the Rician distribution approaches Rayleigh, as K is Rician factor, defined as a ratio ofspecular component power C^2 and scattering component power $2\sigma^2$.

Figure 3 show that: Due to limitation in communication technologies bandwidth with smart grid we used OFDM as a modulation scheme that handle these huge data and overcome the fading Phenomena, where OFDM signals formed of N sub- carriers, which are sent with an equal break for each carrier, a value is null at the central frequency of the adjacent carrier, leading to disappearance interference between carriers. with increasing sub-carriers' number, BER (bit error rate) decrease that confirms the increasing rate of signal reached so it can enhance the channel performance by using all accessible bandwidth. When applying different communication technologies with smart grid their substantial factors differentiates among them and considered as Performance measurement factor of wireless technologies that called). We Applied (LTE, GSM, LEO) communication technologies each one have Spectrum efficiency (bps/Hz) respectively and as the properties of each node as per table 1.

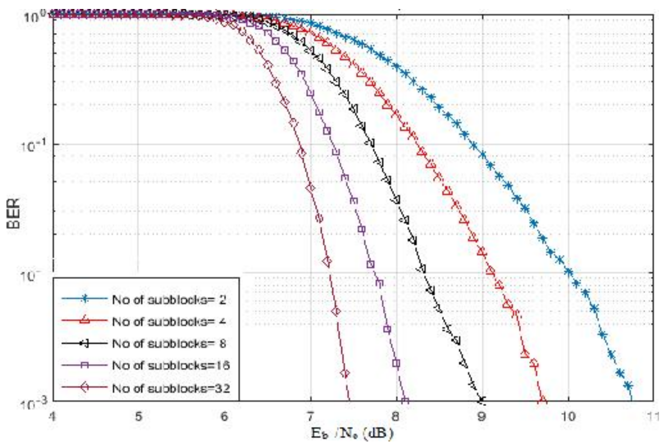

Figure 3: OFDM with different Subcarrier.

VI. CONCLUSIONS

As wireless communication systems become popular technology with Smart Grids. However, its services cannot provide a very big dynamic range of data rates, nor can it meet variety of requirements of their nodes. Since bandwidth resources still scarce, so we use OFDM for improving spectrum efficiency and achieving high wireless transmission rate. To find a way to customize the spectrum as a scarce resource for improving smart grid, we study the max Bandwidth Consumption Gain (BCG)to evaluate the grids performance. this method is approaching the priority selection of each available communication for the different nodes, so increase Smart grid performance, reliability and keeps Smart Grid quality of service.

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