Analysis of Energy Efficiency Methods For 5th Generation Wireless Communication Systems

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ABSTRACT:

Cooper's law conveys that the maximum number of voice conversations or equivalent data transactions that can be conducted in all the useful radio spectrum over a given area doubles every 30 months. In wireless networks the data traffic is progressively increasing. The long-standing tendency follows Cooper's law. The number of mobile devices in use, such as smart phones, is growing worldwide, leading to an increasing demand for data. The information transmission is linked with the energy consumption in the power amplifiers, transceiver, hardware, and base band processing. Energy efficiency measured in bit/joule. The concern on energy efficiency in wireless communications have been growing tremendously. In this paper we analyze a different types of energy efficiency methods representing potential future deployment, for energy efficient future 5G systems.

1. Introduction

India has over huge number of cell towers today and 90%+ sites have grid outages in excess of eight hours a day.10% are completely off-grid huge dependency on diesel generator sets for power backups. India imports few billion liters of diesel generator sets for power backups. India imports billion liters of diesel annually to support these cell sites. Co2 emission exceeds six million metric tons a year as mobile services expand to remote rural areas, enormity of this problem grows. Due to this fast growth in wireless communication technologies, energy consumption is also growing at a very fast rate. The mobile operators are the top energy consumers. The energy consumption is growing. International mobile telecommunications 2020 are the requirements issued by the ITU radio communication sector (ITU-R) of the International Telecommunication union in 2015 for 5G networks and devices. The standard is expected to be completed in 2020.Larger data rates can be achieved by consuming more energy. If energy efficiency is having limit, then 90 x higher data rate in 5G is with 90 X more power consumption. Energy efficiency and spectral efficiency improves with smaller cell sizes and more antennas. In this paper we will take two different cases single antenna systems and multiple antenna systems. The present communication networks are not reliable due lead to an more energy consumption is serious economical and environmental concerns.

2. Single antenna systems with and without interference

Let us take single antenna system in that the input signal is represented by x and channel is represented by h, and received signal is denoted by y. Y=hx+n ,where n is AWGN the capacity of channel is

$$C = B\log_2\left(1 + p\beta / BN_0\right) \tag{1}$$

In single antenna system maximum energy efficiency depends on channel gain β.Now we can add interference to single antenna system. The interference is generated in sub systems which is also operating to get maximum energy efficiency. The interference is denoted by 'α', The total transmitter power is 'p' and total received power is of 'Pα'.The energy efficiency now becomes as

$$EE = B\log_2(1 + p\beta / BN_0 + p\alpha) / p \tag{2}$$

3. MIMO Systems

The transmitter is connected with N antennas and receiver is also connected with M antennas, which is called as Multiple Input and Multiple Output system. The wireless channel matrix for MxN channel is given as H=cMxN. The received signal is denoted as y and it is given by

$$Y = H x + n \quad (3)$$

Where x is the transmit signal and n is AWGN. The channel capacity is in the MIMO systems is given as

$$CC = \min(N, M) B \log_2 (1 + p/MBN_0 \sigma^2 max(H) \quad (4)$$

Where CC is the channel capacity, N is number of transmitting antennas, M is receiving antennas, p is transmitter power, B is bandwidth, H is Channel matrix .When the transmit power is the only factor contributing to the energy consumption.

4. Constant Circuit Power

A more practical energy consumption model is P+μ, where μ ≥ 0 is the circuit power—the power dissipated in the analog and digital circuitry of the transceivers.

$$C = B \log 2(1 + p\beta / BNo) \;/p + \mu \quad (5)$$

Where (a) follows from noting that the EE is an increasing function of B and letting B → ∞, while (b) follows from letting P → ∞. Another way to view it is that P and B are going jointly to infinity, but B has a substantially higher convergence speed such that P/B → 0.

5. Varying Circuit Power

The fact that we treated μ as constant when changing B and P implies that no substantial changes to the hardware are needed when changing these variables. This simplification is hard to justify when taking the variables to infinity. The sampling rate is proportional to B and the energy consumption of analog-to-digital and digital-to-analog converters is proportional to the sampling rate (i.e., behaves as VB for some constant ν), and the same applies to the baseband processing of these samples. The energy consumption of data encoding/decoding is (at best) proportional to the data rate. An alternative EE expression capturing these properties is

$$\mathrm{EE} = \frac{B \log_2\left(1 + \frac{P\beta}{BN_0}\right)}{P + \nu B + \eta B \log_2\left(1 + \frac{P\beta}{BN_0}\right)} \quad (6)$$

Since this EE is achieved by any values of P and B having the ratio in, we have the freedom to choose B to achieve any desired data rate

$$C = Bx\log 2 \,(e). \quad (7)$$

Result:

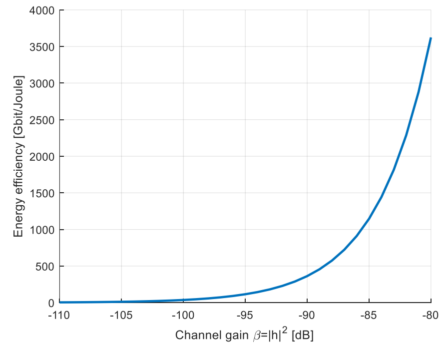

Fig:1Channel gain vs Energy Efficiency

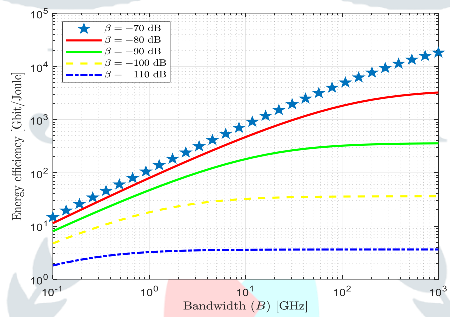

Fig:2 Energy Efficiency is growing w.r.t Bandwidth

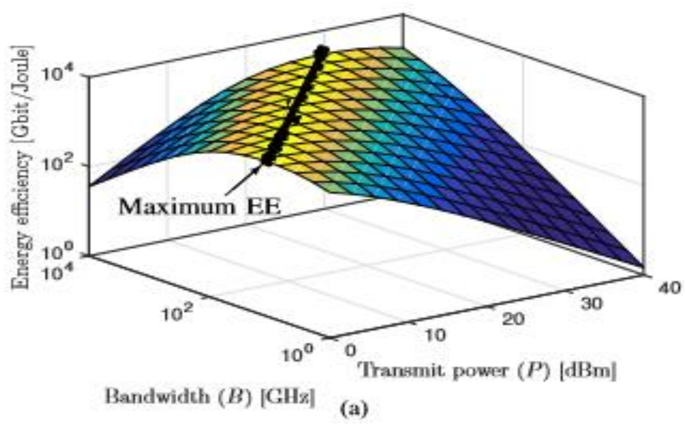

Fig: The EE in(a) vary with the transmit power and bandwidth.

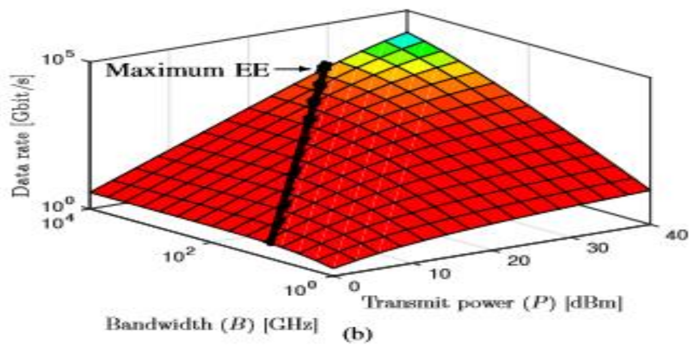

Fig: The data rate in (b) vary with the transmit power and bandwidth.

Conclusion:

Wireless Communications are improving towards evolution for new facilities and applications and the wireless industry has begun to design for energy efficiency wireless communication systems. The energy efficiency is depending on the parameters transmitter power and bandwidth for proper selection.

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