Communications
2019; 7(1): 1-5
http://www.sciencepublishinggroup.com/j/com
doi: 10.11648/j.com.20190701.11
ISSN: 2328-5966 (Print); ISSN: 2328-5923 (Online)

A General Guide for Communication System Engineers to Improve QoS

Saed Thuneibat

Department of Electrical Engineering, Al-Balqa Applied University, Irbid, Jordan

Email address:
Saed1970@bau.edu.jo

To cite this article:
Saed Thuneibat. A General Guide for Communication System Engineers to Improve QoS. *Communications*. Vol. 7, No. 1, 2019, pp. 1-5. doi: 10.11648/j.com.20190701.11

Received: January 19, 2019; **Accepted**: February 25, 2019; **Published**: March 18, 2019

Abstract: The Quality of Service (QoS) is one of most important issues in providing an acceptable level of service. Communication engineers need a guide for action to improve QoS parameters such as data rate, bit error rate, latency, and jitter. Improving QoS includes a set of steps that should be performed by an engineer; these steps are belonging to two categories, system and network steps. In this paper we developed a flow chart of a general guide to improve QoS in a digital communication system, based on our knowledge of the modern communication system and impairments that lead to system degradation. We outline the options and advices to approach the subject of QoS in digital transmission.

Keywords: QoS, Data Rate, Bit Error Rate, Delay, Jitter

1. Introduction

Nowadays, real communication systems become complex and with different resources and requirements. Generally, two types of communication system, base-band and pass-band. In base-band digital communication system, the spectrum of transmitted signal is span from zero to some frequency. For transmission of base-band signal by a digital communication system, the information is firstly formatted by PCM or delta modulation so that it represented by digital symbols. Then, pulse waveforms are assigned by the line coding techniques that represented these symbols. These waveforms usually transmitted over a cable such as coaxial. In pass-band (or band-pass) signal, the signal has a spectral magnitude that span from f1 to f2 around fc, f1 is nonzero and fc is carrier frequency that needs to be much greater than zero.

Two major sources of impairments influence the performance of a digital communication system; noise and InterSymbol Interference (ISI). By noise we meant an unwanted signal which added to transmitted signal. Engineers usually have no control over noise in the meaning that they do not know the amplitude, frequency and duration. In communication system the noise is modeled by AWGN or Rayleigh. Channel noise introduced between the transmitter output and the receiver input. Quantization noise introduced in the transmitter and is carried all the way along to the receiver output. Different parameters used to express noise; SNR, noise figure, figure of merit and $\frac{E_b}{N_0}$ ratio, but the SNR more common and useful. Shannon capacity equation is an example of the usefulness of SNR.

Pulse shaping is used to reduce ISI. System filtering causes the transmitted pulses to spread out as they traverse the system. And they overlap into adjacent time slot. At the receiver the original pulse message may be derived by sampling at the center of each time slot, and then passing a decision on the amplitude of the signal measured at that sampled point. Nyquist investigated the problem of specifying a received pulse shape so that no ISI occurs at the detector. The Nyquist pulse shape is not physically realizable since it dictates a rectangular bandwidth characteristic. Also, with such a characteristic, the detection process would be very sensitive to small timing error. One frequently used system transfer function H(f) is called the raised cosine filter.

A lot of research papers have been published on QoS and improvement techniques. The communication network performance and customer loyalty are investigated in different countries by data obtained through a questionnaire [1-3]. A revision of performance parameters and measurement techniques is discussed. The results are useful for companies to improve the provided QoS and for users with different requirements to the communication networks.

ITU recommendations define the Quality of Service as: Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service [4-7]. This definition allows for objective quantification of the quality of service as a set of service parameters. The QoS improvement in wireless network and in Integrated Services Networks is discussed [8-11].

These research papers are dealing with QoS in networks; we concentrate on QoS and BER in a digital communication system.

2. Digital Communication System

The digital communication system contains a number of essential and optional blocks, as shown in figure 1 [12].

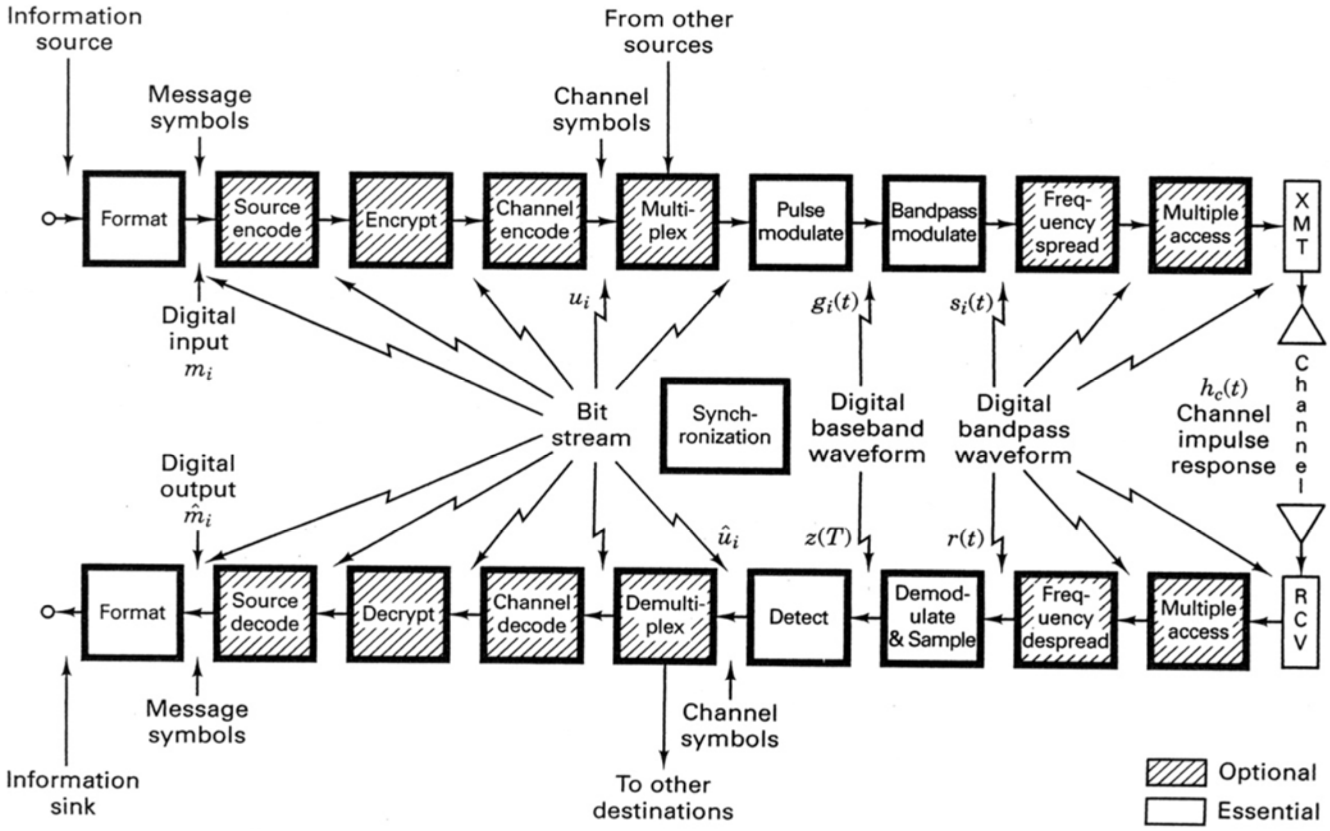

Figure 1. *Block diagram of a digital communication system.*

2.1. The Digital Transmitter

Figure 2 demonstrates a digital transmitter that used to transmit voice signal, as the voice is an analog signal then we need a convertor from analog to digital, here we used PCM. A PCM encoder has three processes, as shown in Figure 2: Sampling, Quantization and Encoding. Before the PCM encoder we implement LPF as pre-alias filter. Usually, polar NRZ is implemented prior to Q-PSK.

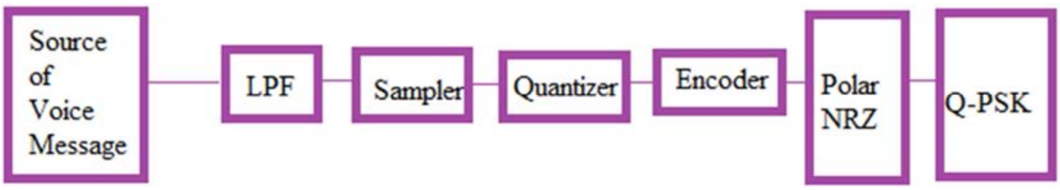

Figure 2. *Block diagram of a digital communication system transmitter.*

2.2. The Digital Receiver with Matched Filter

Two realizations of the signal demodulator in digital communication systems are known. One is based on the use of signal correlator, the second is based on the use of matched filter. Both are designed to improve QoS. In figure 3 we show a receiver that starts with MF to maximize the S/N ratio. Sampler will take this value and applied to decision making device with the operational equation $X_T \overset{1}{\underset{0}{\gtrless}} \lambda$ where X_T is the output of sampler at point T, λ is the threshold value depending on the type of line coding used. In our case, the threshold $\lambda = 0$ for polar NRZ.

The output bit stream is then decode and passed through reconstruction filter to smooth the received signal.

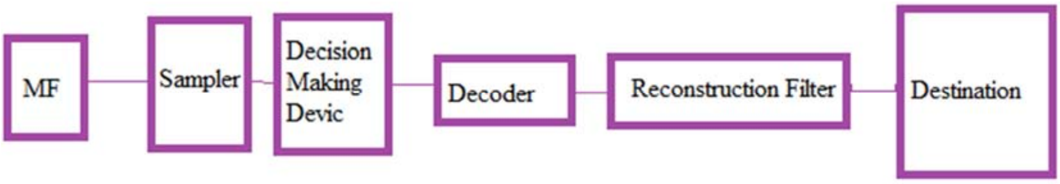

Figure 3. *Block diagram of a digital communication system receiver.*

3. QoS Parameters

Several quality parameters must be considered over the communication system for an estimation of functioning. Most important are Data Rate, Bit Error Rate (BER), Delay and Jitter. These parameters are dependent each on other and related to some basic parameters such the bandwidth of channel and the used modulation technique. In communications, bit rate or data transfer rate (bit/s or bps) is the average number of bits per unit time (second) passing between two equipment (Tx and Rx) in a digital transmission system. BER is the number of bit errors divided by the total number of transferred bits during a connection time interval. BER, often expressed as 10^{-x}, which indicates that one bit of 10^{-x} transferred bits is probably changed. An important performance characteristic of a telecommunications system is the delay that specifies how long it takes for a bit (or packet) of data to travel across the network from the transmitter to the receiver. In communication system, a delay variation is the difference in end-to-end one-way delay between successive bits in a flow. Jitter may be caused by electromagnetic interference (EMI) and crosstalk with carriers of other signals. As the delay, jitter has sufficient influence on QoS for interactive multimedia applications.

3.1. Data Rate

Data rate is the term associated with the rate of data transferred between two or more digital communication devices. It describes how much bits can be transferred in a second. Data rate depends upon the bandwidth of communication channel. If the bandwidth is high, data rate will be also high according to the formula $R_b = 2B \times \log_2 L$, where L is the number of levels.

Data rate need to be increased to satisfy the increasing requirement of users of high data rate application such as VoIP, Video applications.

From the equation, bandwidth and number of levels must be increased to improve data rate. Usually bandwidth is refers to the channel bandwidth and it is difficult to change, the M-ary modulation has more levels than binary.

3.2. Bit Error Rate

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that have been altered due to noise, interference, distortion or bit synchronization errors.

BER is the number of bit errors per unit time. The bit error ratio (also BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval.

Also, the definition of bit error rate can be translated into a simple formula; the equation below is the ratio of energy consumed in bit to the signal spectral noise and represent bit error rate in $BER = 0.5\, erfc\sqrt{E_b/N_0}$.

BER to be decreased to improve the QoS of a digital communication system. Based on BER formulas, we can decrease BER by increasing E_b or decreasing N_0, usually engineers can improve E_b not N_0. MF at Rx and repeaters are used to overcome the noise, pulse shaping with roll-off factor $\alpha = 1$ and equalizers are implemented to reduce the effect of ISI.

3.3. Delay and Jitter

An important performance characteristic of a communications system is the delay that specifies how long it takes for a bit of data to travel across the system from the transmitter to the receiver. Some applications as VOIP and video (video on demand and video chatting) are delay sensitive. Special care of delay must be taken in design and measures of these services. Engineers divide the delay into several contributors as in the equation $\tau_{avg} = \tau_{Tx} + \tau_{Rt} + \tau_{Pg} + \tau_{Rx}$, where τ_{Tx} is Tx delay, τ_{Rt} is router delay, τ_{Pg} is propagation delay and τ_{Rx} is Rx delay. Reducing any of these contributors will improve delay parameter of QoS.

In communication system, a bit delay variation is the difference in end-to-end one-way delay between successive bits in a flow. Jitter may be caused by electromagnetic interference (EMI) and crosstalk with carriers of other signals. As the delay, jitter has sufficient influence on QoS for interactive multimedia applications, small buffer used at Rx to improve jitter characteristic.

4. Simulation Results

For the verification of the proposed ideas, under my superposition, my students: Doa'a BaniSakher, Rawan Al-Kharabsheh and Doha Al-Zoubi, have developed a simulation cod that represent the communication system in their graduation project at AL-Huson university college, BAU, Jordan.

We had run the program and received different results, some of them are depicted below. Figure 4 is showing the dependency of BER on the $\frac{E_b}{N_0}$ ratio by the estimated by simulation curve without using repeater in the system compared with theoretically calculated curve. Figure 5 is showing the same dependency with repeater in the system.

Figure 6 is showing the dependency of BER on the $\frac{E_b}{N_0}$ ratio by the estimated by simulation curve with using repeater and equalizer in the system.

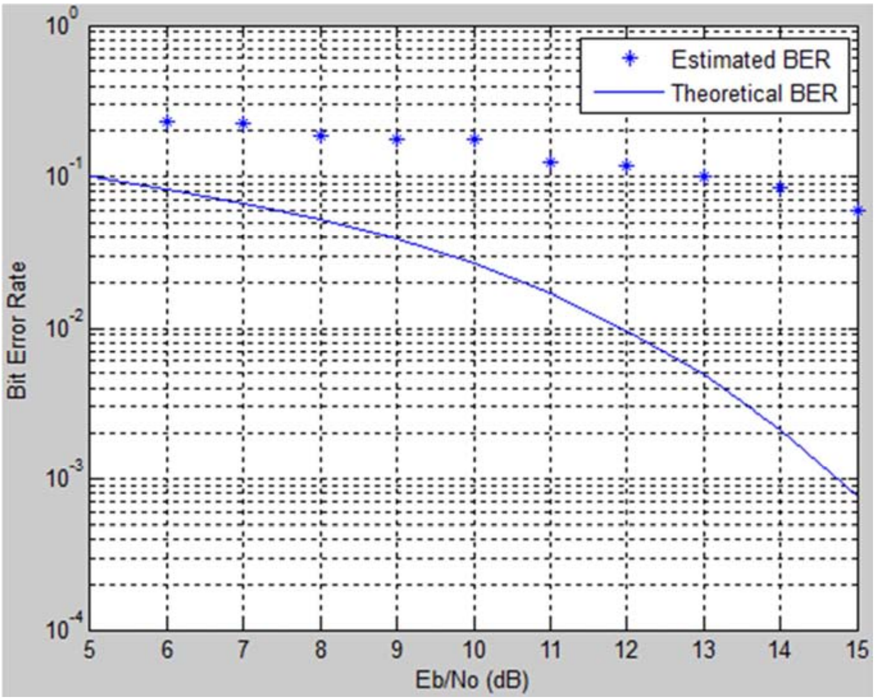

Figure 4. *The dependency of* $\frac{E_b}{N_0}$ *ratio without using repeater.*

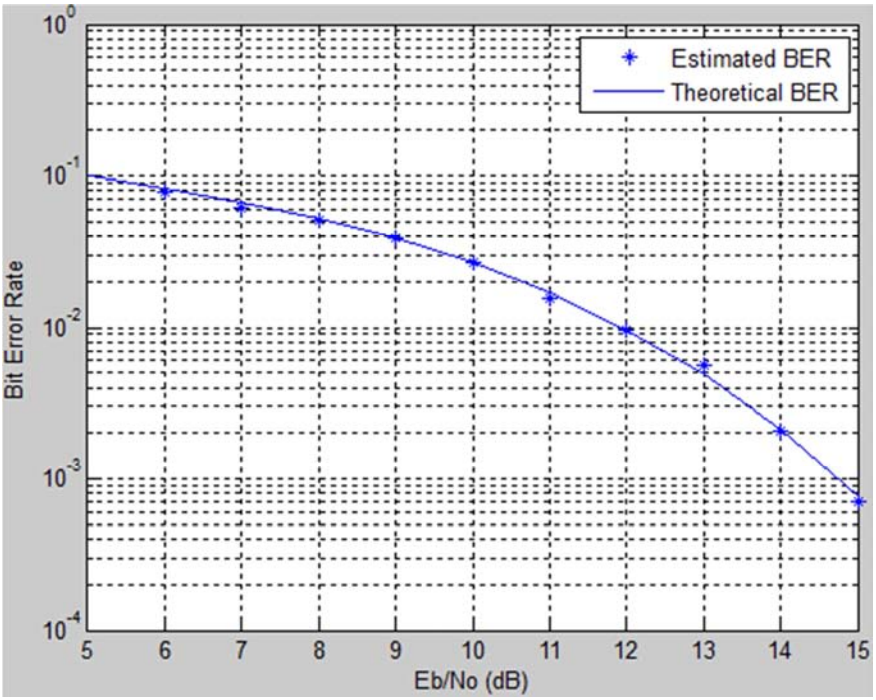

Figure 5. *The dependency of* $\frac{E_b}{N_0}$ *ratio with using repeater.*

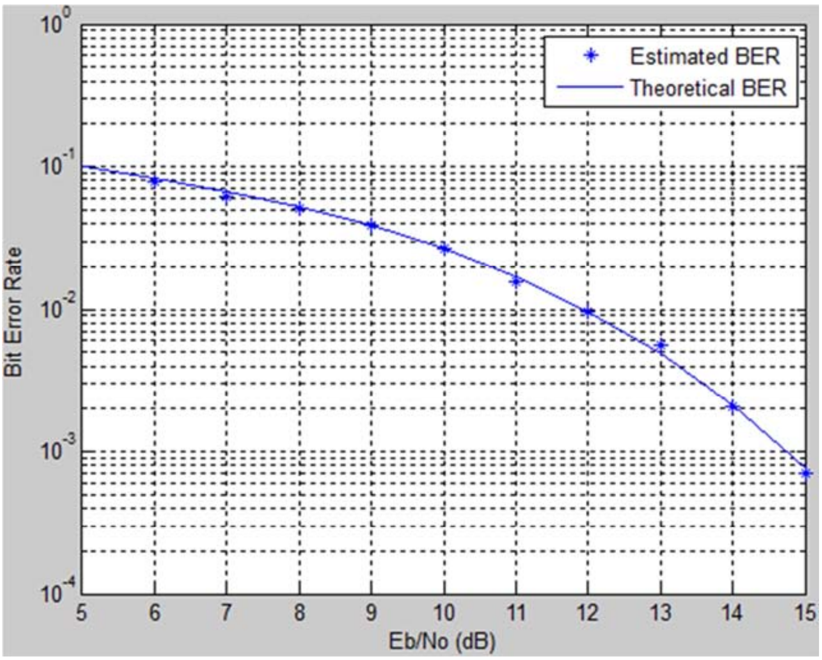

Figure 6. *The dependency of* $\frac{E_b}{N_0}$ *ratio with using repeater and equalizer.*

Figures clearly demonstrated the effect of repeater on the BER dependency in a digital communication system, while equalizer does not affect the BER dependency directly, it defines the upper BER can be achieved.

5. Conclusion

The goal of this paper is to investigate the QoS parameters of a communication system and summarize the options and advices to communication engineers to improve the provided QoS. For various QoS parameters, we suggested an adequate method of improvement. The data rate is improved by implementing M-ary modulation rather than binary techniques and by increasing channel bandwidth if available. The BER is improved by implementing MF, pulse shaping with α =1, repeaters and equalizers. The Delay is improved by reducing several contributors. The Jitter is improved by implementing Small buffer.

References

[1] Ababneh M. S. & Al-Thuneibat S. A. "Communication Network Parameters and Performance Measures: Jordanian Customer Loyalty as a Case Study" Applied Physics Research; Vol. 4, No. 4; 2012 ISSN 1916-9639 E-ISSN 1916-9647 Published by Canadian Center of Science and Education, 58-67.

[2] Adepoju ADELEKE, Suraju Abiodun AMINU, “The Determinants of Customer Loyalty in Nigeria’s GSM Market” International Journal of Business and Social Science Vol. 3 No. 14 [Special Issue – July 2012], 209-222.

[3] Hui Wen Chuaha, Malliga Marimuthu, T. Ramayah, “The Effect of Perceived Value on the Loyalty of Generation Y Mobile Internet Subscribers: A Proposed Conceptual Framework” Procedia - Social and Behavioral Sciences 130 (2014) 532 – 541.

[4] ITU-T Recommendation P. 10/G.100 (2006) Amendment 2: ‘Vocabulary for performance and quality of service’, International Telecommunications Union, 2008.

[5] ITU-T Recommendation E. 800: ‘Definitions of terms related to quality of service’, International Telecommunications Union, 2008.

[6] ITU-T Recommendation G. 1010: ‘End-user multimedia QoS categories’, International Telecommunications Union, 2001.

[7] GSM-Association IR. 42: ‘Definition of Quality of Service parameters and their Computation’, version 4.0, 2011.

[8] D. Wu, "QoS Provisioning in Wireless Networks" Wireless Communications and Mobile Computing, vol. 5, pp. 957--969, 2005. Wiley.

[9] Naveed Farhana, HSN Murthy “QOS in Wireless Network- Current Trends and Future Directions” IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 18, Issue 5, Ver. VI (Sep. - Oct. 2016), PP 01-07 www.iosrjournals.or.

[10] Vipin Kumar, Avadhesh Kumar Gupta “Measuring Parameters of Quality of Service in Wireless Sensor Networks” International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3 Issue 11, November 2014, 4040-4045.

[11] D. Wu, T. Hou, Z.-L. Zhang, H. J. Chao, "A Framework of Node Architecture and Traffic Management Algorithms for Achieving QoS Provisioning in Integrated Services Networks,"International Journal of Parallel and Distributed Systems and Networks, vol. 3, no. 2, pp. 64-81, ACTA Press, May 2000.

[12] Bernard Sklar "Digital Communications, Fundamentals and Applications". Second Edition. Communications Engineering Services, Tarzana, California.