

## Chapter 20

# Mathematical Representation of Quality of Service (QoS) Parameters for Internet of Things (IoT)

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### ABSTRACT

*Now we are in the era of ubiquitous computing. Internet of things (IoT) is getting matured in various parts of the world. In coming few years' billions and trillions of things will be connected to the internet. To deal with these huge number of devices in a network we need to consider Quality of Service (QoS) parameters so that system operations can be performed in a smoother way. Mathematical modelling of these QoS parameters gives an idea about which factors are needs to consider while designing any IoT-enabled system at the same time it will give the performance analysis of the system before implementation. In this paper comprehensive literature survey is done to discuss various issues related to QoS and gap analysis is also done for IoT Enabled systems. This paper proposes general steps to build a mathematical model for a system. It also proposes the mathematical model for QoS parameters like reliability, communication complexities, latency and aggregation of data for IoT. To support proposed mathematical model proof of concept also given.*

## 1. INTRODUCTION

IoT can be called next step to ubiquitous computing. IoT is communication network in which any device, people, and service are connected through the internet. We can say, it is all about communication between the physical objects. The main motive for IoT is to optimize the use of natural resources like electric, gas, water, electricity etc. To run any business, time and money are the crucial factors to matter. With the help of IoT, we can optimize both.

When we consider the general scenario of IoT application, at the basic layer sensors and devices are working which generate huge data. These devices send data to data collection node which will further process by the computing system. Processing and storage can be done in the cloud. The devices having sensing, computing and communicating power can take part in IoT application. With the help of IoT, we are trying to integrate smartness with objects. From another perspective we can say with the help of IoT we are trying to build a system which will have the same behavior as human-like sensation is the way of gaining the knowledge for human, there is Sensor through which IoT will be able to do the same thing. (Jacobsen, Toftegaard, & Kjærgaard, 2012; CISCO, n. d.)

Consider a smart home application in which all the objects are connected. If goods in the house are out of stock, we should get a notification that the goods are out of stock. At the door if anyone comes then camera which is placed on the door capture image automatically and notification are sent to the user. Guest can only enter the house when the owner approves permission. There are so many things we can do with the smartphone application. In such application, we can access any device ubiquitously. The above application seems to be very interesting at the same time we should consider complexities involved regarding such implementation of things.

6LoWPAN is an acronym for “IPv6 over Low-Power Wireless Personal Area Networks It provides communication standard to communicate and exchange data between low power devices via IPV6. 6LoWPAN is low cost, low rate, and low power deployment. (Jacobsen, Toftegaard, & Kjærgaard, 2012) There are various application domains of IoT for example Agriculture, Supply chains, Governments, Retail, transportation, Energy Management and other domains also.

In the current business scenario, communication network plays an important factor or it acts as the backbone of business. High quality of communication network gives high growth and higher profitability in the business. The quality of service is the overall performance analysis of system components. The major factors which affect the quality of service are error rate, bit rate, throughput, and delays. QoS are particularly important for the transport of traffic. There are a number of alternative definitions of quality of service. QoS has sometimes referred a level of quality of service or it is the quality of experience subjective business constraints. The quality of service can be referred as the degree of satisfaction of the user. The quality of service requires mainly those applications who requires more bandwidth. For example, for YouTube, we consider high-quality network based on buffering of the video.

Mathematical modelling gives no of ways to implement the system and it gives an overall idea about what factors should be taken into consideration. We can compare various system performance based on the same parameter with the help of mathematical modelling. Mathematical modelling helps for better decision making. Representing quality of service with the help of mathematical modeling help to analyze various IoT system performance. Section 2 describes the brief introduction of QoS parameters needs to take under consideration for any IoT system. Section 3 and 4 are talks about lit-

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