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   RESULTS & DISCUSSION

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   RECOMMENDATIONS/SUGGESTIONS

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- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio" Ohio State University, Nigeria.

CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

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A DETAILED STUDY ON QUALITY OF SERVICE IN COMPUTER NETWORKS

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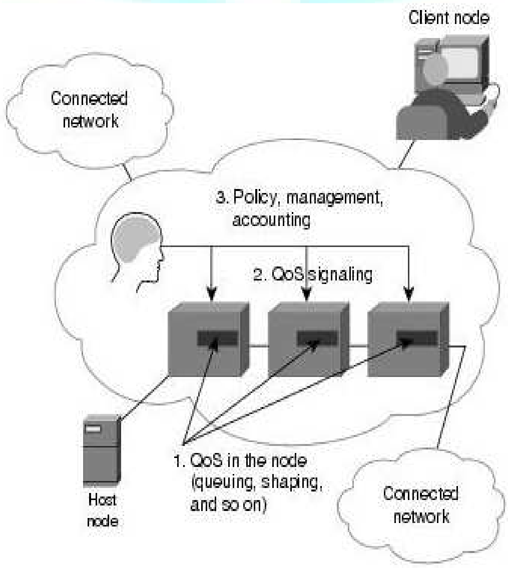
ABSTRACT
The advancement of internet and its applications has made the world so addictive to it because of its efficient and effective use of information distribution and sharing. That is where computer network plays a leading role in performing actions such as transmitting data and quality of service (QoS). The high-speed network supports a wide range of communication more intensive for real-time applications. Hence, the next generation of networks is likely to be connection-oriented for the real-time traffic. This research paper focuses on problems in routing problem and how to overcome it. We propose few network routing algorithms for imprecision decreasing and we achieved it to the big by few assumption of networking strategies.

KEYWORDS
QoS, GoS, QoS Routing, QoS Routing Algorithms.

INTRODUCTION
The Quality of Service (QoS) in Computer Networking is absolutely a new term that is defined as "The capability of a network to provide better service to selected traffic over various technologies and IP-routed networks that may use one or all the available technologies."
QoS refers to a broad collection of networking techniques and technologies. The ultimate goal is to provide guarantees on the ability of the network to deliver predictable output. The Qos elements in networking include availability (also called as uptime), bandwidth (also known as throughput), latency (otherwise called as delay) and error rate.

The concept of QoS evolved due to the market demands forced on the performance of a network by modern and advanced applications, specifically for the real time multimedia applications. Thus, these applications have set a benchmark for the acceptable limitations in time delay when service transferred over an available network.

FIGURE 1: BASIC QOS ARCHITECTURE



The three fundamental components of QoS Implementation are:
- The marking and identification techniques of QoS for coordination from end to end between network elements
- QoS within a single network element
- QoS policy, management, and accounting functions to control and administer end-to-end traffic across a network

Hence, it is classified into three main areas of constraints.

I) SUBJECTIVE HUMAN NEEDS

This is what a computing interaction can do for the process of applications such as Chatting and other Web-related applications.

II) AUTOMATED TASKS

Due to time constraints, the automated tasks back-ups data or information once in a day by a pre-assigned time period allotted.

III) NEED OF APPLICATIONS

Applications required for a transmission rate with limited jitter with temporary allocated of transmitted packets where temporal requirements are intrinsic to QoS.

QoS has become a main issue in the recent years. The concept of QoS was evolved before the applications mandated the use of the service. During the process of initial specification of IP, a *Type of Service* (ToS) byte is allocated in the IP header to accelerate QoS. Before 1980s, implementation of ToS was neglected when QoS was not so famous.

COMPARISON OF GoS AND QoS

Finding the standards of ***Grade of Service*** **(GoS)** that are required to support a particular QoS is not an easy task. Both GoS and QoS vary from its concepts. QoS looks at the situation from customer view and GoS looks at network view.

REFERENCE CONFIGURATIONS

Reference Configuration obtains the networks that are under consideration that generates it. This has one or more customized designs of the path of the connection can take with reference points. Thus, the interfaces are defined between all other entities.

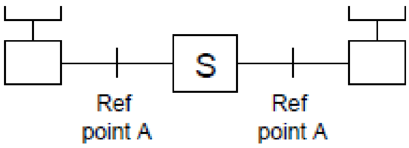
Lets for an example, consider a Telephone Network with terminals, subscriber and transit switches.

There are three ways that the call can be routed in.

1. *Terminal → Subscriber Switch → Terminal*

The Reference Configuration for the above is shown in Figure 2.

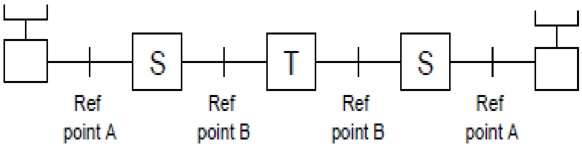
FIGURE 2: CASE 1 REFERENCE CONFIGURATION



2. *Terminal → Subscriber Switch → Transit Switch → Subscriber Switch → Terminal*

The Reference Configuration for the above is shown in Figure 3.

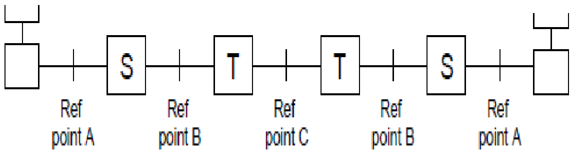
FIGURE 3: CASE 2 REFERENCE CONFIGURATION



3. *Terminal → Subscriber Switch → Transit Switch → Transit Switch → Subscriber Switch → Terminal*

The Reference Configuration for the above is shown in Figure 4.

FIGURE 4: REFERENCE CONFIGURATION



Based on the given requirement set for QoS, the GoS set of parameters are first selected and send on an end-to-end procedure within the network boundaries. This process takes place for each service. Thus, GoS is arrived at a derived reference points. This allows the partitioning of end-to-end GoS objectives for each network component.

QoS PERFORMANCE MEASURES

Quantitative measures of QoS must be carefully defined to provide a good QoS on a network. The general parameters of parameters of QoS are

a) Bandwidth
b) Jitter
c) Latency and
d) Packet Loss

- ***Bandwidth*** – It is the rate at which an application's traffic must be carried by the network
- ***Latency*** – It is the delay in tolerance of application in delivering the packet data
- ***Jitter*** – It is the variation in latency
- ***Loss*** – It is the percentage of lost data

BANDWIDTH

The term **Bandwidth** offers the capability to a network to provide a better service to selected network traffic within TCP/IP networks. Theoretically, the bandwidth describes the range of possible transmission frequency. In practical, bandwidth describes the size of the line of an application program that requires for communication over a network.

The significance of a channel bandwidth determines the capacity of the channel which gives the maximum rate of information that can be transmitted.

Information Transmission Rate and Channel Capacity relationship was clearly explained in Information Theory by Claude Shannon.

According to *Shannon*, if information rate is R and channel capacity is C, then, there are many possible ways to find a technique for transmitting information with low probability of error with the condition $R<=C$. In reverse, it is not at all possible if $R>C$.

PACKET DELAY AND JITTER

Packet Delay is also called as Latency. There are 3 types of delay.

1. Serialization Delay

2. Propagation Delay
3. Switching Delay

SERIALIZATION DELAY

It is also known as ***Transmission Delay***. The time taken by a device to synchronize a packet on a given rate of output is called serialization delay. This delay is the main function between the packet size and bandwidth.

Example

A 64 byte Packet Size takes 171µs when sent at the rate of 3Mbps. It is the same, that the packet takes 26ms for 19.2kbps.

PROPAGATION DELAY

Propagation Delay is the time taken by a bit to travel from a transmitter to a receiver. There have upper limits on speed to make the best speed of light travel. This delay is a function between travelled distance and link medium.

SWITCHING DELAY

Switching Delay is the time delay between receiving a packet and retransmitting it on a network system. It is the function of the device speed.

There are other delays that contribute for the overall performance on a network. Packet Jitter is the variation in packet delay of the system. Queuing delay is negligible when the networks performance is fast and so no congestion. When the congestions over the network takes place, queuing delay gets increased.

So, the probability (p) of n clients in a queue can be expressed as:

$P(n) = (1-r)*r^n$

When service rate is µ, average queuing delay (aqd) can be expressed as:

aqd = 1/(1-r) µ

PACKET LOSS

Packet loss is an important measure in QoS. If packet loss exceeds a specified limit, some functions of an application may not function properly or may not function at all.

Example

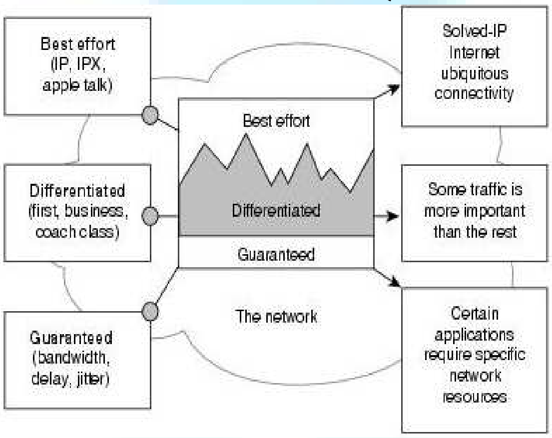
In a streaming video frames, after a certain number of frames are lost, the streaming becomes useless for user.

Thus, sometimes the number will be zero in few cases. And so, the guaranteed number of limits of lost packets is necessary for such applications for QoS implementation. Thus, at most of the times, packet loss occurs due to the drops during congestion when exceeds the queue size. Corrupt packets also cause these packet losses.

QoS LEVELS

There are many applications that still don't require QoS. They differ in degrees of priorities and guarantees for implementation process. We have some tasks that don't need any guarantees whereas the other end needs correct guarantees that cannot be compromised, at one end. Such levels of QoS are grouped into 3 classes such as Soft and Hard QoS and Best Effort Service.

FIGURE 5: THREE LEVELS OF QoS



BEST EFFORT SERVICE

Best Effort Service does not provide any guarantee. Thus following the extreme level, cannot be considered as a QoS. Most of the networking applications work on the best effort service. An example for one such is File Transfer Protocol (FTP). Guarantees or Performance measures are not necessary but the only output we expect is whether successful transmission was taken place or not.

SOFT QoS

Soft QoS is commonly called as Differentiated Service. There are no absolute guarantees in this level. Different priorities are assigned to different tasks on a network.

The applications are categorized into different priority classes. If guarantees are not necessary, most of the application traffics work much better. For example, traffic control should be given high priority to ensure the best connectivity and functionality over the network.

HARD QoS

QoS Networking has made developers to face challenging tasks in many fields. Many researchers have contributed to the development of fast and quick networks. Optical networks use Wavelength Division Mulitplexing (WDM) technology on a fiber line for transmission rate in tera bits per second.

There are a number of factors that contributes to the issues in routing QoS. One such is diversity of requirements and guarantees of distributed computing applications running at the same time. Thus, the problem extends its applications to implement zero constraint requirements for QoS. The other major factors that cause problems in implementing QoS is maintaining network information in a large and dynamic network.

Each node on the network has to be maintained in its local state in order to maintain its network state information. And then, these local states should be combined to form the global state information.

A node maintains the network information using either the two algorithm:

3.1.1 Link-state Algorithm

3.1.2 Distance-vector Algorithm

This exchanges the local states between all the available nodes in the network in a periodical manner. However, the resulting information may not be accurate due to several other factors. Thus, dealing with uncertainty about the network global state is the biggest issue that our paper trying to solve.

ROUTING CLASSIFICATION

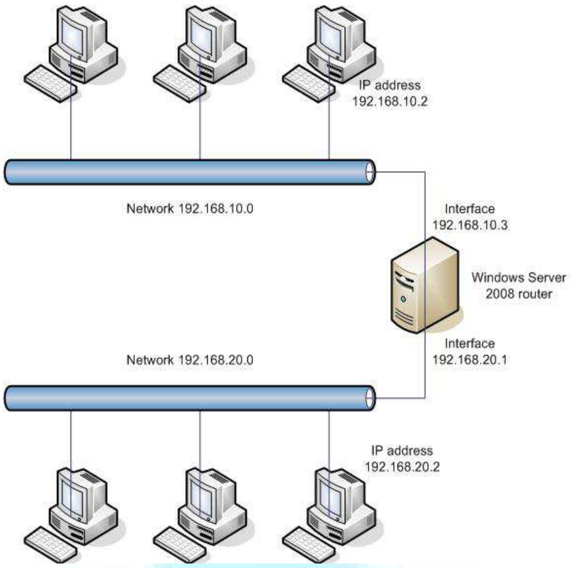
QoS routing classification done according to the destination of the searching path into two main ways:

a) Unicast Routing Algorithms
b) Multicast Routing Algorithms

Unicast Routing is where the problem is to find the best feasible path from source node to destination node satisfying the assigned constraints.

Multicast Routing is where the problem is to find the best feasible tree that covers the source node with the destination nodes satisfying the assigned constraints.

FIGURE 6: MULTICAST ROUTING NETWORK



QoS algorithms can be classified accordingly to the search path and strategy of deployment.

ROUTING STRATEGIES

There are 3 main routing strategies presented in our research. They are:

1. Source Routing
2. Distributed Routing
3. Hierarchical Routing

SOURCE ROUTING

In ***Source Routing***, feasible path is computed at source node locally. It maintains its own maintenance mechanism of the global state network information. The huge benefit of source routing is localized storage of network state information and centralized computation of path. Maintenance of global state enables source node to compute the path locally. In such cases, the complexity is smaller than distributed computing. Thus, source routing is easier for designing and implementation and guarantees loop free routing among the networks. However, this has two major problems. One is inaccuracy of state information and the other is global state precision at each node is directly proportional to update frequency. Hence, the imprecision in global state information results in failure of finding the existing feasibility.

DISTRIBUTED ROUTING

Distributed Routing is the second highest used strategy. This algorithm uses the distributed computing for path computation. We do this by the exchange of control messages and global state information stored locally at each node. Some routing algorithm doesn't require the maintenance. The biggest advantage in distrusted routing is distributed computation of path that enables shorter response time. And so, it resembles better scalability. Shorter response time, and higher scalability is achieved at the expense of higher network traffic due to more exchange of messages. This is not loop-free due to the nodes are inconsistent.

HIERARCHICAL ROUTING

Hierarchical Routing is grouped into clusters and is into a higher level of clusters. This continues to build up forming a multi-level hierarchy. The aggregated state is maintained instead of global state information. The use of partial global states is maintained by logical nodes that enhances the scalability over other routing algorithms. The overall traffic in network does not get as intense as in distributed routing.

Hierarchical routing combines the advantages of both source and distributed routing. Here, the problem in this type of routing is it is not trivial but aggregation of network states introduces extra imprecision.

CONCLUSION

This paper concludes that the performance of routing algorithms is not designed specifically to take imprecision into account but degrades significantly as the imprecision grows. Most of the routing algorithms that are available today are not considering this uncertainty into account during implementation. In spite of it, the developers assume that it does not exist at all. Hence the nature of uncertainty is inherent. And, research has been done to evaluate the impact of neglecting the performance of different routing algorithms. Of all, we have proposed few routing algorithms with the main objective of handling intrinsic imprecision and reducing its effect.

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