THROUGHPUT IMPROVEMENT IN DATA SWITCHED NETWORKS USING IMPROVED MARKOV MODULATED POISSON TECHNIQUE

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ABSTRACT

In the rapidly evolving landscape of communication networks, the demand for higher throughput and efficient data transfer has become paramount. Data-switched networks, integral to our modern connectivity, face constant challenges in optimizing their performance to meet the ever-increasing demands of users and applications. This necessitates the aim of this paper tailored towards throughput improvement in data switched networks using improved Markov modulated Poisson technique. The data-switched network was characterized using field data. Matlab simulation was carried out to determine traffic congestion on the network. Matlab/Simulink model for effective capacity enhancement was developed using Poisson and Markov Processes. Results show that maximum throughput data occurs when the capacity of the network has not been exceeded. Results also showed that when signal-to-noise ratio was 10 and throughput was1 then the maximum effective capacity that can support optimum transmission rate is 0.32 bps. Results also show that a further increase in the transmission rate degrades the effective capacity performance. Also, when signal-to-noise ratio was 100 and the quality of service index was 1, then the maximum transmission rate obtained for effective network traffic capacity was 0.36 bps.

Key words; QoS, throughput, effective capacity, signal-to-noise ratio, Poisson and Markov

1. INTRODUCTION

An efficient and effective data communication network is difficult to establish globally today due to some limiting factors. One such factor that contributes to the difficulty in the establishment is the traffic characteristics of the network which must be understood deeply (Idigo, et al, 2011).Without a deep knowledge of the traffic characteristics, Quality of Service (QoS) cannot be assured. Quality of Service refers to the control procedures that can provide an efficient performance of the network (Ifeagwu, et al, 2017). QoS is the primary requirement for acceptable performance and efficiency. Latency and reliability are the key metrics of QoS that should not exceed the specific thresholds (Alor, et al, 2017). Therefore, managing the performance of computer networks involves optimizing the way networks function to maximize capacity, minimize latency and offer high reliability regardless of bandwidth available and occurrence of failures. Network performance management consists of tasks like measuring, modeling, planning and optimizing computer networks to ensure that they carry traffic with the speed, capacity and reliability that is expected by the applications using the network required in a particular scenario.

Wireless channel change due to the changes in the environment and multipath fading can lead to variations in the strength of received signals, which also affect the QoS requirement and present the need for effective capacity of the network link layer. Effective capacity is defined as the maximum constant arrival rate that a given time-varying service process can support while providing statistical QoS guarantees (Ohaneme,et al,2012). It is derived from the large deviation theory and incorporates the statistical QoS constraint by capturing the decay rate of the buffer occupancy probability for the queue length. The effective capacity of wireless channels mainly focuses in constant arrival rates in the analysis of throughput. In this paper, we focused in using Markovian source models including discrete-time Markov and Markov modulated Poisson sources with effective capacity to conduct throughput analysis of random and bursty source traffic patterns in a data network.

This paper is structured in such a way that section one deals with the Introduction. Section two comprises the review of related works. Section three of the paper highlighted the various materials and methods used for carrying out the research work. The results and findings are contained in section four while the conclusion is in section five of the paper. This paper recommends that using an adaptive discrete-time Markov modulated Poisson process to effectively manage traffic in a data-switched Network is an addition to knowledge in data communication systems. This paper recommends that future work should look into investigating the reliability trade-off in optimization. It also suggests that future research should aim to investigate power allocation as well and move the analysis from fixed rate to adaptive rate transmission for performance evaluation under Poisson and Markov process

2. REVIEW OF RELATED WORKS

In Wang, et al, (2007), the authors proposed a Protocol which Employs Packet-Based Computation (PBC) to optimize congestion control for WSN. PBC works under both single-path routing and multi-path routing scenarios and employs a hop-by-hop rate adjustment technique called priority-based rate adjustment (PRA) to adjust the scheduling rate and the source rate of each sensor node in a single-path routing WSN. PBC utilizes a cross-layer optimization and includes intelligence congestion detection according to packet inter-arrival time and packet service time. In Monowar, et al, (2012), the author aimed at Prioritized heterogeneous traffic-oriented congestion control protocol **(**PHTCCP) which ensures efficient rate control for prioritized heterogeneous traffic by using a node priority-based hop-by-hop dynamic rate adjustment technique. The protocol uses intra-queue and inter-queue priorities along with weighted fair queuing to ensure feasible transmission rates of heterogeneous data. To control congestion, the scheduling rate is decreased to the value of packet service rate and the higher link utilization is achieved by taking advantage of the excess link capacity. PHTCCP is energy efficient, feasible in terms of memory requirements and provides lower delay. In Heikalabad, et al, (2011), dynamic prediction congestion control **(**DPCC) can predict congestion in sensor nodes and dynamically broadcast the traffic on the entire network fairly. This protocol is an upstream congestion control mechanism that supports single-path routing and nodes are supposed to generate continuous data. DPCC enhances throughput and reduces packet loss while guaranteeing distributed priority-based fairness with lower control overhead.

In Lee, et al, (2010), focused on the adaptive compression-based congestion control technique (ACT) which uses discrete wavelet transform (DWT), adaptive differential pulse code modulation (ADPCM), and run-length coding (RLC) as the compression technique. The ACT first transforms the data from the time domain to the frequency domain, reduces the range of data by using ADPCM, and then reduces the number of packets with the help of RLC before transferring the data to the source node. The authors have experimentally demonstrated that ACT increases the network efficiency and guarantees fairness to sensor nodes, as compared with other existing methods. In Wan, (2009), **Cross-layer active predictive congestion control** (CL-APCC) applies queuing theory to evaluate data flows of a single node according to its memory quality, combined with the analysis of the average occupied memory size of local networks. It also improves the performance of the networks.

3. MATERIALS AND METHOD

(a) **Materials Used:** The material used is summarized in Table1.

Table 1; List of equipment used and functions

Equipment	**Functions**
Drive test monitoring van	Navigating through measurement routes
Hp laptop with TEMS software	Monitoring and analysis of log files
Global positioning system	Longitude and latitude data
MatLAB software/Python software	Programming and simulation
Data cables and USB hub	Interconnectivity between the mobile station and the base station.
Base station	Data switched network

(b) **Method Adopted**

The drive test information collected was deployed to test the performance of the network, reliability and latency in the communication network. The characterization of the data-switched network was done by measuring the network parameters to know their impact on the network. The network and application performance were measured using key traffic performance indicators such as bandwidth, throughput, end-to-end delay, number of packets sent/received per sec, and number of bytes sent/received. The simulation parameters used in this paper was summarized in Table 2.

Table 2: Simulation Parameters

Parameter	**Values**
Simulation time	60s
Rayleigh fading block coefficients	1
Transmission fixed rate r	0 – 10 bps
Channel state	ON/OFF
SNR	10, 100
QoS exponent θ	1 – 10
Traffic Pattern	CBR
channel negotiation (Δ)	1.27 ms
UPD traffic flow	1 Mbps
Packet size	64 Kb

The simulation considers SNR whose values are linear (0 to 100). The QoS exponent (θ) used is 0.1 and 1. The simulation time lasted for 60seconds. The QoS exponent used is in the range of 1 -10. The packet size that is allowed on the network is of 64kb.The second method adopted was Poisson and Markov method for the implementation of traffic management as shown in Figure 1;

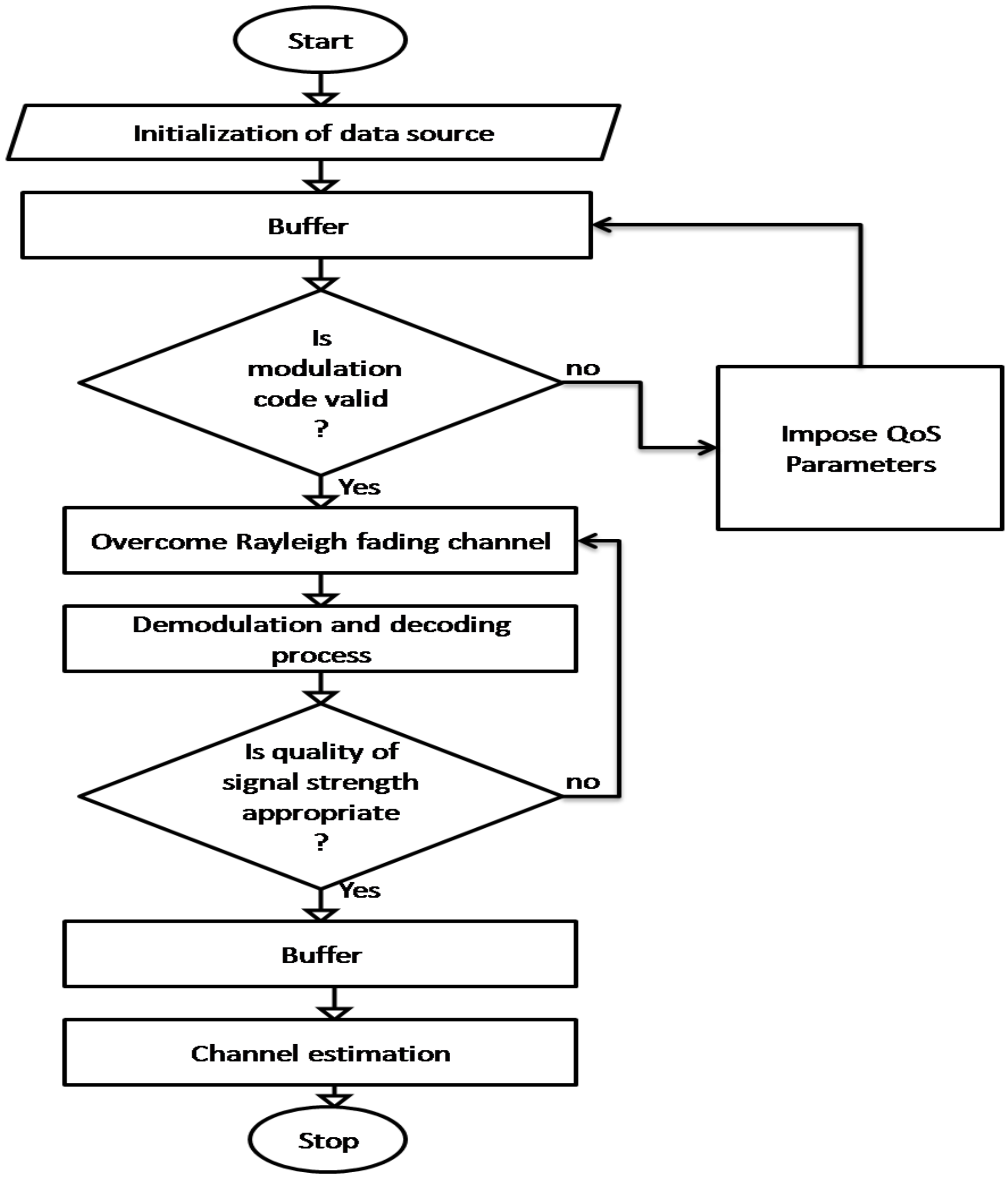

Figure 1: Flow chart of the Poisson and Markov processes

Figure 1 shows the Model for Poisson and Markov processes. The Model generates packets using a Markov-modulated Poisson process, which is a Poisson process whose rate depends on the state of a Markov Chain (ON/OFF). The process is an interrupted Poisson process because the "off" state prevents packet generation.

4. RESULTS AND FINDINGS

(a) Results

The result from traffic analysis on the data switched network is shown in Figure 2.i.e. network throughput analysis. The results from designing of data network traffic Model using improved Markov and Poison Process is shown in Figure 3. The result of effective network capacity as a function of SNR with fixed transmission rate r = 1 bps and QoS exponent θ = 1.was shown in Figure 4and the results of the comparison of effective network capacity as a function of QoS exponent θ with fixed transmission rate r = 1 bps and SNR = 10, 100 is shown in Figure 5.

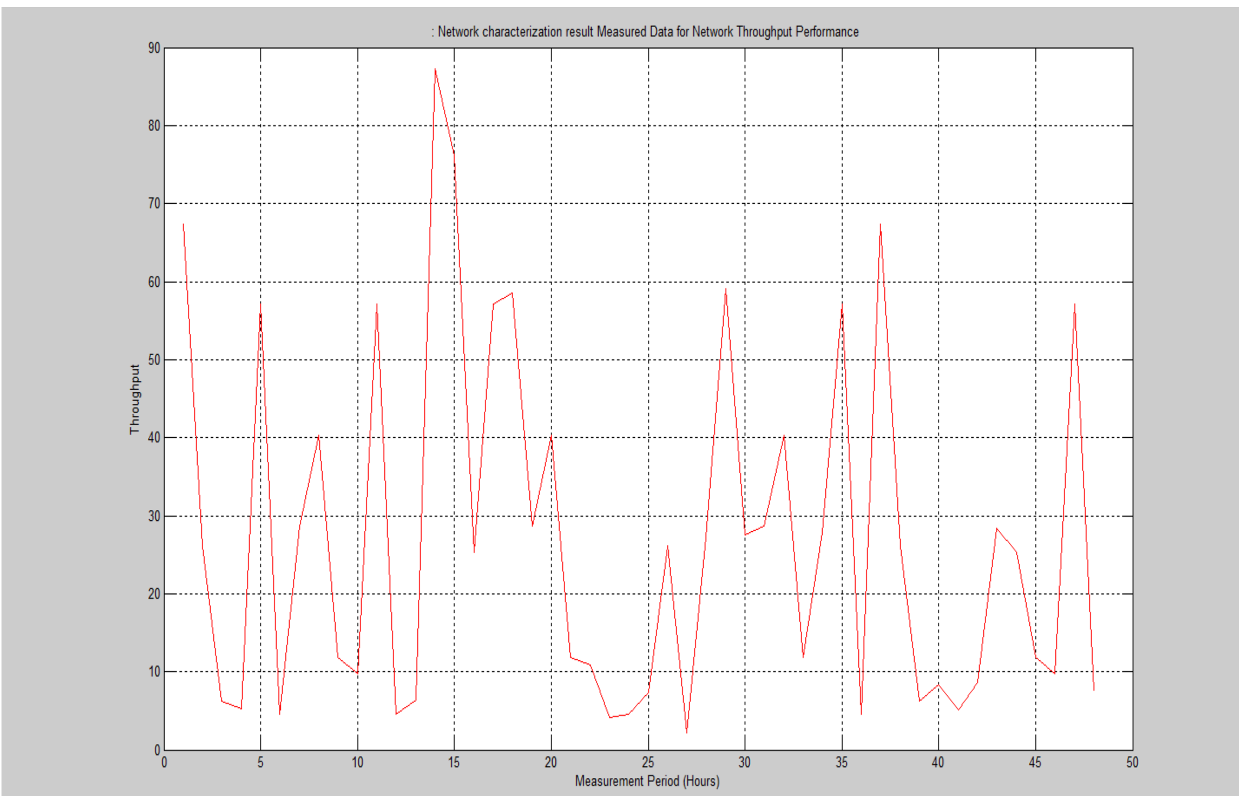

Figure 2: Traffic analysis on the data switched network

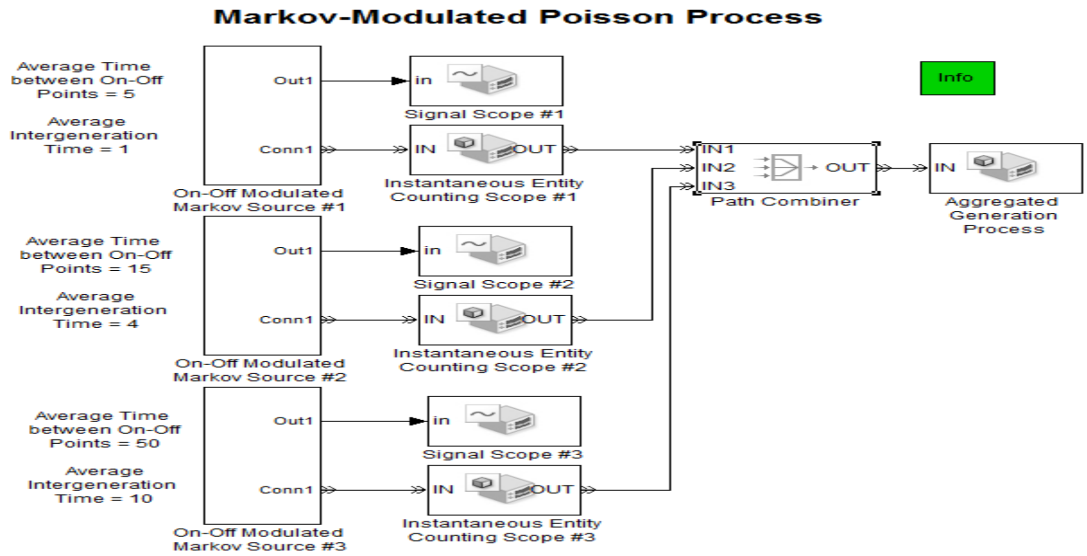

Figure 3: Simulink Model of the Markov Modulated Poisson based system

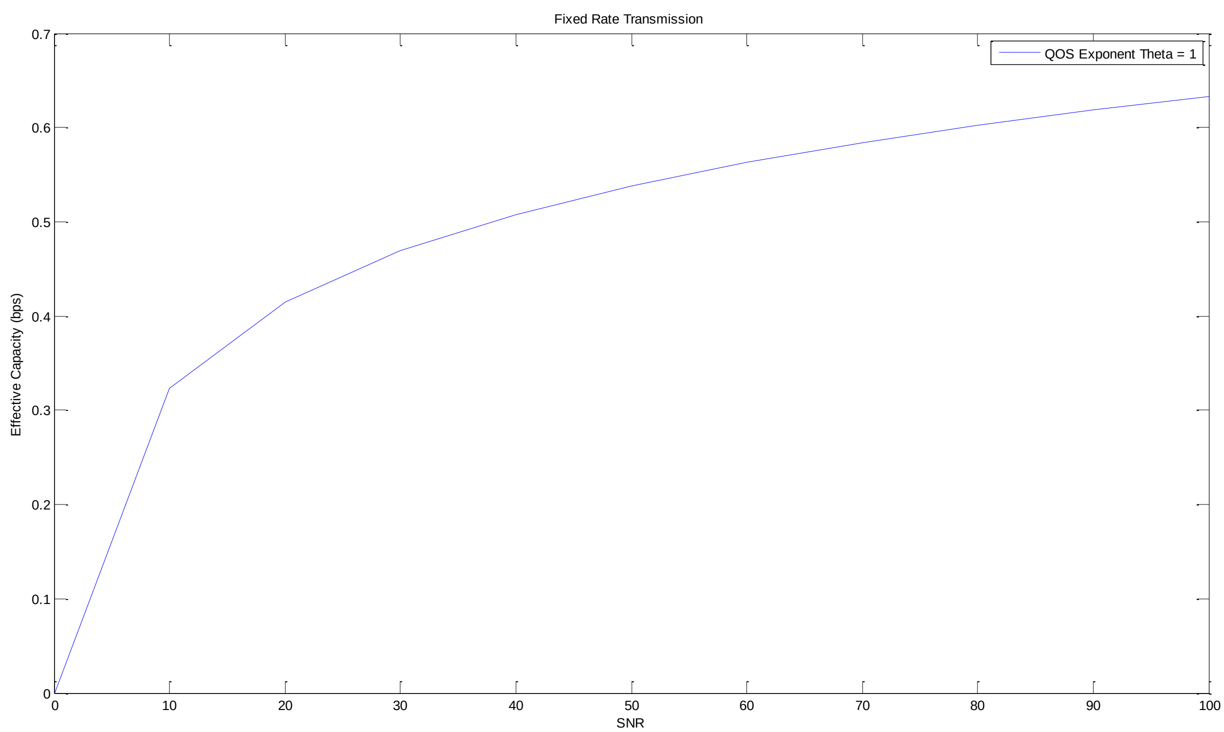

Figure 4; Result of effective Network Capacity as a function of SNR with fixed transmission rate r = 1 bps and QoS exponent θ = 1.

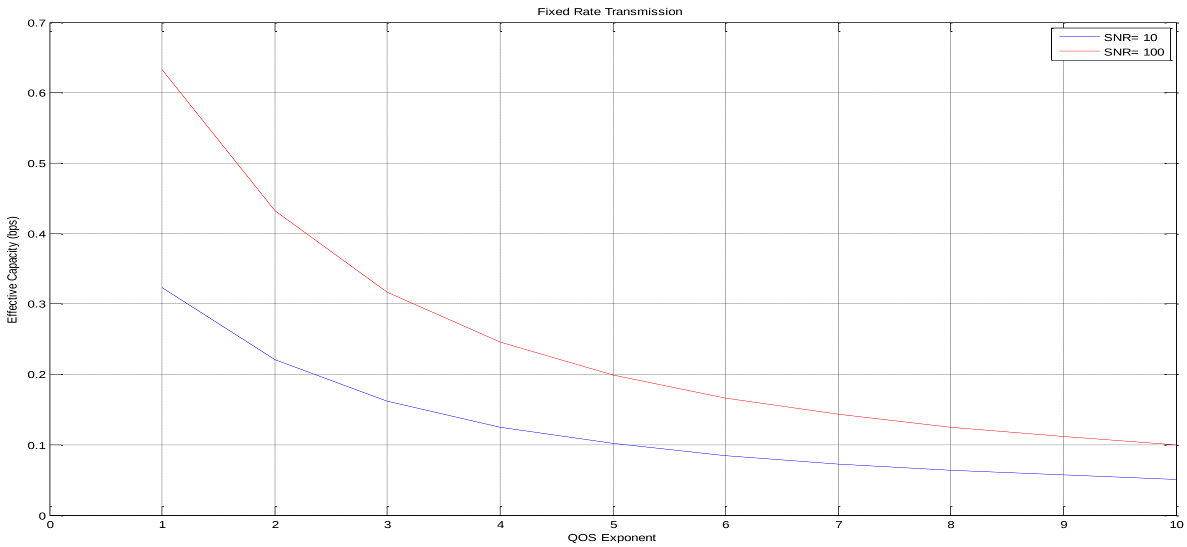

Figure 5: Comparison of effective capacity enhancement versus QoS exponent θ with fixed transmission rate r = 1 bps and SNR = 10 and 100

(b) Findings

Figure 1 shows the traffic response of the network in terms of the throughput. It shows throughput declines only when the flow traffic exceeds the network capacity and this leads to congestion i.e the maximum throughput occurs at measurement point 13 to15 shows that the network is excellent while the poor network exists between 25 to 30measurement points. Figure 2 shows the developed Matlab Simulink Model for effective capacity in the data-switched network using improved Poisson and Markov Processes. MATLAB script was used to code the Poisson and Markov processes into the model. Figure 3 shows the result of effective network capacity as a function of SNR with fixed transmission rate r = 1 bps and QoS exponent θ = 1.It shows that effective network traffic capacity increases more when SNR increases and we have QoS exponent (θ) as 1 than when the QoS exponent (θ) used is 0.1. So QoS exponent is a determinant in improving traffic management in data networks.Figure4 shows a comparison of results of effective capacity as a function of QoS exponent θ with fixed transmission rate r = 1bps and SNR = 10 and 100. When SNR = 10 and θ = 1 then the maximum effective capacity that can support optimum transmission rate is 0.32 bps. A further increase in the transmission rate degrades the effective capacity performance. When SNR = 100 and θ = 1, then the maximum transmission rate obtained for effective network traffic capacity is 0.36 bps.

5. CONCLUSION

This paper formulated an effective transmission rate model to achieve adequate reliability and latency requirements for traffic management. The research incorporated Poisson and Markov source models to investigate their performance over sources arrival traffic and Rayleigh fading channel. In the paper, it was discovered that the source, buffer, and channel characteristics have a major impact on the performance of the model when certain QoS constraints are imposed. We conclude that optimizing the effective network traffic capacity and effective bandwidth concerning the transmission rate allows for high link throughput while allowing larger arrival rates**.**

6. REFERENCES

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