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A Robust Comparative Analytical Study of NICs and its Effect on Internet Network Services

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Abstract:- This research paper clearly identifies the problems of data transmission traffic, erratically slow data and video streaming on the World Wide Web internet through the network interface cards (NICs). It also provides the reliable solutions and appropriate means to address these perennial problems of ICT-Based institutions and organisations. The entire wired or wireless internet data network connectivity of an institution is sustained by the standard of installed Network Interface Cards (NICs). The standard and the relative performance metrics of NIC types such as 1Gbps, 10Gbps and 100Gbps were adequately examined using different information data sizes of 20MB, 40MB, 60MB, 80MB and 100MB which is either meant for data upload or download on the internet network. Specifically, the paper categorically discusses the parameters for performance metrics of each of these Ethernet card which include the data transmission time, data total time delay and throughput. The research work accurately established the active features of the NICs as the major backbone of the Internet network and the transmission control protocol (TCP) which is designed for reliable transmission of data over the internet. TCP as a connectionless protocol of the NIC is majorly used for surfing webs, downloading and uploading files. In practical terms, the TCP is able to dynamically adapt its packet sending rate to the network conditions in order to achieve the highest possible throughput. In a nut-shell, this research paper proposes an upgrade to 100Gbps Ethernet card on the Internet infrastructures of ICT-Based institutions in order to ensure reliable, efficient, sustainable, fast and effective internet data access in all internet devices connected to their networks.

Keywords:- *Ethernet Card, Data transmission traffic, Transmission Control Protocol, Data transmission time. Data Total Time Delay, Throughput, Internet networks.*

I. INTRODUCTION AND CONCEPTUAL FRAMEWORKS

The entire wired or wireless internet data network connectivity of an institution is sustained by the standard of installed Network Interface Cards (NICs). The categorisation of the Ethernet includes Ethernet-10Mbps, Fast Ethernet-100Mbps, and Gigabit Ethernet-1,000Mbps and above. Several protocols are required to provide necessary functionality for internetworking. The software installed and embedded on the Ethernet that provides this is known as the Transport Control Protocol/ Internet Protocol (TCP/IP). TCP/IP acts as glue to link different types of local area networks (LANs) and wide area networks (WANs) to provide a single integrated network or seamless communication. The internet network also form an integral part of this networking which invariably exhibit seamless communication through the TCP/IP. In the reality, the IP provides unreliable connectionless best effort datagram delivery services whereas the TCP/IP provides reliable, efficient and cost-effective end-to-end delivery of information data. When an application uses the connection-oriented service, the client and the server residing in different end systems send control packets to each other before sending the packets with the real data (i.e. e-mail messages, Whatsapp messaging platform etc). This process is referred to as hand-shaking. The so-called hand-shaking procedure alerts the server and client allowing them to prepare for onward transfer of packets. It is interesting to note that this initial hand-shaking procedure is similar to the protocol used in human protocol that is human interaction. Internet's connection-oriented services come with several other services which include, Reliable Data Transfer, Flow Control and Congestion Control. In the case of reliable data transfer, an application can rely on the connection to deliver all of its information data without error and in the proper order. Reliability is achieved through the use of acknowledgement and retransmission. Flow control makes sure that neither side of a connection overwhelms the other side by sending too many packets too fast. The internet's congestion control service help prevent the internet from entering a state of gridlock [21], [22].

The remainder of the paper is organised as follows: Section 2.0 of the research work describes the literature review with significant related and recent related works. The research methodology was extensively discussed in section 3.0. The results were clearly distributed and discussed in section 4.0 and finally the conclusive report was found in section 5.0.

II. LITERATURE REVIEW

A. Recent Related Works

Adaramola et al (2023) a concise technique for the empirical evaluation of internet data channel capacity parameters for improving quality of service (QoS) was proposed. This technique successfully performed in an ICT-based environment [75]

Cibira et al (2022) presented a novel concept developed on statistical data detection and monitoring of sensing signals. This technique successfully performed in an ICT-based environment [16], [61].

Lakshmanna et al (2022) surveyed the major efforts that were achieved in the field of deep learning (DL) for the IoT technology. The survey was implemented in the IoT environments using deep learning on the IoT devices [16], [57].

Schellinas et al (2022) proposed the network performance in the IoT system by incorporating the long Short-term Memory (LSTM) algorithm in the IoT environment using machine learning (ML) and deep learning (DL) [16], [58].

Oktian et al (2022) introduced a bandwidth trading framework to utilize block-chain and software defined networking. This was implemented and tested in an ICT-based institution [16], [62].

Negi et al (2022) proposed and presented an optional control system that minimized the closed-loop of the physical system and reduced the overall data bandwidth cost in the ICT-based environment [16], [63].

Bzai et al (2022) discussed the literature on the classification of three perspective applications using machine learning (ML)-enabled IoT [16], [66].

Subramani et al (2022) proposed a technique to reduce the energy consumption for IoT devices and increased the efficiency in addition to route adjustment scheme. The IoT devices were used in the IoT environment in course of testing the proposed method [16], [64].

Hui et al (2022) proposed a dynamic algorithm for internet data bandwidth allocation. However, the neural network was used to predict and improve its polling mechanism. This was implemented using machine learning (ML) and deep learning (DL) in the IoT-based environment [16], [65].

Chauhan et al (2021) proposed a bandwidth adjustment technique that considered the sensitivity of applications using queuing system in the fog or cloud in an ICT-based organization [16], [54].

Nakhlestani et al (2021) a voltage regulator referred to as low drop-out (LDO) was modelled, designed and constructed. This regulator was used to enhance the availability of data bandwidth for IoT applications in IoT environment. The LDO regulator model was incorporated with a special communication circuits in its implementation [16], [53].

De et al (2021) proposed an antenna design parameterization to enhance the internet data bandwidth and communication in numerous wireless body area networks (WBANs) in an ICT-based environment. The solution is proposed exclusively for WBANs [16], [55].

Mei et al (2021) proposed internet data bandwidth prediction methodology to enhance the quality of experience (QoE) in 4G and 5G networks in a broadband network [16], [56].

Pratap et al (2020) the maximization of the number of tasks for the IoT-based 5G network environment was presented and proposed. This was adequately examined in an ICT-based environment [16], [51].

Wang et al (2020) a scheme flowchart to achieve real-time routing traffic that is timely sensitive in an ICT-based environment introduced and presented. The proposed method was successful when optical networks were utilized [16], [47].

Pappas et al (2020) machine learning (ML) and deep learning (DL) programming was used to predict the data bandwidth in mobile broadband networks in the wide area network (WAN) of an organization [16], [48].

Labonne et al (2020) proposed a method for predicting internet data bandwidth on network links in an organization using machine learning (ML) and deep learning (DL) [16], [49].

Yoo et al (2020) a technique to predict the internet data bandwidth that was available for video streaming over HTTP using the machine learning (ML) and deep learning (DL) in a wide area network (WAN) environment was proposed [16], [50]

Islam et al (2019) proposed a communication trial to enhance the data bandwidth for IoT-based applications for an ICT-based organization and IoT environment. This trial was achieved only from a communication perspective [16], [42].

Medeiros et al (2019) proposed a multi-objective approach to guide the routing process in mixed IoT traffics in IoT environment based on the use of Machine Learning (ML) and Deep Learning (DL). This approach was tested using only a data set of elderly health care scenario [16], [43].

Ghanbari et al (2019) the investigations and survey about resource allocation algorithm and methods in IoT environments was proposed. It supports IoT devices and it ended up as a survey [16], [45].

Fang et al (2019) presented and proposed a learning methodology for software agent to monitor and control the sending rate of internet video calls in an ICT-based institution [16], [46].

Zhao et al (2018) proposed an information flowchart model to minimize usage of bandwidth for IoT applications for an ICT-based institution and IoT environment [16], [40].

Ma et al (2017) proposed two different methods to optimize the allocation of data bandwidth for heterogeneous IoT traffics [16], [39].

Marquesone et al (2017) designed and implemented data bandwidth consumption architecture in an organization without the specification of the IoT technology [16], [37].

Liu et al (2017) proposed a model to adapt the internet data bandwidth in wireless sensor network (WSN) in an institution also considered that the WSN is the same for Internet of Things (IoT) [16], [38].

Ito et al (2016) improvement of transmission links utilization in an ICT-based institution using a specialized algorithm was carried out [16], [36].

Adaramola et al (2015) studied, examined and analysed the performance parameter metrics of NICs. The empirical data analysis was carried out using 10Mbps, 100Mbps, 1,000Mbps and 10,000Mbps NICs. It was proved that 10,000Mpbs was the most effective NIC that has the lowest transmission time whilst transferring message data via the internet network. [30].

Guerin et al. (2012) proposed an approximate expression for the effective data bandwidth of both individual and multiplexed connections. He argued that this approximation is necessary for real-time internet network traffic control [3].

Elwalid et al (2012) an approximate solution for the packet-loss rate (PLR) at a statistical multiplexer using a hybrid Chernoff-dominant eigenvalue (CDE) approach was proposed [7].

Elwalid and Mitra (2011) proposed the effective internet data bandwidth for general Markovian traffic sources in a Wide Area Network [2].

Carlos and Jaime (1998) proposed an admission control scheme based on adaptive internet data bandwidth reservation to provide quality of service (QoS) guarantees for multimedia traffic in high-speed wireless cellular networks. The proposed scheme can also adjust the amount of reserved bandwidth based on the current network conditions [35].

The research on performance of NICs, IEEE 802.11, s-MAC and effective internet data bandwidth solutions has generally been addressed in the context of high-speed wired asynchronous transfer mode (ATM) and wireless networks. In the recent times, it has tremendous advance on the Internet of Things (IoT), Edge and Cloud data bandwidth management of various institutions [11], [12], [13], [15], [16], [17], [19], [67], [68], [69], [70], [71], [72], [73] & [74].

III. RESEARCH METHODOLOGY BASED ON QUALITY OF SERVICE THROUGH ETHERNET CARD CAPACITY

Ethernet data transmissions period on internet and network throughput is extremely crucial to the overall quality of service (QoS) of the internet users. This is a metric to evaluate the performance and effectiveness of the internet services of efficient ICT-based institutions.

The data transmission analysis on the internet via the Ethernet card is needed in order to sufficiently support reasons for upgrade of the enterprise or institution WAN network interface cards. The data analysis is basically achieved using the maximum or highest Round Trip Time (RTT) of the TCP/IP on the Ethernet Cards and the maximum period of data acknowledgement (T_{ack}) as described in [4], [5], [21], [22], [23], [24].

For better analysis, we consider different information data sizes of 20MB, 40MB, 60MB, 80MB and 100MB to be transmitted on the internet network. The channel is having a one-way delay round trip time (RTT) of 1ms and it also configured to receive an acknowledgement in 1ms with the TCP/IP on the Internet [6], [7], [8], [9], [11]. In this scenario, we can analyse the empirical data for the transmission time, total time delay and throughput of the Ethernet as follows:

Considering the link having a maximum channel capacity of 1Gbps, the empirical data for the NIC is analysed using acceptable standards and a comparative performance analysis was examined as well.

Round Trip Time, $RTT_{total} = RTT + T_{ack}$

RTT_{total} = 1ms + 1ms = 0.002 second = 2ms [11], [13], [14].

Consider an Ethernet card with a maximum channel capacity of 1Gbps.

In the first scenario, when a data size of 20MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{20 \times 8 \times 10^6}{1 \times 10^9}$$

T_{tx} = 0.16 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.16

T_{total} = 0.162 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{20 \times 8 \times 10^6}{0.162} = 0.9877 \times 10^9$$

T_{put} =0.9877Gbps

In the second scenario, when a data size of 40MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{40 \text{ x } 8 \text{ x } 10^6}{1 \text{ x } 10^9}$$

T_{tx} = 0.320 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.320

T_{total} = 0.322 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{40 \times 8 \times 10^6}{0.322} = 0.9938 \times 10^9$$

T_{put} =0.9938Gbps

In the third scenario, when a data size of 60MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{60 \text{ x } 8 \text{ x } 10^6}{1 \text{ x } 10^9}$$

T_{tx} = 0.480 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.320

T_{total} = 0.482 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{60 \times 8 \times 10^6}{0.482} = 0.9959 \times 10^9$$

T_{put} = 0.9959Gbps

In the fourth scenario, when a data size of 80MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{80 \text{ x } 8 \text{ x } 10^6}{1 \text{ x } 10^9}$$

T_{tx} = 0.640 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.640

T_{total} = 0.642 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{80 \times 8 \times 10^6}{0.642} = 0.9969 \times 10^9$$

T_{put} =0.9969Gbps

In the fifth scenario, when a data size of 100MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{100 \text{ x } 8 \text{ x } 10^6}{1 \text{ x } 10^9}$$

T_{tx} = 0.800 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.800

T_{total} = 0.802 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{100 \times 8 \times 10^6}{0.642} = 0.9975 \times 10^9$$

T_{put} =0.9975Gbps

Considering the link having a maximum channel capacity of 10Gbps, the empirical data for the NIC is analysed using acceptable standards and a comparative performance analysis was examined as well.

Total Round Trip Time, $RTT_{total} = RTT + T_{ack}$

RTT_{total} = 1ms + 1ms = 0.002 second = 2ms

Consider an Ethernet card with a maximum channel capacity of 10Gbps.

In the first scenario, when a data size of 20MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{20 \text{ x } 8 \text{ x } 10^6}{10 \text{ x } 10^9}$$

T_{tx} = 0.016 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.16

T_{total} = 0.018 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{20 \times 8 \times 10^6}{0.018} = 8.8889 \times 10^9$$

T_{put} = 8.8889Gbps

In the second scenario, when a data size of 40MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{40 \text{ x } 8 \text{ x } 10^6}{10 \text{ x } 10^9}$$

T_{tx} = 0.032 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.032

T_{total} = 0.034 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{40 \times 8 \times 10^6}{0.034} = 9.4117 \times 10^9$$

T_{put} = 9.4117Gbps

In the third scenario, when a data size of 60MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{60 \text{ x } 8 \text{ x } 10^6}{10 \text{ x } 10^9}$$

T_{tx} = 0.048 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.048

T_{total} = 0.050 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{60 \times 8 \times 10^6}{0.050} = 9.600 \times 10^9$$

T_{put} = 9.600Gbps

In the fourth scenario, when a data size of 80MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{80 \times 8 \times 10^6}{10 \times 10^9}$$

T_{tx} = 0.064 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.064

T_{total} = 0.066 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{80 \times 8 \times 10^6}{0.066} = 9.6970 \times 10^9$$

T_{put} = 9.6970Gbps

In the fifth scenario, when a data size of 100MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{100 \times 8 \times 10^6}{10 \times 10^9}$$

T_{tx} = 0.080 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.080

T_{total} = 0.082 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{100 \times 8 \times 10^6}{0.082} = 9.7561 \times 10^9$$

T_{put} = 9.7561Gbps

Considering the link having a maximum channel capacity of 100Gbps, the empirical data for the NIC is analysed using acceptable standards and a comparative performance analysis was examined as well.

Total Round Trip Time, $RTT_{total} = RTT + T_{ack}$

RTT_{total} = 1ms + 1ms = 0.002 second = 2ms

Consider an Ethernet card with a maximum channel capacity of 100Gbps.

In the first scenario, when a data size of 20MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{20 \times 8 \times 10^6}{100 \times 10^9}$$

T_{tx} = 0.0016 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.0016

T_{total} = 0.0036 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{20 \times 8 \times 10^6}{0.0036} = 44.4444 \times 10^9$$

T_{put} = 44.4444Gbps

In the second scenario, when a data size of 40MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{40 \times 8 \times 10^6}{100 \times 10^9}$$

T_{tx} = 0.0032 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.0032

T_{total} = 0.0052 second

Throughput, T_{put} is computed as:

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$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{40 \times 8 \times 10^6}{0.0052} = 61.53846 \times 10^9$$

T_{put} = 61.5385Gbps

In the third scenario, when a data size of 60MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{60 \text{ x } 8 \text{ x } 10^6}{100 \text{ x } 10^9}$$

T_{tx} = 0.0048 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.0048

T_{total} = 0.0068 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{60 \times 8 \times 10^6}{0.0068} = 70.5882 \times 10^9$$

T_{put} =70.5882Gbps

In the fourth scenario, when a data size of 80MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{80 \text{ x } 8 \text{ x } 10^6}{100 \text{ x } 10^9}$$

T_{tx} = 0.0064 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.0064

T_{total} = 0.0084 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{80 \times 8 \times 10^6}{0.0084} = 76.1905 \times 10^9$$

T_{put} = 76.1905Gbps

In the fifth scenario, when a data size of 100MB was considered:

Transmission time, T_{tx} is given as:

$$T_{tx} = \frac{\text{Data Size}}{\text{Channel} - \text{Bandwidth}}$$

$$= \frac{100 \text{ x } 8 \text{ x } 10^6}{100 \text{ x } 10^9}$$

T_{tx} = 0.080 second

Total time delay, T_{total} is given as:

$T_{total} = RTT_{total} + T_{tx}$

= 0.002 + 0.008

T_{total} = 0.01 second

Throughput, T_{put} is computed as:

$$T_{put} = \frac{\text{Data size}}{\text{Total Time delay}}$$

$$= \frac{100 \times 8 \times 10^6}{0.01} = 80 \times 10^9$$

T_{put} = 80Gbps

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IV. RESULTS AND DISCUSSION

The Network Interface Cards (NICs) comparative performance analysis was empirically carried out with very robust and reliable results. The detailed results are shown in the tables below.

Table 1: The Data Transmission Time of 1Gbps Ethernet Card

Data Size (MB)	Data Transmission Time (ms)	Throughput (Gbps)
20.0	160	0.9377
40.0	320	0.9938
60.0	480	0.9959
80.0	640	0.9969
100.0	800	0.9975

Table 2: The Parameterization Metrics of 1Gbps Ethernet Card

Data Size (MB)	Data Total Time Delay (ms)	Throughput (Gbps)
20.0	162	0.9377
40.0	322	0.9938
60.0	482	0.9959
80.0	642	0.9969
100.0	802	0.9975

Table 3: The Data Transmission Time of 10Gbps Ethernet Card

Data size (MB)	Data Transmission Time (ms)	Throughput (Gbps)
20.0	16	8.8889
40.0	32	9.4117
60.0	48	9.6000
80.0	64	9.6970
100.0	80	9.7561

Table 4: The Parameterization Metrics of 10Gbps Ethernet Card

Data size (MB)	Data Total Time Delay (ms)	Throughput (Gbps)
20.0	18	8.8889
40.0	34	9.4117
60.0	50	9.6000
80.0	66	9.6970
100.0	82	9.7561

Table 5: The Data Transmission Time of 100Gbps Ethernet card

Data Size (MB)	Data Transmission Time (ms)	Throughput (Gbps)
20.0	1.6	44.4444
40.0	3.2	61.5385
60.0	4.8	70.5882
80.0	6.4	76.1905
100.0	8.0	80.0000

Table 6: The Parameterization Metrics of 100Gbps Ethernet card

Data Size (MB)	Data Total Time Delay (ms)	Throughput (Gbps)
20.0	3.6	44.4444
40.0	5.2	61.5385
60.0	6.8	70.5882
80.0	8.4	76.1905
100.0	10.0	80.0000

The MATLAB programmes developed and simulated with empirical data are displayed in Appendix A of this paper.

The graphs of the different parameters for analysing the effectiveness of the NICs are displayed hereunder.

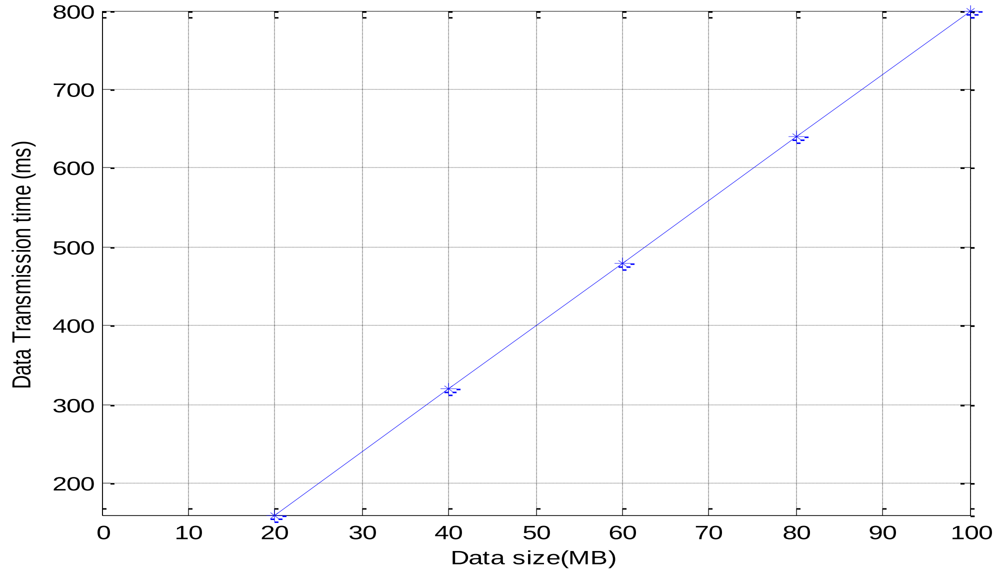

Fig. 1: Data Transmission Time versus Data Size in 1Gbps Ethernet Card

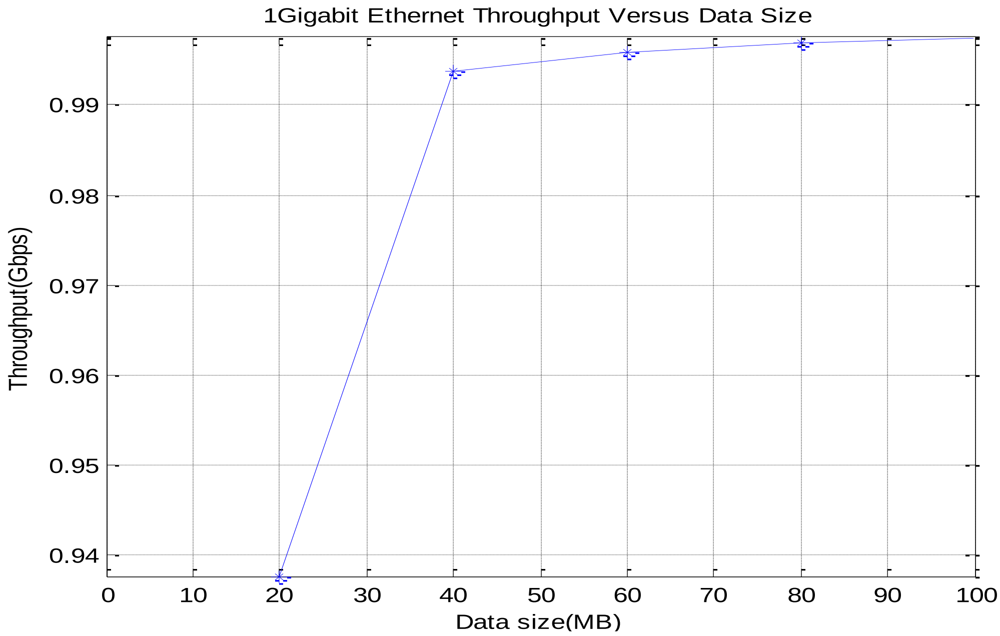

Fig. 2: Throughput versus Data Size in 1Gbps Ethernet Card

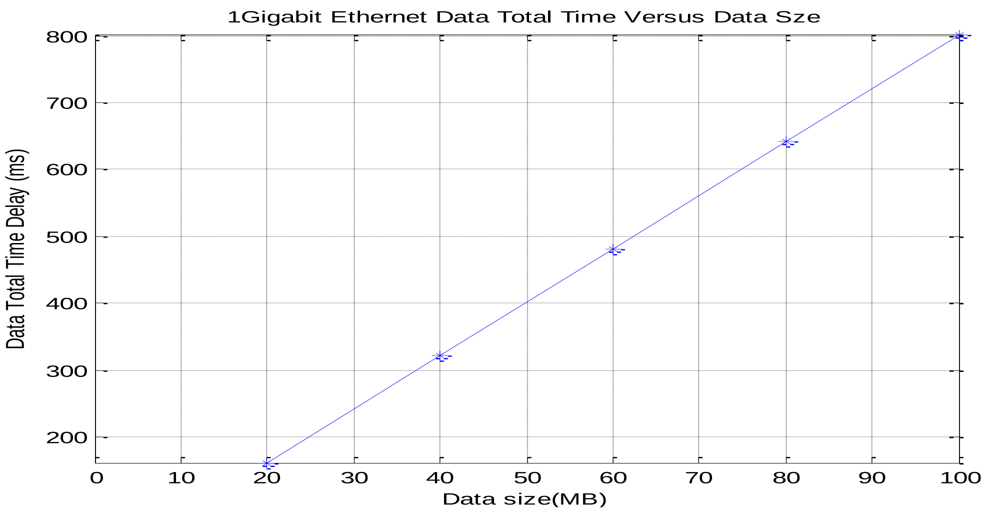

Fig. 3: Data Total Time Delay versus Data Size in 1Gbps Ethernet Card

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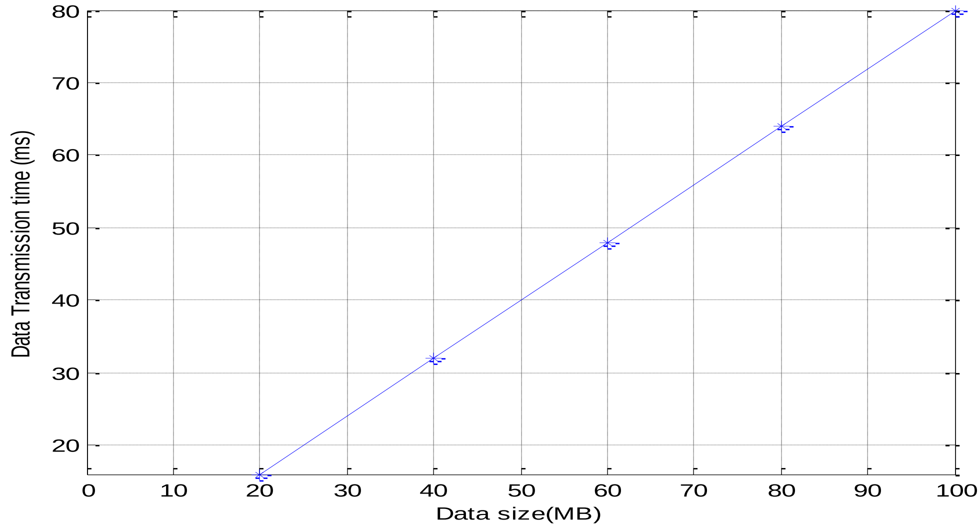

Fig. 4: Data Transmission Time versus Data Size in 10Gbps Ethernet Card

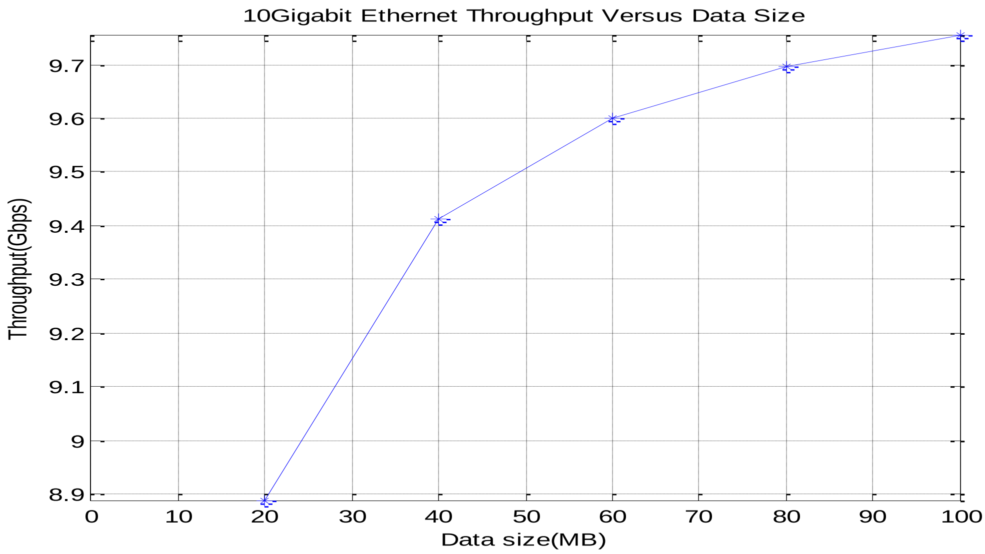

Fig. 5: Throughput versus Data Size in 10Gbps Ethernet Card

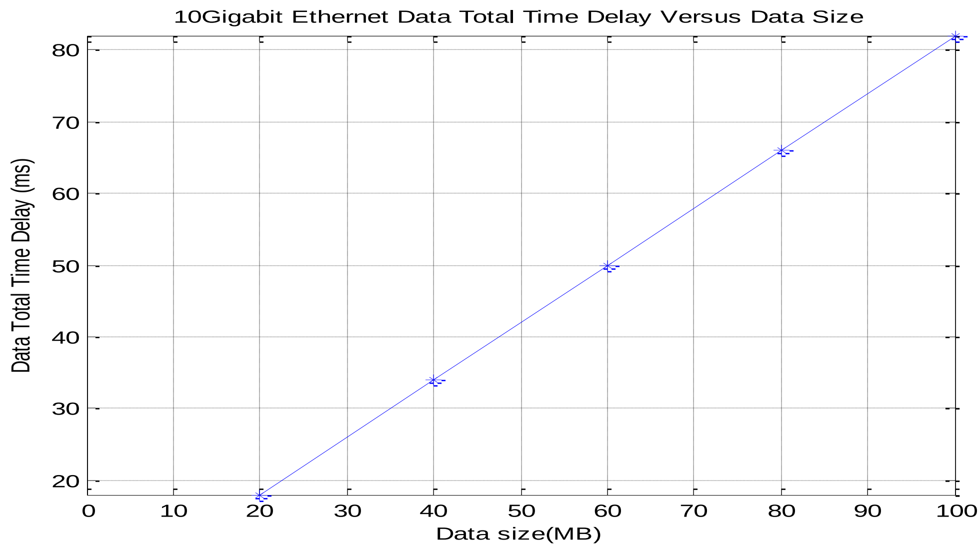

Fig. 6: Data Total Time Delay versus Data Size in 10Gbps Ethernet Card

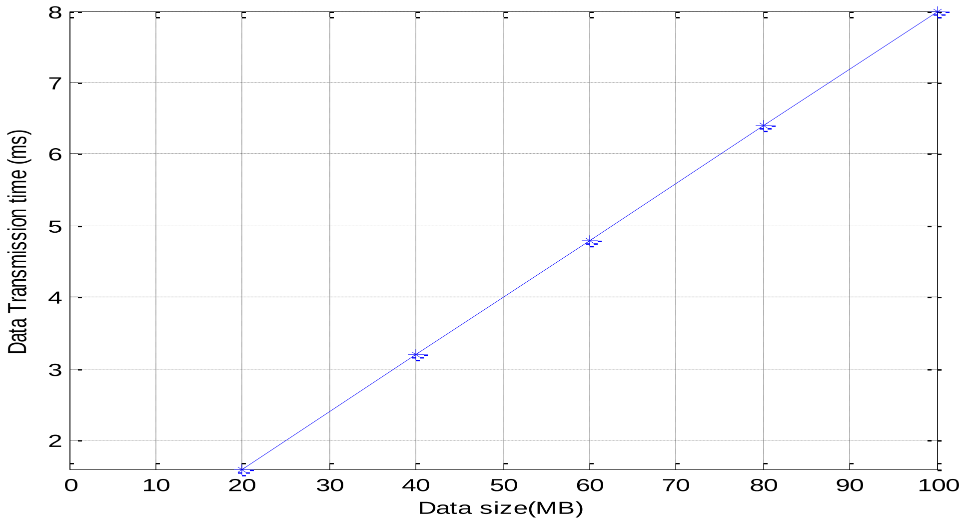

Fig. 7: Data Transmission Time versus Data Size in 100Gbps Ethernet Card

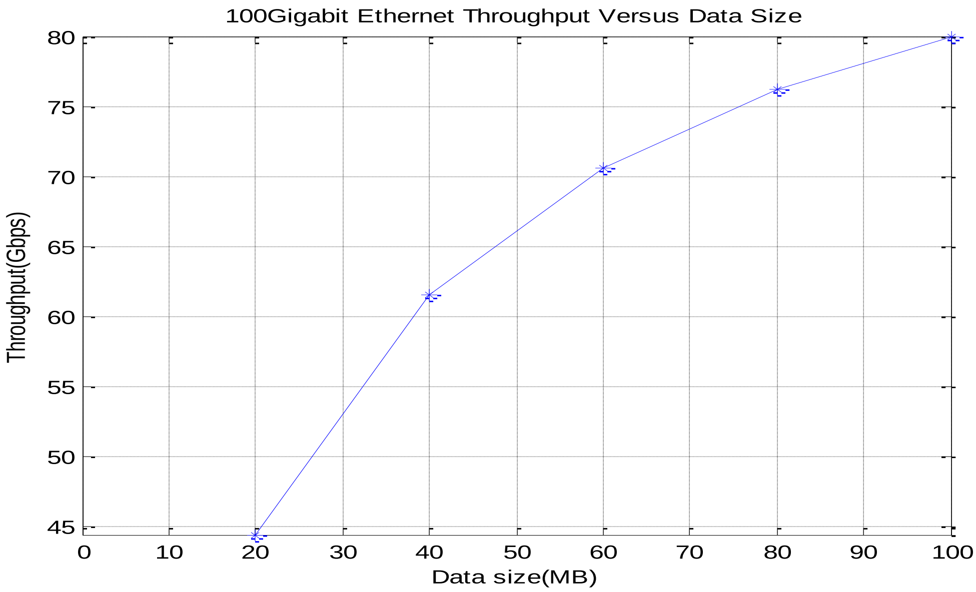

Fig. 8: Throughput versus Data Size in 100Gbps Ethernet Card

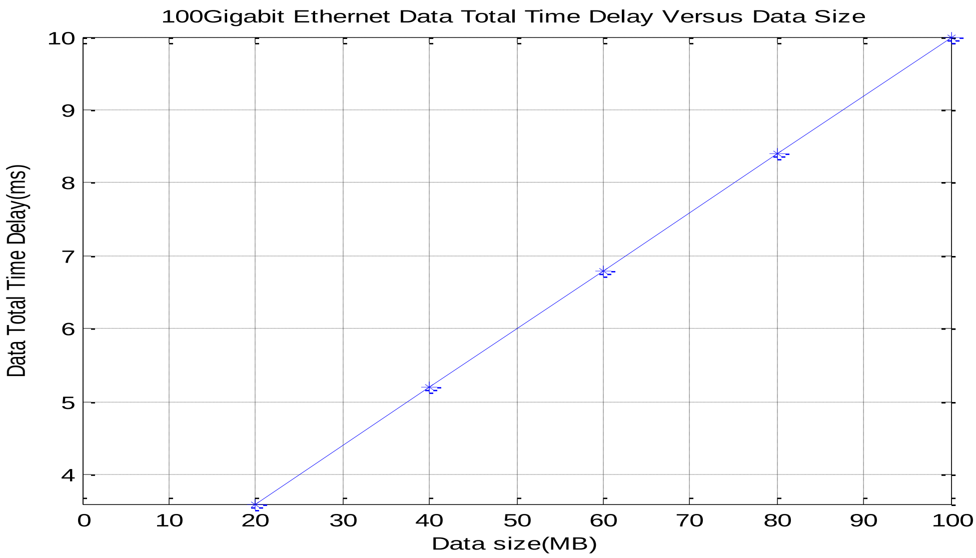

Fig. 9: Data Total Time Delay versus Data Size in 100Gbps Ethernet Card

In the process of examining the Ethernet internet data transmission analysis, the results showed that 100Gigabit Ethernet has the best performance analysis. The detailed results are clearly displayed in the tables and graphs above. The comparative analysis can be expressed as follows:

- Figure 1 shows that a linear relationship exists between the data transmission time and the data size. As a result of this, a 1Gbps Ethernet can transfer a data size of 100MB in 800 milliseconds over the internet network with a throughput of 0.9975Gbps.
- Figure 2 is an asymptotic plot of the throughput versus the data size. As a result of this, a 1Gbps Ethernet card could exhibit a channel capacity of 0.9975 Gbps in the process of transmitting a data size of 100MB over the internet network.
- Figure 3 shows that there is a linear relationship between the data total time delay and the data size. Therefore, a 1Gbps Ethernet can transfer a data size of 100MB in 800 milliseconds over the internet network with a throughput of 0.9975Gbps and a total time delay of 802 milliseconds.
- Figure 4 shows that a linear relationship exists between the data transmission time and the data size. As a result of this, a 10Gbps Ethernet can transfer a data size of 100MB in 80 milliseconds over the internet network with a throughput of 9.97561Gbps.
- Figure 5 is an asymptotic plot of the throughput versus the data size. As a result of this, a 10Gbps Ethernet card could exhibit a channel capacity of 9.97561 Gbps in the process of transmitting a data size of 100MB over the internet network.
- Figure 6 shows that a linear relationship exists between the data total time delay and the data size. As a result of this, a 10Gbps Ethernet can transfer a data size of 100MB in 80 milliseconds over the internet network with a throughput of 9.97561Gbps and a total time delay of 82 milliseconds.
- Figure 7 shows that a linear relationship exists between the data transmission time and the data size. As a result of this, a 100Gbps Ethernet can transfer a data size of 100MB in 8 milliseconds over the internet network with a throughput of 80Gbps.
- Figure 8 is an asymptotic plot of the throughput versus the data size. As a result of this, a 100Gbps Ethernet card could exhibit a channel capacity of 80 Gbps in the process of transmitting a message size of 100MB over the internet network.
- Figure 9 shows that a linear relationship exists between the data total time delay and the data size. As a result of this, a 100Gbps Ethernet can transfer a data size of 100MB in 8 milliseconds over the internet network with a throughput of 80Gbps and a total time delay of 10 milliseconds.

V. CONCLUSION

In this research work, the comparative parameterization metrics and performances of the 1Gbps, 10Gbps and 100Gbps Ethernet Interface cards were examined. With reference to the graphical analysis earlier described, 100Gbps NIC proved to be the most reliable, effective and efficient in terms of its data transmission time and throughput on the internet network. This NIC could achieve the fastest data transmission time and highest possible throughput while surfing the webs, downloading and uploading files. Invariably, it possesses an empirical throughput of 80Gbps and data transmission time of 8milisecond in the process of transmitting information data size of 100MB on the Internet network [10]. As a result of this, a 100Gbps Ethernet card could exhibit a channel capacity of 80 Gbps in the process of transmitting information data size of 100MB over the internet network.These parameterization metrics of this NIC had already translated to the means of ensuring quaity of service (QoS) in ICT-based institutions and organisations.

VI. RECOMMENDATIONS

It is recommended that the wired network cabling of the entire ICT-based institution be upgraded to optic-fiber to complement the capacity of the throughput of the 100Gbps Ethernet card whilst surfing the webs. The overall outcomes of this research work showed that the excellent performance of the optic-fiber cabling is highly preferable to that of UTP Category 5, 6 or 7. In order to ensure high quality of service (QoS), it is highly recommended that a 100Gbps Layer 3 Stackable and Chassis switches which produce the best data transfer speed be installed on the wired internet network of the institution. This network switch has better performance when compared with the store-and-forward type mostly used in the institution of higher learning.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX A

MATLAB PROGRAM OF ETHERNET DATA TRANSMISSION TIME AND THROUGHPUT

```
clc
clear
N=[20,40,60,80,100];
T1 =[160.0,320.0,480.0,640.0,800.0];
T2 =[0.9377,0.9938,0.9959,0.9969,0.9975];
T3 =[16.0,32.0,48.0,64.0,80.0];
T4 =[8.8889,9.4117,9.6000,9.6970,9.7561];
T5 =[1.6,3.2,4.8,6.4,8.];
T6 =[44.4444,61.5385,70.5882,76.1905,80.0000];
figure(1), plot(N,T1, '*-'),axis([0,100,160,800])
xlabel('Data size(MB)')
ylabel('Data Transmission time (ms)')
grid on
figure(2), plot(N,T2, '*-'),axis([0,100,0.9377,0.9975])
xlabel('Data size(MB)')
ylabel('Throughput(Gbps)')
grid on
figure(3), plot(N,T3, '*-'),axis([0,100,16,80])
xlabel('Data size(MB)')
ylabel('Data Transmission time (ms)')
grid on
figure(4), plot(N,T4, '*-'),axis([0,100,8.8889,9.7561])
xlabel('Data size(MB)')
ylabel('Throughput(Gbps)')
grid on
figure(5), plot(N,T5, '*-'),axis([0,100,1.6,8.0])
xlabel('Data size(MB)')
ylabel('Data Transmission time (ms)')
grid on
figure(6), plot(N,T6, '*-'),axis([0,100,44.4444,80.0000])
xlabel('Data size(MB)')
ylabel('Throughput(Gbps)')
grid on
```

MATLAB PROGRAM OF ETHERNET DATA TOTAL TIME DELAY AND THROUGHPUT

```
clc
clear
N=[20,40,60,80,100];
T1 =[162.0,322.0,482.0,642.0,802.0];
T2 =[0.9377,0.9938,0.9959,0.9969,0.9975];
T3 =[18.0,34.0,50.0,66.0,82.0];
T4 =[8.8889,9.4117,9.6000,9.6970,9.7561];
T5 =[3.6,5.2,6.8,8.4,10.0];
T6 =[44.4444,61.5385,70.5882,76.1905,80.0000];
figure(1), plot(N,T1, '*-'),axis([0,100,162,802])
xlabel('Data size(MB)')
ylabel('Data Total Time Delay (ms)')
title('1Gigabit Ethernet Data Total Time Versus Data Sze')
grid on
figure(2), plot(N,T2, '*-'),axis([0,100,0.9377,0.9975])
xlabel('Data size(MB)')
ylabel('Throughput(Gbps)')
title('1Gigabit Ethernet Throughput Versus Data Size')
grid on
figure(3), plot(N,T3, '*-'),axis([0,100,18,82])
xlabel('Data size(MB)')
ylabel('Data Total Time Delay (ms)')
title('10Gigabit Ethernet Data Total Time Delay Versus Data Size')
grid on
figure(4), plot(N,T4, '*-'),axis([0,100,8.8889,9.7561])
xlabel('Data size(MB)')
ylabel('Throughput(Gbps)')
title('10Gigabit Ethernet Throughput Versus Data Size')
grid on
figure(5), plot(N,T5, '*-'),axis([0,100,3.6,10.0])
xlabel('Data size(MB)')
ylabel('Data Total Time Delay(ms)')
title('100Gigabit Ethernet Data Total Time Delay Versus Data Size')
grid on
figure(6), plot(N,T6, '*-'),axis([0,100,44.4444,80.0000])
xlabel('Data size(MB)')
ylabel('Throughput(Gbps)')
title('100Gigabit Ethernet Throughput Versus Data Size')
grid on
```

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Michael Funso Adaramola is a Lecturer in the Department of Electrical and Electronics Engineering, Lagos State University of Science and Technology, Ikorodu, Lagos State, Nigeria. He received the B.Eng. degree in Electrical and Electronics Engineering from University of Ilorin, Ilorin in 1991 and the M.Sc. degree in Communication Engineering from University of Lagos, Lagos State in 2012. He is currently a Ph.D. student in Electronics and Computer Engineering Department of Lagos State University, Epe, Lagos State. He had done an outstanding research work on FFT Algorithm and Effects of Data windowing on Power Spectral Estimation during his first degree programme in 1991. He was awarded the best student in Electronics and Communication Engineering option during his first degree academic works in university of Ilorin, Ilorin, Kwara State, Nigeria. Additionally, he is currently engaged in research analysis on Internet Services performance of ICT-based Institutions of higher learning and Quality of Service parameters. He became a registered member of the Council for the Regulation of Engineering in Nigeria (COREN) on 21st December, 2009 where he was awarded the R. Eng. Certification. He has over fifteen (15) years of lecturing experience in higher institutions and research works. However, his current area of research work includes Internet Data Communication and Networks Design, Implementation and Management, Wireless Communication Systems Design and Implementation, GSM Switching Systems Design, Microwave Engineering Systems Design, Digital Signal Processing Systems Analysis, and Time Series Systems Design. Already, he has published over twenty (20) articles in both local and international journals.

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Oluwagbemiga Omotayo Shoewu had his B.Sc. in Electronics and Computer Engineering, M.Sc. in Electrical Engineering and Ph.D. in Electronics and Telecommunication Engineering. He also studied Post-graduate Diploma in Education. He is currently a member of IEEE and IETF. He is founder and pioneer of Wireless Communication Research Group (WCRG) in Lagos State University, Epe Campus, Lagos State, Nigeria. He is a pioneer in Radio Wave Propagation for Cellular Networks in Dry land and Wetland terrains in Nigeria. He is also a specialist in Wireless Communication Systems Design and Implementation. His research works has influenced many International Researchers around the globe. Recently, he and his students invented the SOUP, SPOUSE and BASKET mobile applications for wireless communication designs. He is currently the Head in the Department of Electronics and Computer Engineering, Faculty of Engineering, Lagos State University, Lagos State, Nigeria. He has contributed to over150 papers both in local and international journals.

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Research and Academic Experience:	Engineering Institute of Technology (Supervisor-Postgraduate) July 2021- Till date University of Canberra, Australia – Graduate Student Researcher Sept 2012 – April 2016 • Conducted research on "Modelling and Simulation of an Efficient Dynamic Smart Solar Power Grid System" under the supervision of Prof. Xu Huang & Dr. Dat Tran University of Canberra, Australia – Research Assistant - Aug 2013 – Nov 2013 • Ensured compliance with safety rules in laboratory settings. • Facilitated practical demonstrations to reinforce theoretical learning. • Provided assistance to students struggling with experiment procedures. • Conducted laboratory classes and assessed student performance. Lagos State Polytechnic, Nigeria - (Lecturer) - Jan 2011 – Sept 2012 • Prepared and delivered lectures with excellent communication skills. • Consulted with students to clarify course material and assignments. • Marked and assessed student work. • Developed lecture materials with guidance from the course coordinator.
Research Area:	Renewable /Green (Solar) Energy, Electrical Power Systems
Number of Published papers:	15 International papers