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CLASDN- An Extension in Networking for Efficient Multimedia Data Transmission

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***Abstract*—** Network communication has been experiencing major changes over the last few decades as the number of Internet applications is increasing at an exponential rate. The devices that are used to access the internet, the applications that are accessed over the internet and the types of networks are changing continuously. Although layering is based on sound engineering principles and was a huge success in wired networks, the layered stack of protocols is not tuned to handle multimedia applications in interactive environment and to address this cross-layer conception is envisioned. Cross-layer collaborations can work between an existing stack of protocols and are a promising solution. To exploit adaptability cross-layering allows sharing across protocols and layers and allows information exchange. In this paper, we proposed a working technique called Cross-Layer Approach-based Software Defined Networking (CLASDN) technique that makes the multimedia delivery effectually in networks.

***Keywords*—** Networking, Software Defined Network, Multimedia, Transmission Cross-layer.

I. INTRODUCTION

As the TCP/IP protocols are designed and adapted for wired networks, transmission of wireless data gives difficulties to the accurately stated and rigid protocol stack. Recently, there has been substantial interest and research into the modeling of protocols suitable for wireless networks which permit some level of coordination across the layers. This is popularly known as cross -layered approach. The cross-layered methodology is not a new terminology. It is being studied for the most recent ten years, but its significance has increased now because of the huge success of the wireless systems and the wide use of multimedia applications [1].

Software addresses and solves existing problems. While Computer Science research is vastly different from commercial development, it is hoped that Software-defined networking (SDN) can contribute something useful to the development of networks in the communication context. SDN enables to create highly programmable networks using workflow automation. It helps in overcoming the drawbacks related with layering network infrastructure. The Software Defined Networking (SDN) has great potential to give a breakthrough for many Internet of Things (IoT) concepts. For the flexibility in controlling and managing the intricate network and to make data traffic management, SDN acts as one of the major motivations. The increased market of SDN is as shown below Figure. 1. From the surveys of Market Research Future, it is forecasted that global software-defined networking market is anticipated to raise at USD 61 Billion by the end of 2023, and at 39% of CAGR between 2017 and 2023 [2], [3].

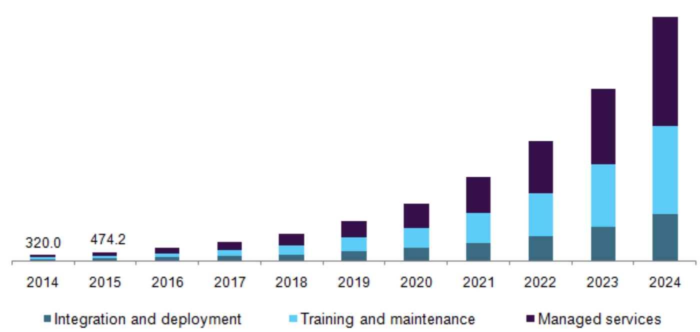

Figure 1. Global SDN market by services between 2014 - 2024 (USD Million)

Delivering bandwidth savvy multimedia traffic in different network environments is a challenge. The intrinsic specification of media activity is the prerequisite of Quality of Service. Technical parameters like latency, bandwidth, jitter, and delay are used to measure these parameters.

However, the best effort services are supported by the existing internet services. There is a high demand on multimedia delivery with smooth access to the internet with mobile and wireless access that increases the dependency on the internet for various services over the wireless internet that indeed demands huge delivery of multimedia [4]. Various layers have altered effects in delivering quality oriented multimedia services. In the meantime, due to the diverse functionality of the layers, they have different approaches to improve multimedia transmission [5].

From the user's perspective, multimedia means information that can be represented in the form of audio and video and also text, images as well as graphics and animation. The Internet is a major source of data communication. The user requires the real-time multimedia services to access in devices also without any reconfiguration or any extra work with cost on the user. There are some causes of diminished quality in real-time multimedia streaming. Understanding the quality of multimedia streams in real time is very important as the amount of multimedia content on the internet increases day by day [6].

The user requires Quality of Service (QoS) for using these vast devices for multimedia streaming and efficient usage of a resource of the network in real-time. The congestion control is one of the major challenges to be addressed in networks [7]. The need to define QoS arises from the realization that the users require different quality presentations at different times. The growth of multimedia applications over wide area networks in real time for multimedia applications has increased research interest in QoS. Parameterization allows for flexibility and customization of the services so that each application does not result in implementing a few of new set of service providers.

The main objective of this paper is to address the transmission efficiency of multimedia data for interactive applications using Cross-Layer Approach-based Software Defined Networking (CLASDN) technique. A framework and algorithm are developed to describe the process of effective networking. Section 2 presents the background study, section 3 presents the technique implemented, section 4 presents the results of the technique, and section 5 presents the conclusion.

II. Related Work

There are many studies in cross-layer approach in the context of multimedia, and SDN but has various drawbacks as specified in below Table 1 and followed by the background study.

Table 1: Study of Multimedia Data Transmission Over Layers

Authors	**Application Layer**	**Transport Layer**	**Network Layer**	**Data Link Layer**	**Physical Layer**
Rung-Shiang Cheng [8]	-	Reliable end-to-end byte streaming, transmission throughput,	Link breakage notifications	Reliable data transmission	Distinct propagation characteristics
FeiXie [9]	Video-on-demand, Patching	-	multicast routing	channel allocation, admission control	Preservation of Bandwidth and multicast
Lijun Chen [10]	-	Routing, Joint congestion control, and scheduling designs	Network resource allocation	congestion control throughout multi-hop networks	-
Bjorn Scheuermann [11]	-	Congestion control, process-to process Communication	Data routing, queue management	Acknowledgements and retransmissions	-
Mohammad HosseinYaghmaee [12]	System lifetime, Error detection, Response time, Data reliability and Data resolution	Congestion control	robustness, routing, maintenance, Path latency	Throughput, Communication range, transmission reliability, and energy efficiency	-
Bo Fu [13]	QoS, Security, Secure coding and packetization	Congestion-distortion Optimized scheduling	Congestion-optimized routing	Capacity assignment	Adaptive modulation
Denis Rosario	Robust video	-	-	Link quality,	Quality commun

[14]	distribution, error coding			energy, and human visual system information	ication

In [15], a critique of SDN challenges for the future Internet is addressed. Convergence, programmability, cloud platforms, architecture, and mobility concepts are classified based on their specifications. It shows how SDN research involved in centralized and distributed control planes. Challenges in mobility management and virtualization are also given attention, and bandwidths are quite complex to detect in such networks. In [16], the paper follows the OpenFlow and describes the challenges of SDN in an infrastructure layer, a control layer, and an application layer. The authors show SDN benefits in providing enhanced configuration and improved performance. Various design guidelines and the SDN projects are projected. Standardization, Implementation, and Deployment are the challenges specified for better future networks.

In [17], for the better availability of requirements and real-time behavior, SDN is revealed as the cloud model to adopt in telecom networks along with virtualization. Benefits of SDN in multitude environments such as networks and data centers and described. What the authors view to simplify the network architecture using L3 routing and L2 switching equipment's. SDN exploits various advantages of using it in building networks, and programmable devices that simplify the management, and also by calculating overall delay, the performance can be improved is the challenge specified. In [18], the authors explain how to achieve manage routing in networks with controlled logical software. Various design principles of SDN are summarized. SDN technologies principles, challenges, applications, and the driving forces of SDN are explained.

In [19], an overview of SDN techniques is described. The SDN paradigms regarding Network management and its design for potential benefits are offered. The state of the art of control plane and data plane are briefly discussed. And also, existing applications of SDN are also explained, challenges on bandwidth, throughput, and delay are also envisioned. In [20], the authors presented various studies on cloud computing that focus on network virtualization, security, and power optimization. The authors propose the configuration, evaluation methods, and application models. Various projects that deal with energy efficient power management are also focused. Joint, Host, and Network optimization techniques are discussed in detail to achieve QoS management. In [21], authors propose a solution for wireless personal area networks. Using centralized and logical software controller the technique is implemented. The results depict the improvement of performance in network management. There are various techniques which explores the gain in bandwidth and achieve other QoS parameters like security as shown in [22], [23].

To overcome the above-said drawbacks, novel fusion techniques using the cross-layer approach, and a new dimension for communication is proposed in networks using CLASDN technique as discussed in next section 3.

III. CROSS-LAYER APPROACH-BASED SOFTWARE DEFINED NETWORKING (CLASDN) TECHNIQUE

The SDN gives the following applications and usability for the multimedia data transmission

Table 2: Study of SDN metrics, and usability

Metric	Application	Usability
Multimedia systems usability measure	Multimedia Systems	Learnability, efficiency, delivery, satisfaction, quality
Software usability measure inventory	Software	Control, efficiency, affect

The following figure 2, gives the detailed architecture of CLASDN technique, that contains Communication medium, users, coordination, Devices, and content as the panels in it.

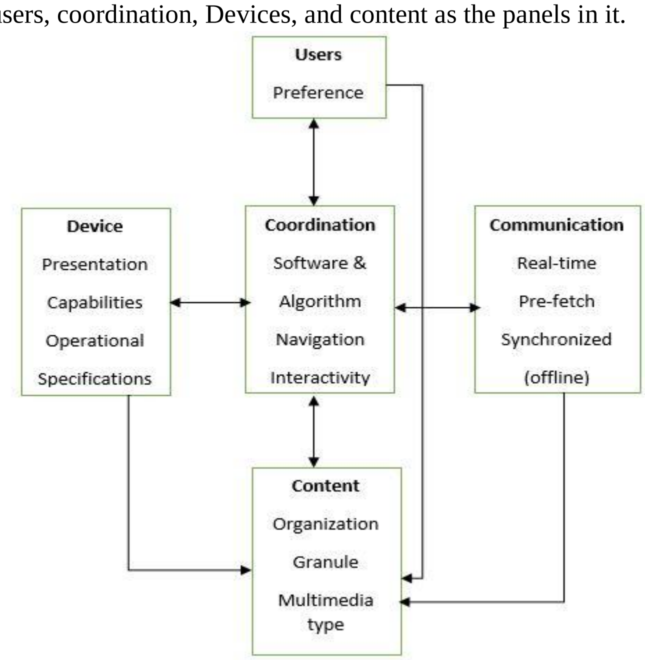

Figure 2. The architecture of CLASDN technique

CLASDN Architectural Dimensions:
CLASDN have Five dimensions for efficient transmission of multimedia data in networks using software-defined network cross-layer approach. In communication, the sub-dimension mode of real-time transmission, throughput determines the multimedia adaptation capabilities. We use prefetching for interactive applications. For the seamless adaptation, we use synchronization in offline mode. The coordination mode represents navigation, software and algorithm techniques, and interactivity to provide better Quality of Experience (QoE) to the users. For calculating the improvement in performance, we are calculating delay and bandwidth in the transmission.

Novel Cross-layer technique:
In this paper, we are proposing *Circular Cross-layer interaction (CC Technique)* based on cross-layer interactions on completely new abstractions for the world of protocols. In this technique, the layers are virtually imagined in a manner of circular fashion of layers, such that each layer automatically has access to its previous and succeeding layers.
Let us consider an example to achieve better transmission; we use mainly four layers, i.e., Application layer, Network layer, Transport layer, and MAC layer along with SDN technique.

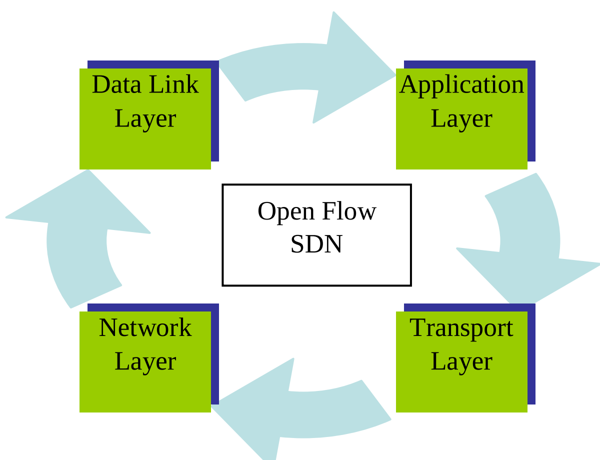

Figure 3. CC Technique

Delay and bandwidth calculation:
For offering better QoS, the residual bandwidth is to be known. It is trivial in wired networks, as it has a point-to-point medium. Whereas, in wireless networks, a node can use the shared channel when all of its neighbors do not send or receive the packets. We use a ratio of busy and free times to estimate the residual bandwidth (R_b) using IEEE 802.11. The algorithm to evaluate the priority score in the transmission using SDN technique is as shown in the following Algorithm.

Algorithm: OpenFlow CLASDN technique for transmission

A message is delivered from u to v when a new neighbor tries to connect a node. The Lscore parameter gives distance. As the sequence is more, the score increases.
We consider B_r as bandwidth requested, the elementary function of bandwidth E_c, M_b gives the maximum achieved bandwidth, R_b is cross-layered for network layer to compute E_c.

$$E_c = B_r / M_b - (R_b + B_r) \quad - (1)$$

The delay function can be calculated using the following equation (2), delay can be given by

$$D_n = (D_{init.} - D_{ack}) + P_e \quad - (2)$$

Where D_n is a delay at the n^{th} node, D_{init} is a delay at starting node, D_{ack} is a delay of acknowledgments, and P_e is the error probability.

The end to end global performance called P_g results from bandwidth elementary function and delay values is as shown below in equation (3)

$$P_g = B_r / M_b - (R_b + B_r) + (D_{init.} - D_{ack}) + P_e \quad - (3)$$

Input: *CS* the candidate sequences to evaluate and D_u the partition of node *u* at time *t*.
Ouput: *LSCORE* the set of local scores assigned to each sequence.
Begin
If (recv(v,connect) **then** send(v,@ Distributed$_{SP}$); **EndIf**
If (recv(@Distributed$_{SP}$,CS) **then**
  For (S ∊ CS) **do**
    LSCORE[S] ← ∅;
    If (S ⊆ D_u) **then**
    LSCORE[S] ← 100+size(S);
 EndIf
    Else
      //Give S a mark, and a better mark to long sequences
      LSCORE[S]←(size(LCS(S, D_u))*100)/size(S))-size(S);
  EndFor
  send(@Distributed$_{SP}$, LSCORE);
EndIf
End

The results are shown in the next section.

IV. Results and Discussion

The CLASDN is integrated with different schemes to select the best path for multimedia data transmission. The traffic parameters are given in following table 3.

Obtained residual bandwidth and delay are shown in figures 4 and 5.

Table 3: CLASDN specifications over different video genres and traffics

Upstream traffic		Downstream traffic	
Mean Packet Size (bytes)	Mean Inter- Departure time (ms)	Mean Packet Size (bytes)	Mean of Inter-Departure time (ms)
35.03	2.9	1,108.59	1.6
61.19	3.3	722.58	1.8
34.01	2.6	955.65	2.48
59.83	1.5	674.38	2.1

The graph contains various schemes like Analytical GUI Aware Routing (AGAR), Delay Built Dijkstra (DBD), Equivalent Charge Multi-Path routing (ECMP), Hedera, and compared with Cumulative Delivery Function (CDF) and Residual bandwidth. Figure 4 shows CDF measured for 100 video flows using CLASDN technique in various schemes. From figure 4, we can see AGAR has better CDF than others.

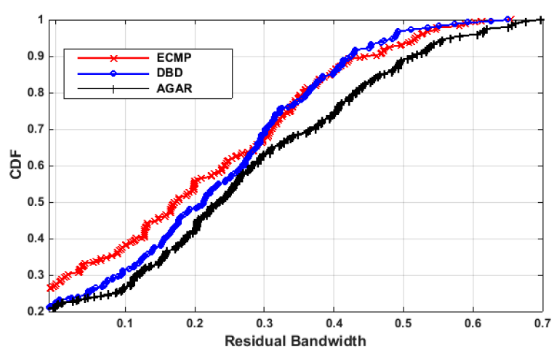

Figure 4. Residual bandwidth for average 100 video transmissions

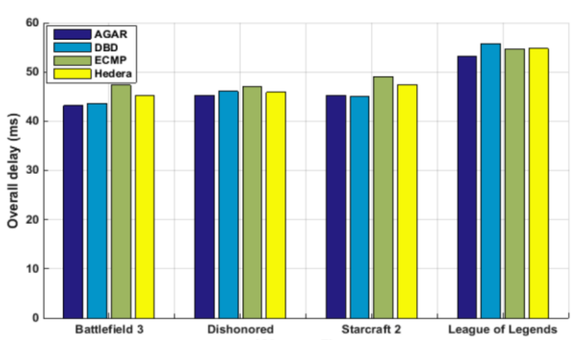

Figure 5. The user delay for 100 video game flows

From the results, we can conclude that the average delay that is obtained integrating CLASDN technique in AGAR works well than other schemes. Although AGAR has a lower delay, DBD performs fair for high delay videos and games. Thus, the proposed technique results show the decrease in delay and can perform better in less bandwidth also, that gives the enhancement of multimedia transmission in networks.

V. Conclusion and Future Scope

As the future holds intellectual nourishment, even though many studies that are available on the multimedia transmission, research on Cross-Layered SDN is still opening new perceptions, especially on a dynamic reworking of network performance, but also on balance between interoperability and performance. In conclusion, based on the proposed technique, CLASDN approach can be envisioned as a suitable method to address evolving issues associated to advanced performance for multimedia transmissions and throughput if disciplined architecture offering long-term benefits is followed. Also, the results show that the proposed scheme acts as an extension for the schemes in networking to produce a more balanced data transmission.

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Authors Biography

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