

# IMPROVED SOFTWARE DEFINED NETWORK ROUTING FOR TELECOMMUNICATION NETWORKS

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**Abstract:** The rapid advancements in the telecommunication networks, has led to the day by day progress in the data communication leading to the inclusion of many devices that causes complexities in managing and the maintaining of the networks. The outgrowing number of new network devices makes the traditional telecommunication networks incompatible to their flexible operation and the management. So the trending software defined networking can be opted for the provision of more convenient service providing a seamless communication, but the SDN's lags in the self-adaptability and the efficient usage of the resources as it uses the concept of the traditional networks so the paper proposes an modified method of software defined networking based on the deep learning to enhance the performance, of the telecommunication networks. Further the evaluation of the telecommunication network routing with the improvised SDN, on the packet loss rate and the average delay shows that the proposed method is compatible for the seamless information provision of the nowadays telecommunication networks.

**Keywords:** Telecommunication network, Software defined Networking, Deep learning, seamless communication, packet loss rate and average delay.

## 1. INTRODUCTION

The telecommunication is a very popular network as it helps in the long distance communication for the purpose of extending a conversation or the information transfer. These network are an accumulation of the terminal nodes, through which a connection can be extended to ensure a far distance communication among the terminals. The signals or the information through the proper links reach the appropriate destination utilizing the packet switching, message and the circuit switching. The information's are forwarded to the proper destination utilizing the unique addresses provided in the address space. Some of the commonly known telecommunication networks are computer networks, internet, telephone network, global telex network, and aeronautical network. the general structure of the telecommunication networks include three major parts the data plane, control plane and the management plane, the traditional telecommunication networks result with the difficulties in managing and maintenance , as the number of devices used keep on increasing. The steps in eluding the drawbacks of the traditional telecommunication networks

lead to the emergence of a promising paradigm called the software defined networks that allow the network to be programmable and utilize a software in controlling and the managing of the network. SDN serve as a prominent network in the network management as they reduce the difficulties in the managing the network by separating the control and the data plane of the network [1], being a novel strategy of programmability for network, the software defined networks allows a flexible and faster development in the both the planes [2] paving way for the network abstractions and facilitates network evolution. The SDN can be utilized as an alternative overcoming the complexities in the managing the traditional communication systems [3] the software defined network acts as the key provisionary paving way for the software defined environment. The software defined networking along with the open flow monitor creates a more flexible and an improved network structure in the research for the developing efficient network operations [4]. Further the software defined networking with the slight modification incorporating the deep learning models enable the routing to be automatically adaptable to the traffic density [11], the computation overload caused by the traditional software defined networking that processes and configures routing methods for each flow that is new is overcome by the machine learning process, that enables pre-design solution based on the flow feature extraction, route selection and the requirement prediction, enhancing the performance of the routing with the software defined networking[14].

The paper also proffers an deep learning routing in the software defined networking to improve the performance of the software defined routing in terms of the average delay and the packet loss rate.

The remaining of the paper is organized with the section 2 the related works, section3 the proposed work and section 4 presenting the result evaluation of the proposed method and section5 the conclusion,

## **2. RELATED WORKS**

Farhady et al [1] the review of the SDN-related technologies, is presented, including the three main parts of the Software defined networking, the control plane, data plane and its applications. Denazis, et al [2], the author explains the layers and the structures of the software defined networking and the interface between the layers. Kreutz et al [3] the paper presents the survey on the software defined network, proceeding with the motivations of the software defined networking, and its efficiency compared to the traditional networks. Van et al [4] presents the OpenNetMon, an approach and a software implementation in monitoring the flow metrics and the quality of service of the network. Nunes et al [5] the paper presents the survey, showing importance for the historic attitude of the programmable networking and address the recent developments in the programmable network through the software defined networking. Bernardos et al [6], the paper provides the SDN approach to the wireless network to improvise the further

the networking features by improving the mobile deployments Qin et al [7], the paper proposes a multi network architecture along with the middleware performing the operations of the middleware for handling the heterogeneous tasks of the IOT networks, Akyildiz et al [8] the paper is used in realizing the software defined networking structure of the 5G wireless system, Lopez et al [9], the technique creates the way for the deployment of the national and the continental ultra-stable meteorological optical networks Clímaco et al [10] Stampa et al [11], the routing optimization of the software defined networking is developed using the deep-reinforcement learning agent, to make the network automatically adaptable to the prevailing traffic conditions. Pasca et al [12] AMPS is proposed in the paper to improve the overall network performance by integrating the machine learning techniques in the software defined networks, LeCun et al [13] the paper details the deep learning techniques in the various fields that outperforms the performance of the human beings, Chen et al [14] details the improvement in the routing performance utilizing the machine learning techniques, Uzakgider,et al [15] presents a deep learning architecture for the layered adaptive video streaming over the SDN

## **2.1. EXISTING SOFTWARE DEFINED NETWORKING**

The software defined networking being a prominent paradigm in the wired and the wireless communication network, is very flexible to upgrading and effectively controls the operations by separating the data plane and the control plane. This enables to have an overall control over the each actions taken in the network and also ensures an easy upgrading according to the evolving innovations. The data plane completely holds all the networks devices that are used in forwarding the packets, for e.g. the network devices such as the routers, switches, are all combined into the data plane. The control plane holds the software to control or monitor the overall work of the network, the control and the management layer is placed between the application layer and the forwarding layer. The fig below shows the architecture of the Software defined networking.

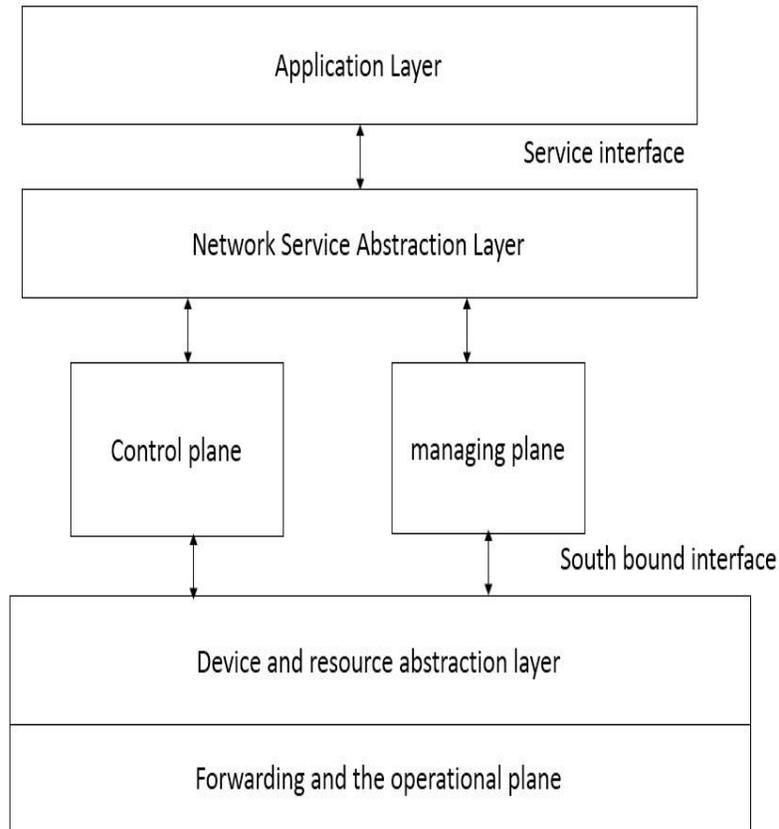


Fig .1 Software Defined Networking Architecture

The working process of the software defined network comprises of the following steps that performs the process of the neighbor discovery, once identified, updates the information of the neighbors to the control plane that develops a global view of the network. The control plane with the software's installed frames a set of rules to forward the packets. The rules are defined based on the match and the actions, the match holds the address of the source and the destination switches and the actions are the definite actions to be taken for the flow of the information's. Based on these rules, the switches examine the packet header and exploits the relevant actions, that are updated on the forwarding table, if the relevant action is not found the information's are forwarded to the control plane to further proceed with the updating of the configured rules. The fig.2 below explains the working procedure of the SDN

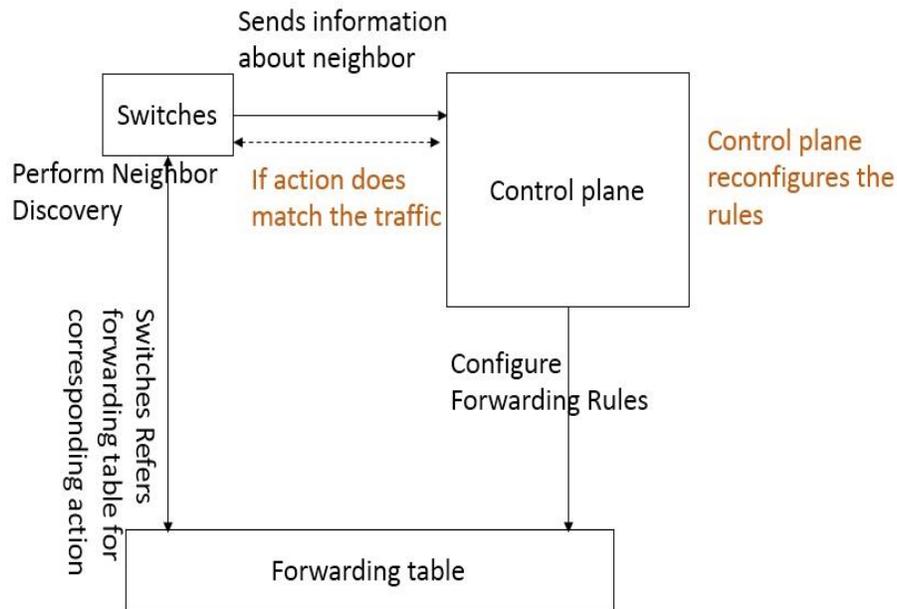


Fig .2 Working process of the Software Defined Networking

But since the forwarding plane over burdens the complete process of computation and communication in both the forwarding layer and the control layer. By framing new route for each traffic [14] and introduce complexities in the control plane due to frequently changing path [15] there is necessity for improving the performance of the software defined networking in the telecommunication networking. More over the traditional SDN based on the traditional routing process once again deteriorates the performance of the network. So the paper proffers the deep learning approach in SDN routing to improve its overall performance in the telecommunication network in terms of the average delay and the packet loss rate.

So the proposed process utilizes the convolutional neural network in the SDN for enhancing the routing performance of the SDN for the telecommunication networks.

### 3. CONVOLUTIONAL NEURAL NETWORK

The convolution neural network constitutes three layers usually known as the convolutional, pooling and the fully connected. The inputs are fed into the convolution part and the outputs are observed from the fully connected layers. The convolution neural networks process of training is segregated into two levels as the forward and the

backward propagation. The input proceeding through different layers before reaching the output and the approaches to identify and adjust the biases and the weights is known as the forward and the backward propagation respectively.

The information provided in the input and the output gained from the first two layers are usually in form of two dimensional matrix, the working of the CNN is as follows, the convolutional neural network extracts the features of the network, operates over it and attains the feature map at the output of the first stage. The next stage proceeds with the down sampling to minimize the spatial size that does the reduction of the number of parameters, this is done in the pooling layer, this proceeds to the final layer called the fully connected layer, where each parameter is connected to its parameters of previous layer and finally proceeds with the regressions in the final layer of the fully connected layer to attain the output,

The main aim of training in the CNN is to minimize the loss function and maximize the training data possibility. The fig.3 below shows the working principle of the convolutional neural network.

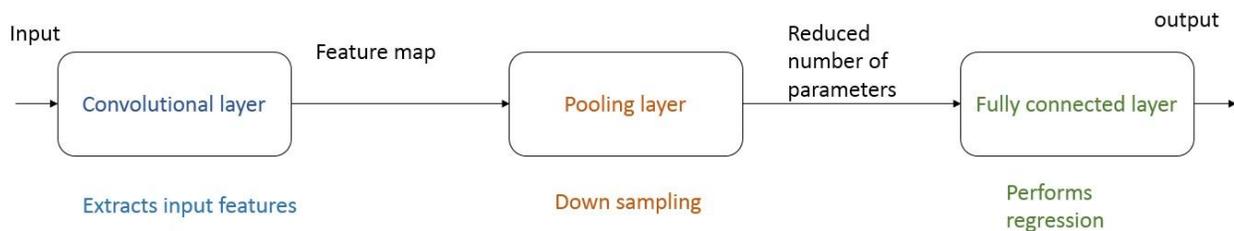


Fig .3 Working Process of CNN

### 3.1. THE PROPOSED METHOD WITH THE CNN IN SDN ROUTING

The procedure in the proposed including the CNN for the software defined routing, traverses into two phases, the construction of the convolutional neural network for the various paths, followed by the selection of the path. The path selection is further based on two strides, procurement of the data and the periodic training of the CNN. In order to perform the above process it essential to gather the traffic pattern, periodically update the paths and regularly train the convolutional neural network. The fig.4 below shows the proposed SDN architecture with the CNN based routing.

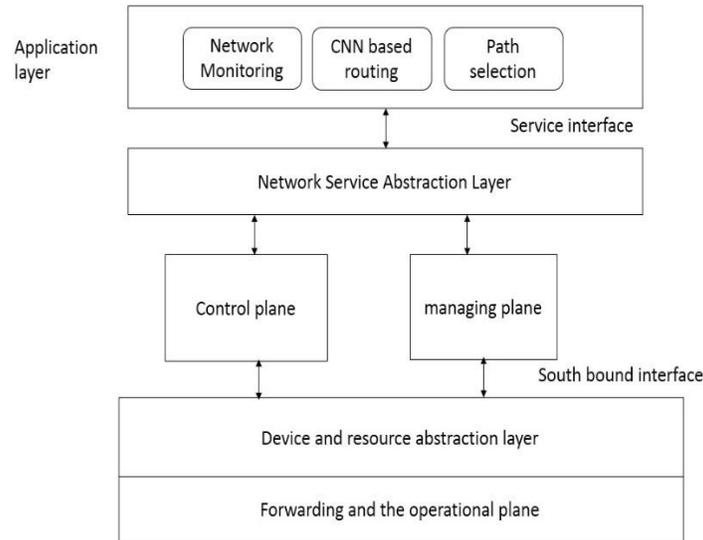


Fig. 4 Proposed SDN Architecture

The steps below show the framing of the convolutional neural network and the selection of the path utilizing the CNN and its periodic training phase.

Step 1: The switches in the forwarding plane performs the neighbor discovery process, and forwards the information gathered based on the neighbors (weights) to the controller,

Step 2: The control plane produces the global view of the entire network based on the topology of the network and enumerate the combination of the paths with the graph theory.

Step3: Once the combination of the paths are obtained, convolution neural network for path combination ( $CNN_{path}$ ) and the convolutional neural network for the routing ( $CNN_{routin}$ ) is obtained

Step4: For all the combination of the path generated, the control plane enumerates the optimal path and the configures the rules for forwarding over the matching switches, for each pattern observed in the flow of the traffic, the packets are send based on the rules , the pattern is recorded and the time delay is estimated

Step5: checks for the congested path applying the equation  $time\ delay_{path} > 2(minimum_{delay})$  , if satisfied the path is detected with congestion and if not the path is congestion free

Step6: Control plane presents a dataset, and trains all the  $CNN_{routin}$  with the acquired dataset. The data recording is done by the switches simultaneously along with the packet forwarding

Step7: For every path combination obtained, the CNN based routing is done applying forward and the backward propagation to identify the optimal path

Step 8: The optimal path is found enables the transmission of the information,

Step 9: conduct regular training of CNN on the updated information, and proceed with the transmission

Since the time taken for the regular training of the CNN is above the minimum level, the routing of the information's proceed with the previously trained CNN until the next training process is finished. The path with the minimum delay is opted to be optimal one for transmission in the telecommunication network.

#### 4. RESULTS AND DISCUSSION

The combination of the software defined networking and the convolutional neural network, in the proposed process ensure a delay less and the congestion free transmission by, enumerating different traffic patterns and identifying the shortest path, The training of the Convolutional neural network further on regular basis enables one to decide with the proper trail for the transmission. The evaluation of the proposed method, with the various number of packets, with the size of the packets ranging between 1000 to 1024 bytes, over a simulation time of 1000 s, is validated over the average delay of the telecommunication network and the packet loss rate in the network to ensure that the proffered method improves the performance of the network,

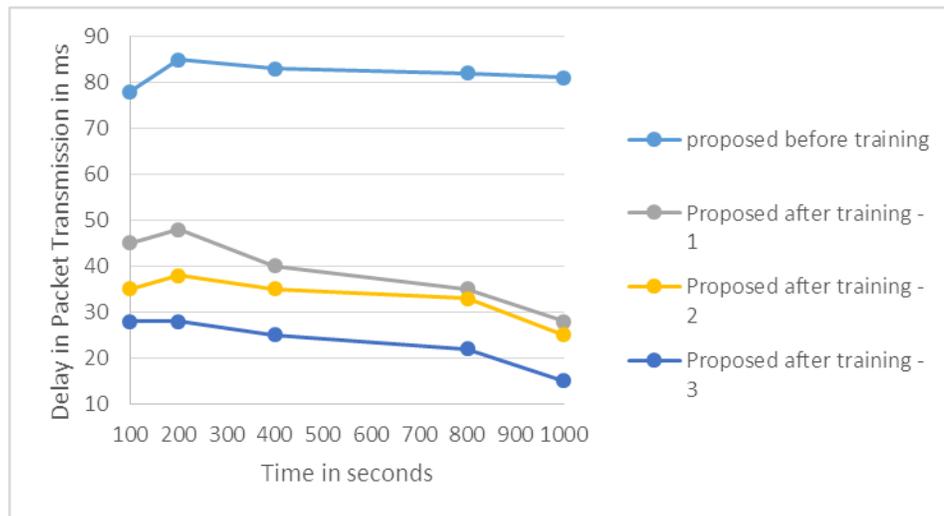


Fig .5 Delay in Packet Transmission

The fig. 5 above shows the average delay in the transmission of the packets over the simulation time of 1000 seconds before and after the training, the average delay obtained before training, utilizing the normal SDN routing that is based on the traditional routing methods is considerably high compared to the routing based on the combination of the CNN and the SDN. Though the proffered method takes much timing in the periodic training, since it employs the previously trained CNN in action, during the regular training phase, the delay in the process of the path selection is also reduced. More over the capability of the proposed method to decide with the shortest path with the minimum congestion and delay enables a delay less packet transmission.

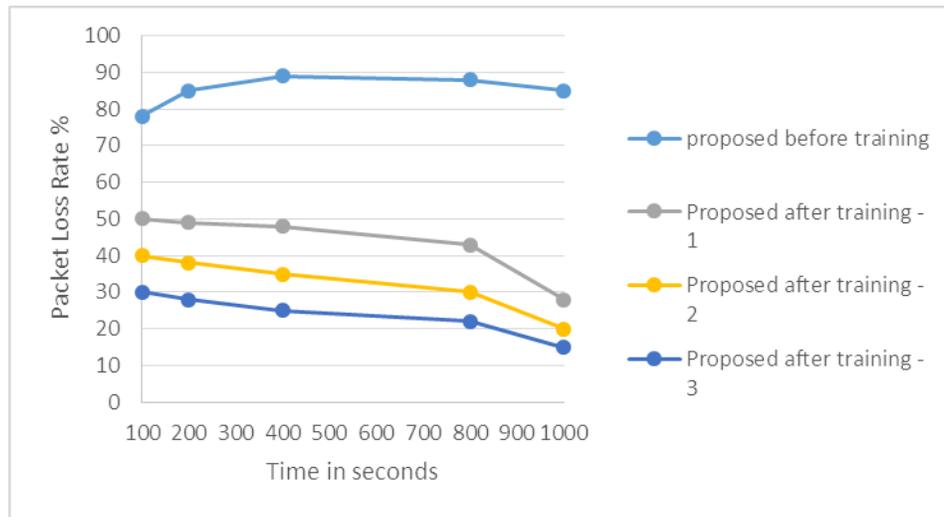


Fig .6 Packet Loss Rate

The fig 6 shows the packet loss rate of the proposed method, the packet loss rate attained over the proffered method is much lower compared to the traditional software defined network based routing. The results obtained for the varying number of the packets show that the packet loss of proposed method is 35% lower the traditional software defined network based routing. Thus the deep learning in the software defined networking routing ensures an improved performance in the telecommunication networks. Than the prevailing traditional software defined networking routing.

## 5. CONCLUSION

The proposed method developing a routing process by combining the procedure of the software defined networks and the convolutional neural network, for the telecommunication network, proceeds with the routing discovery process based on the software defined network routing and proceeds with the training of the convolutional neural network with the path pattern obtained and the data set acquired by the switches and follows the forward

propagation and the back ward propagation in the selection of the optimal path with the minimum delay , shortest distance and lower congestion. The self-adapting capability of the convolutional neural network significantly manages the cost of the controller and the storage cost of the switches also remain reasonable as the storage complexity  $iso(K + N) \approx o(n)$ . Further the validation of the proposed method in terms of the average delay in the transmission of the packets and the packet loss rate prove that the CNN+SDN routing enhances the performance of the telecommunication network. Further the paper is proceed with the CNN based routing evaluating the trust management of the nodes to remove the unwanted mishappenings in the network,

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