An Intelligent System For Multimedia Transmission in IOT Environments

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Abstract- *In today's world where a lot of multimedia traffic in transmitted through networks. Software-defined architecture (SDN) has the capability to improve the efficiency of network management. Combination of SDN and Artificial Intelligence provide an answer to the problem of handling large amount of multimedia traffic. We propose an artificial intelligent system to detect and correct errors during transmission of multimedia in IoT environments connected through an SDN.The artificial intelligent system described in this paper consists of two different modules. The first module is used to classify the criticalness of data being transmitted through the network. The second part is an estimator that informs the SDN controller the resources required and actions that have to be performed to guarantee quality of service and quality of experience.*

Keywords- IoT; Artificial intelligence; multimedia;

I. INTRODUCTION

Over the recent years, video transmission through networks has developed drastically. Numerous reports express that this pattern will increment in the coming years. Cisco, in its Cisco Visual Networking Index, Forecast and Methodology 2016– 2021 report [1], states that video traffic in 2021 will be three times that of the 2016 video traffic. Moreover, this traffic will speak to 82% of the complete Internet traffic in 2021. Besides, it says that video observation traffic on the Internet will be multiple times more prominent amid that equivalent period than the traffic we currently have. In addition, Cisco predicts that 3.4% of the video traffic that will be transmitted however Internet in 2021 will be created by video reconnaissance traffic. The number IoT devices connected through networks is increasing day by day. Cisco in its white paper [2] reported that it is expecting about 50 billion IoT devices to be connected to the internet by 2020.

Networks can have extraordinary confinements in the event that they are overseen statically, due to the unbending nature of these mechanisms. Networks, which are overseen statically by directions or static contents, are less efficient and, furthermore, their asset provisioning is less programmed. Over the years, the frequently proposed procedure to improve network management in various investigations, is applying Software Defined Networ-king (SDN). Through the SDN Controller, we can apply distinctive rules about traffic that flows across the network, which enable us to have versatile networks. For the most part, by applying SDN, we can expand the efficiency and diminish the expense of network management, Artificial Intelligence (AI) oversees assets and network traffic progressively. Utilizing AI to contemplate the traffic of the network, we can find the distinctive kinds of flow that are being transmitted. In this manner, traffic examples can be gotten, which would then be able to be connected in SDN basic leadership. Consolidating AI procedures with SDN, adaptive practices are accomplished so as to improve the performance of the network. In our investigation we have considered a lot of multimedia traffic. We propose a SDN centre system to deal with the distinctive IoT networks. .After that, the AI system that we have created detects traffic that is considered critical. In addition, the AI system is also able to estimate the necessary resources to guarantee an adequate level of Quality of Service (QoS) or Quality of Experience (QoE) of the multimedia transmission. This AI system is integrated in the SDN to avoid QoS and QoE problems during the streaming of multimedia traffic. Thereby, it is possible to act when the resources are not enough for having an adequate transmission.

II. SYSTEM DESIGN AND IMPLEMENTATION

A. Architecture

The proposed architecture consists of two networks, one is the edge network that consists of IoT nodes and the network head. On the other hand is a SDN network that is the core network which consists of SDN controller and switches. The two networks are joined by the Network Head (NH) of each IoT network. It is a special node that manages the IoT network communication and sends the data through the SDN network. Moreover, it uses the OpenFlow standard to communicate with the controller and send it statistics about the use of the network. This role is played by an OpenFlow enable switch. There are also OpenFlow-enabled switches that do not act as the NH of an IoT network. However, the SDN controller has the AI module and it is in constant communication with it. The AI module is a set of software programs that uses AI techniques to provide the functionalities to the system proposed. Fig 1 [3] describes the various roles performed by the actors in the system.

The SDN controller is in charge of network management and sends the statistics that gather from the SDN nodes (NH sand other SDN switches) to the AI module. The AI module uses this set of data in order to apply the AI techniques and inform the controller about the multimedia traffic flowing through the network and its resource requirements. This module is divided into two parts: The traffic classifier, which reports whether the incoming flow is critical or not.

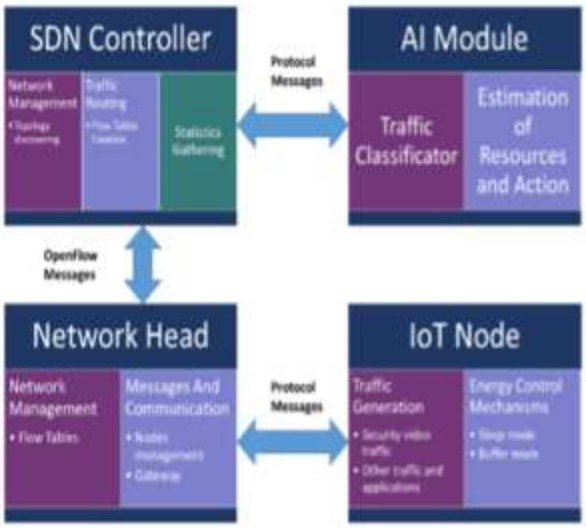

Figure 1: Scheme of each actor in the system and their interaction

B. Algorithm

The algorithm [3] described below tells about the actions that are performed when a new packet arrives and how it is gathering statistics about the network. When a new packet enters, it is sent to the AI module which detects if the packet is critical or not. If it is critical then it also estimates the actions to be performed and the resources required to provide QoS and QoE. The controller is informed about the actions that have to be performed and once it is done with them then it performs the usual stats reporting activity.

```
Algorithm 1 Actions Management
Given: Actions
Initialize_AI(Actions)
Cat_Prev = Cat_initial
Foreach new iteration
        Stats = Get_Statistics()
        AI_Sent_Statistics(Stats)
        If New_Packet do
                Cat = AI_Send_Packet(Packet)
                If Cat != No_Crit do
                        Execute_Action(Cat)
                End If
        End If
End Foreach
```

C. Artificial Intelligent System

The AI system is responsible for two functions, one is classify the multimedia traffic and another is to estimate the network resources. Classification makes use of supervised machine learning algorithms like SVM, KNN or neural networks. The statistic method is based on discriminant analysis [4].The optimal model can be found out by calculating various parameters like accuracy (A), precision (P), recall (R) and F1 score. Accuracy measurements are calculated using:

$$P = \frac{TP}{TP+FP} \quad (1)$$

$$R = \frac{TP}{TP+FN} \quad (2)$$

$$A = \frac{TP+TN}{TP+TN+FP+FN} \quad (3)$$

$$F1 = \frac{2 \times P \times R}{P+R} \quad (4)$$

These measurements provide a way to analyse the accuracy of our model. The above calculations inform that SVM model provides the best result. Its accuracy is 84%.

The resource estimation model is based on Bayes probabilistic theorem. Mathematically, the probability that one event occurs – given some input parameters – is defined by the Bayes statistic estimator:

$$Pr(r|j,d,p,b,n)= Pr(r)\, Pr(j,d,p,b,n|r) / Pr(j,d,p,b,n) \quad (5)$$

wherePr(j,d,p,b,n|r) is the maximum likelihood function. It estimates the probability that a resource r is chosen. That probability is calculated, given some network parameters j, d, p, b (jitter, delay, lost packets and delay), and if the node is NH or not (n).

III. RESULTS

The results of the experiments are discussed here. Fig 2 [3] describes the scenario where there is a bandwidth problem and AI module has indicated an action of using an alternative path, with increment in delay. Without any system that performs actions to improve the QoS, the bandwidth has a maximum of 1.83Mb/s. However, with the proposal, that maximum increases up to 3.08Mb/s. The minimums are 16.4kb/s and 104.12kb/s, respectively. The average bandwidths are similar, 1.19Mb/s and 1.08Mb/s.

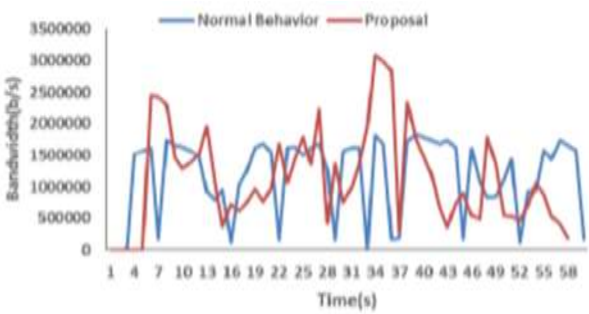

Figure 2 : Bandwidth obtained in Scenario

Fig 3 [3] compares the performance in terms of jitter. The average jitter without the proposed system is 2.47ms. However, by using the alternative path, the average is 8.19ms. Maximums are 11.13ms and 47.62ms, respectively. Finally, the minimum jitter also increases from 0.01ms to 0.13ms with the proposed action.

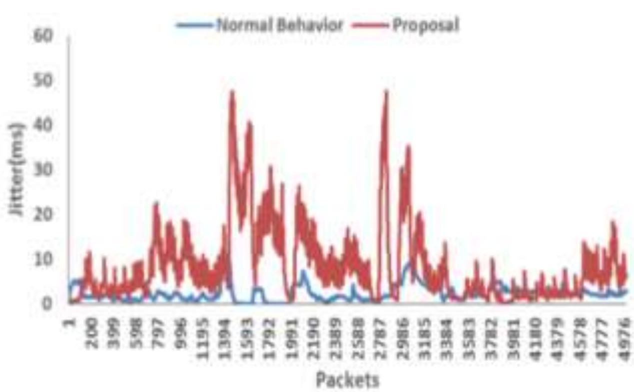

Figure 3: Jitter obtained in scenario

IV. CONCLUSION

Networks that are managed statically have a lot of limitations. In this paper we proposed an artificial intelligent system to detect errors and correct them in multimedia transmission in IoT environments connected through a SDN. The system performs various actions to guarantee QoS and QoE. It helps us to improve QoS in different cases when the network suffers problems like congestion etc. As future work, we can improve the system accuracy by using the end users' interaction. Moreover, in future works, we will analyse the correlation between the objective QoE metrics and MOS or DMOS. Thereby, this study could be applied to future research in order to improve the performance. Furthermore, some other statistical methods will be studied in order to improve the results in the estimation process for network resources selection. Improving the classification method, by using a more complete data-set would allow us to improve this accuracy.

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