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Reliable Video over SDN Using RBFS-Prune in an Unstructured Campus Network

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Abstract

Video applications expect the network to choose the most reliable path in the network, hinged on the minimum bandwidth needed by the application and the maximum delay and jitter that the application can tolerate. The network also needs to provide better QoS for any request from its origin to its destination. This paper cites the following: First, it cites apropos benefits of using Reliable Video over SDN (RVSDN) in an unstructured campus network. Next, it cites the design of using Recursive Best First Search-prune algorithm in RVSDN and its implementation. Third, it suggests use of Recursive Best First Search (RBFS)-prune algorithm can reduce the usage of SDN controller memory over A*-prune algorithm.

Key Words:RBFS-Prune, RVSDN, reliable video.

1. Introduction

At present, insistence for live streaming and Video On demand(VOD) have heightened to approximate 70 percentage of the internet traffic till 2017 [1]. This increase in demand for live streaming and VOD is the result of tremendous usage of VOD applications like Netflix, YouTube, Amazon Prime video and social networking applications such as Facebook, Twitter, Skype across the globe. A certain level of QoS is a very substantial factor for VOD and live streaming. Many QoS frameworks (like integrated services, MPLS) are there which provides QoS for real-time applications like VOD and live streaming but has its own snags[2] since these frameworks were not developed to handle high demand [3].

Presently network QoS framework contemplate factors such as network bandwidth, delay and jitter to ensure quality. These factors are vital for ensuring QoS in applications that transfers live audio video packets. But these constraints are not enough to make sure that the packets are forwarded through a reliable network path. Reliability of a network is considered as the competence of a network to act according to the requirement of the application [4].

Multi-path selections in network schema aids in enhancing bandwidth capacity, handle link failures smoothly and/or downturn the probability of failures. It also assist load balance and failover when dominant paths lose-out. But selection of multi-path does not focus on the issue of reliability of bandwidth sensitive data such as video, especially in the case of interactive video, tele-surgery or robotic packets. The calculation issue of reliable path has been solved using Reliable Video over SDN (RVSDN) which applies A*prune algorithm for the reliable path calculation for video [5]. In this paper, we scrutinize the capability of the network to calculate multiple reliable paths with minimum time and space complexity in an unstructured campus network. The focus of this paper is the suggestion to use *Recursive Best First Search-prune* algorithm in RVSDN to maintain reliability and at the same time reducing the time and space for searching for a path.

2. Overview

In this section, implementation of VSDN framework and its restraints in providing QoS for audio-video applications is discussed concisely. The current implementation of RVSDN is discussed here.

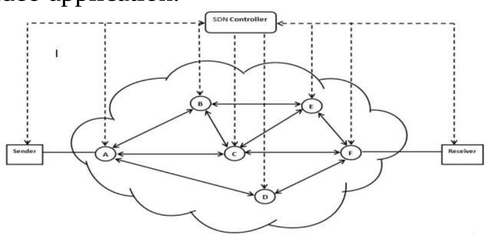
A. Video Over SDN

In traditional IP network there will not have any central knowledge about the topology of the network. VSDN employs SDN[6] and OpenFlow[7] to detach control and forward planes of the routing devices such as switches or routers.

The SDN controller keeps the overall view of the network. An architecture that uses SDN for streaming video packets will have the ability to address the path inflexibility problem in the earlier network frameworks.

This architecture guarantees the required QoS for applications that need more bandwidth, like streaming audio and video. VSDN is also adept of determining the optimal path for video, based on jitter, delay and network bandwidth [8].

But for interactive video applications, it fails to provide end to end quality of service as a result of the trailing. When an application request for a service VSDN identifies a single path to the destination. This is the dominant restraint since it is onerous to recognize and recalculate a new path when single path fails. Second restraint of VSDN for providing reliable video over Software Defined Network (SDN) is, it do not contemplate reliability while selecting the transmission path. Since reliability is a major concern for video applications it affects the QoS of video application.



F1igure 1: Video over Software-Defined Network Architecture

B. Benefits of Implementing RVSDN in Unstructured Campus Network

Presently campus are going for E-classrooms and E-learning since it enables the educators to achieve a great degree of coverage for their target audience. It also accredit the students to get classes from experts across the globe and aid jiffy learning. Usage of interactive video and VOD also have coequal effectiveness in the curriculum. In institutions like medical colleges use of services like telesurgery is also upsurging. Since these services need an obligatory QoS, employing RVSDN in an unstructured campus network is a boon.

3. Related Works

Finding out the optimized reliable path between any two nodes in a local network can be obtained by using an algorithm identical to shortest path first algorithms like Dijkstra or Floyd. For this, a matrix algorithm and a labeling scheme is used for the prediction of MRP by Petrovic and Jovanovic [9].

Wang et al. insure the transfer of alleviation materials after natural calamity using MRP. They uses the approach to calculate the MRP with factors such as higher reliable connectivity and minimal deviation distance [10]. They modified the Dijkstra's shortest path algorithm in order to calculate the reliability and weightage value, after comparing the modified versions of depth first search and Dijkstra.

Lee et al. focused to single out MRP after contemplating link cost and capacity. They calculated packet loss probability by using RED technique. It is then integrated along with Floyd's algorithm and will find out the reliable path[11].

RVSDN (figure 2) is introduced as an upgradation to VSDN architecture for automatously handling the assurance of reliability for a video application's request [5]. It is implemented using the basic VSDN architecture by incorporating A*prune algorithm for reliable feasible path calculation [5], since estimation of feasible path in Constraint Based Routing (CBR) using more than one constraint results in NP- Hard [12]. A* prune algorithm is a combination of A* search algorithm and a pruning technique [13]. The detailed explanation of A* prune is beyond the scope of this paper.

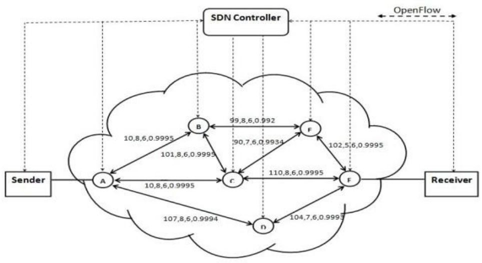


Figure 2: VSDN Architecture with Link Constraints

Though A* prune reduce the time complexity for estimation of feasible path, its restraint is that it consumes a larger amount of space since it stores the calculation of all the expanded nodes[10]. Through this paper we are suggesting another algorithm to reduce the usage of memory for reliable feasible path estimation.

4. Proposed Design

Here, the proposed design of RVSDN using RBFS-prune algorithm is explained. It also included how RBFS-prune algorithm surmounts the limitation of A*-prune depicted in section III.

A. Reliable Video Over SDN (RVSDN)

Figure 2 explains the RVSDN architecture framework. The required reliability factor specified by the application is also taken into consideration. The SDN controller is programmed in such a way that the routing algorithms should consider the reliability factor also. In RVSDN, the constraint based routing examines the bandwidth, delay and jitter of the path selected by the routing algorithm in SDN controller. This is achieved by integrating a variation of A* prune algorithm in VSDN [5]. Since it uses A* prune algorithm it cache the determined results of all the expanded node in its memory. The excess memory used by a* prune [10] can be utilized for other useful activities by the SDN if it is replaced with Recursive Best First Search (RBFS) - prune algorithm since RBFS uses less memory for its path calculation.

B. Recursive Best First Search (RBFS)-Prune Algorithm

RBFS- prune algorithm is a combination of RBFS search algorithm and an appropriate prune algorithm. The entire network topology can be represented by a Graph G consisting of N devices connected to it and Edges represents the path between two nodes. The algorithm begins by taking a starting node n from G. Then it traverses all possible combination of paths from n to the destination. By performing proper pruning on these paths against certain constraints C, acceptable paths are identified and are included in the set P(n, N, H(p), C) where H(p) is the hops needed in each path. These paths are sorted in ascending order and path with minimum hops is expanded first. This process continue until either shortest feasible path is identified or there is no subtree for further expansion.

C. Possible Changes in RVSDN with the Application of RBFS-Prune Algorithm

RBFS is a best-first search that runs with minimum space with respect to the maximum search depth , regardless of the cost function used since it does not stores the intermediate search results unlike A* algorithm [14]. So applying RBFS along with a proper pruning technique in RVSDN instead of A* - prune algorithm will help in possible reduction in the use of SDN controller's memory. These memory thus can be used for other activities or SDN applications.

In an unstructured campus network, the number of routers will be fixed and their specifications will be as per the requirement of the campus network. Also, the memory capacity of the installed devices will be limited. In such a network, since the number of resources and memory of these devices are limited, space complexity of the algorithm is more important than time complexity.

5. Implementation

Algorithm 1 exemplifies the pseudo code used by the RVSDN controller for the calculation and selection of reliable path. The node constraint NC takes **B**andwidth, **D**elay, **J**itter, and Reliability as parameters. The source and destination switches (i.e., A and F nodes in figure 2) are obtained using the functions *GetSourceSwitch* and *GetDestinationSwitch*. *CalculateFeasiblePath* takes SS, DS, NC as parameters where SS is source switch, DS is the destination source and NC is the created node constraint. It returns all the candidate paths based on a predefined threshold value. *GetReliablePath(FP, R)* sorts the candidate paths received, according to the passed reliability constraint. Algorithm 2 exemplifies the allocation of reliable path for the service. Using *ObtainedResource(RP)*, RVSDN controller reserves the required resources for the reliability paths. The controller saves the reliable path in the database with the unique path id UPID and the paths are established using *AllocateReliablePath(OFPFC_ADD, RP)*.

Alg - 1: Algorithm to find an estimate of reliable path

CalcRPath(G, B, D, J, R)
G - Network Graph
B - Bandwidth
D - Delay
J - Jitter
R - Reliability
NC= CreateNodeConstraint(B, D, J, R)
SS = GetSourceSwitch(G)
DS = GetDestinationSwitch(G)
FP = CalculateFeasiblePath(SS, DS, NC)
RP = GetReliablePath(FP, R)
return RP
CreateNodeConstraint(B, D, J, R)
B_n - Bandwidth of current node
B_r - Required bandwidth for the service
D_n - Delay of current node
D_r - Maximum delay tolerance of the service
J_n - Jitter of current node
J_r - Maximum jitter tolerance of the service
R_n - Reliability of the current node
R_r - Minimal required reliability for the service
CC=log(sqrt(sqr(B_n-B_r)+sqr(D_n-D_r)+sqr(J_n-J) + sqr(R_n-R_r)))
return CC

Alg-2: Algorithm to assign Reliable Path to traffic.

RP_Alloc(RP, UPID)
if (ObtainedResource(RP))
{
PathDatabase.Insert(UPID, RP)
RP_Alloc (OFPFC_ADD, RP)
return TRUE
}
return FALSE

where RP is the Reliable path and UPID is the unique ID of the path.

6. Conclusion

The insistence for video applications is increasing from time to time and there is a minimum QoS and reliability that needed to be satisfied for these requests. This paper presented the design of implementing RVSDN using RBFS-prune algorithm in an unstructured campus network to increase the QoS and reliability of the VOD and live streaming. The implementation of RBFS- prune algorithm in RVSDN results in reduced usage of memory in SDN controller. This also helps in efficient memory utilization while obtaining reliable feasible network path by the SDN controller although it takes more computation time than a* prune. In future, this architecture can be implemented in wide area network (WAN) using the hybrid a*-RBFS algorithm with proper pruning technique which has less time and space complexity.

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