Indian Journal of Science and Technology, *Vol 9(25), DOI: 10.17485/ijst/2016/v9i25/96634, July 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Advance Signaling Cost for Multicast Fast Reroute Proxy Mobility Management

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Abstract

Background/Objectives: Mobile data traffic over IP has grown very rapidly in size. This huge increase in size creates high demand performance on network that supports mobile multicast services. This motivates the development of a better performance procedure with better signaling cost. **Methods/Statistical analysis**: A mathematical evaluation of signaling cost for multicast network mobility management namely Proxy Mobile IPv6 (PMIPv6). The signaling cost is derived from a novel combination of Multicast only Fast Reroute (MFR) and predictive Context Transfer (CT) with network mobility management. The signaling cost is designated base on the improved signaling call flow of the advanced method combination. It is calculated as the location updates and the packet delivery cost of the call flow. **Findings:** This combined procedure helps to mitigate unnecessary multicast network mobility traffic as usage increases. From the results it is clearly shows that the location update for the advanced signaling cost remain consistent regardless of the traffic usage. Where else for the standard method the signaling cost increases significantly, in parallel with the traffic increase. This is hardly because of the reduced location updates and the packet delivery cost of the novel combination procedure. Therefore through this implementation better signaling cost formula is brought forward. **Application/Improvements:** The advanced signaling cost helps to overcome performance degradation in multicast mobility management application such as live Internet video, Internet-video-to-TV, online video, webcam viewing, video conference and web-based video monitoring.

Keywords: Fast Reroute, Mobility Management, Multicast, Signaling Cost

1. Introduction

The typical network mobility protocol has solved host mobility performance problems. It has seen much attention in theoretical, mathematical, simulation, and also in practical solutions. However, it does not include the multicast traffic that is very efficient in solving one to many destination communications applications.

Mobile multicast communication over IP has grown very rapidly in size. Applications using Big Data, Cloud Computing, and Internet of Things (IoT) are closely dependent on each other. Most of these traffics are mobile and involve multicast communications. Thus brings high demand on network that supports mobile multicast services. The Cisco® Visual Networking Index (VNI)[1-3] has forecasted that the average mobile data speed will soon bypass 3Mbps by 2017. It is expected that monthly global mobile data traffic will be 30.6 Exabyte's by 2020. The highest projected usage is three-fourths (75%) of the world's mobile data traffic is video by 2020. It is likely by 2020, 66% of all global mobile devices will use IPv6 mobile network. There will be 7.6 billion IPv6-capable devices by 2020[1-3].

Multicast Mobility Working Group (MULTIMOB WG) offers direction to support multicast in network mobility environment[4-5]. The group works on extensions of network mobility to develop its capability to support multicast efficiently[4-5]. It has resulted in the development

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of several techniques. These techniques are categorized as base solution[6], direct routing[7-9], and specific route[10]. These techniques require communications to go through Local Mobility Anchor (LMA) and Mobile Access Gateway (MAG) which are the network entities defined in PMIPv6[4-5].

The aim of this paper is to suggest a novel technique that improve signaling cost route for multicast support in network mobility namely Proxy Mobile IPv6 (PMIPv6)[4]. The outcomes of the developed route are analyzed intensely and comprehensive assessment is presented. The parameters reflected in this technique are packet delivery cost, location update and signaling cost. The developed route results in highly better of total signaling cost.

The paper is prepared as follows: section 2 provides current applications trend in network mobility. Section 3 highlights details of the enhanced route for multicast network mobility. It specifies the network model and the signaling call flow for the enhanced route. Section 4 describes the performance evaluation. Section 5 is the results and discussions for the selected network model. Lastly, the summary is precisely written in section 6.

2. Applications Trend

Some of recent network topics are Internet of Everything (IoE), Internet of Things (IoT), Big Data and Cloud Computing. All of these topics are closely related to mobile applications. Most of the data traffic are real time or close to real time applications. Example applications are live Internet video, Internet-video-to-TV, online video, webcam viewing, video conference and web-based video monitoring[1-3]. Figure 1 shows the predicted usage of mobile data applications.

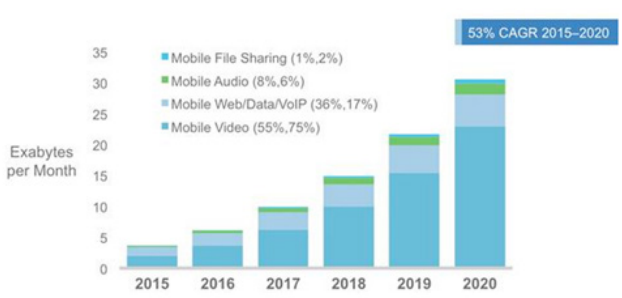

Figure 1. Mobile Data Traffic by 2020 (Source: Cisco VNI Mobile, 2016)

Internet video uses mobile multicast communication method to distribute its data. It is a one source to many receivers method. With the exponential increase of mobile devices usage, having its own specific address for communication is becoming a high necessity. Mobile IPv6 protocol offers additional huge range of advantages. In Mobile IPv6 every device has a globally routable public IP address on the Internet. Therefore it is not just a need, but more towards necessity to improve mobile IPv6 performance. Figure 2 shows the expected Mobile IPv6 data traffic.

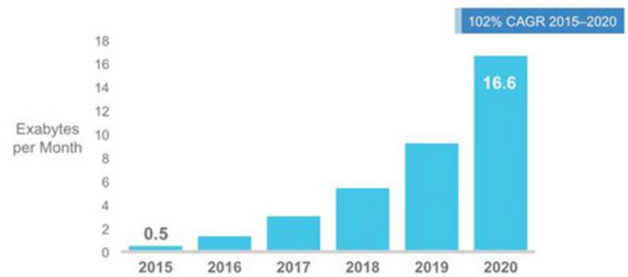

Figure 2. Projected Mobile IPv6 Data Traffic 2015–2020. (Source: Cisco VNI Mobile, 2016)

In network mobility, maintaining reachability while moving is a challenge. Some of the challenges of mobile multicast are receiver movement, source movement, deployment issues and multicast routing tree constructions[11-12]. In receiver movement challenge, parameters that are likely affected are service recovery, packet loss and packet duplications. As for source movement challenge, transparency is among the main considerations. In deployment challenges the fast upgrade of technologies in terms of hardware, software and firmware, brought compatibilities and versions conflicts. While for the multicast routing tree it depends on the tree topologies, number of hops, degree of topology changes and number of receivers. This paper focuses on improving mobile multicast receiver movement performance in terms of its signaling cost procedure.

3. New Signaling Cost Technique

This paper improves signaling cost procedure by combining predictive Context Transfer (CT)[13-15] with Multicast only Fast Reroute (MFR)[16]. In order to enhance the mobile multicast, the procedure ensures the delivery of the packets to the mobile hosts with better performance. This is done by minimizing the packet delivery cost and the location update cost of mobile multicast. It is a novel procedure to the current PMIPv6, this procedure is named as CTMFR-PMIPv6.

The CT is designed by the Internet Engineering Task Force (IETF) to provide general mechanisms for exchange of context data for moving Mobile Nodes (MN) between access routers. It gives support of the seamless handover based on service continuation using context. It is used to transfer different kind of control data and resources based services. The proposed is to quickly re-establish services when the nodes move and change access routers. The MFR basically describes a mechanism for end-to-end failure detection and recovery. MFR logic determines a primary link and a secondary link. Both links join the tree via both simultaneously and both receive multicast data. But only the packets from the primary link are accepted and forwarded down the tree while the packets from the secondary are discarded. It is a local swapping, therefore it is fast and greatly improving convergence times. In this paper the multicast data primary link is swap based on the MN location. Figure 3 shows the network model in intra domain communication of CTMFR-PMIPv6. While Figure 4 shows the network model in inter domain communication of CTMFR-PMIPv6. Figure 5 shows a domain of CTMFR-PMIPv6 in hexagonal-shapes cells.

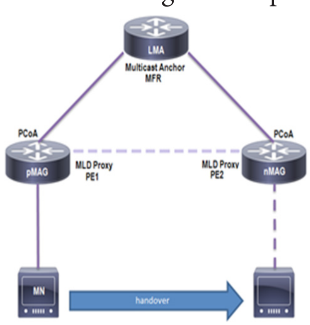

Figure 3. Intra domain network model for CTMFR-PMIPv6.

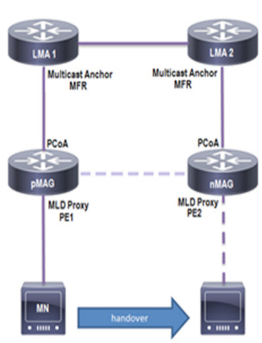

Figure 4. Inter domain network model for CTMFR-PMIPv6.

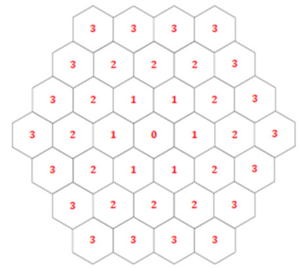

Figure 5. Hexagonal-cell network model for CTMFR-PMIPv6.

Referring to the network model the LMA is the multicast anchor and supports MFR functions. As shown in Figure 6 the MAGs are the provider edge and the MLD[17] proxy for the MN. While Figure 7 shows the swapping of primary and secondary link as the mobile node moves from one location to another location.

When the MN is connected to previous MAG (pMAG), the LMA traffic forwards the multicast data to primary PE1 and secondary PE2. The pMAG discards one of the multicast data traffic and transfers single multicast data traffic towards the mobile node. When the MN is connected to the next MAG (nMAG), the LMA traffic forwards the multicast data to primary PE2 and secondary PE1. The nMAG discards one of the multicast data traffic and transfers single multicast data traffic towards the mobile node. Before the MN is disconnected from the pMAG, the Context Transfer Data is transferred in advanced to the nMAG. So when the MN is connected to the nMAG, the multicast data continues without any update requirement.

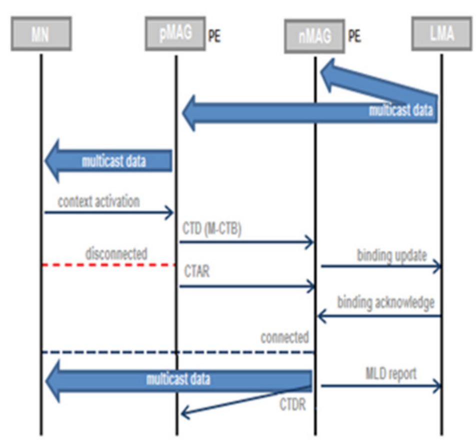

Figure 6. Signaling call flow for the integration of CTMFR-PMIPv6.

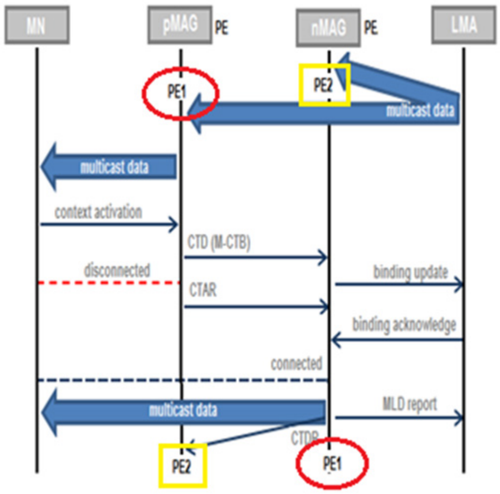

Figure 7. Signaling call flow for the integration of CTMFR-PMIPv6.

4. Performance Evaluations

In order to evaluate the advance technique, the total signaling cost is derived from the signaling call flow. As shown in the flow, each time the mobile node moves from one subnet to another subnet, the mobile node needs to send a binding update to the home agent in order to update its location. The cost of location update is affected by different factors such as, the number of the mobile nodes, residence time of the mobile node, the frequency of changing the subnet, the length of the binding update path, numbers of hops, and processing time. In this paper, it is assumed that the signaling cost is equals to the summation of the location update cost and the packet delivery cost. This advanced signaling cost is compared with two other techniques. The other two techniques are the standard based solution and CT PMIPv6. The parameters and values used are referred to Table 1[17-20].

Table 1. Parameters[17-20].

Parameters	Descriptions
β_c	Total signaling cost
C_{pd}	Packet delivery cost
C_{lu}	Location update
C_l	Local update cost
P_m	Processing cost of MAG C_{pd} papppp
P_l	Processing cost of LMA C_{pd} packer
N_m	Number of MAG
N_{mg}	Number of Multicast Group
ρ	Number of MN
pbu	Packet binding update
pba	Packet binding acknowledge
τ	Unit transmission cost
d_{lm}	Hop distance LMA-MAG
pc_m	Processing cost at MAG
pc_l	Processing cost at LMA

The total signaling cost is denoted as β_c, packet delivery cost is denoted as C_{pd} and the location update cost is denoted as C_{lu}. The location update includes the local binding update cost denoted as C_l. Hence, the total Signaling Cost is:

$$\beta_c = C_{pd} + C_{lu} \tag{1}$$

The packet delivery cost is described as;

$$C_{pd} = d_{lm}\,(P_m + P_l) \tag{2}$$

While the location update is described as;

$$C_{lu} = \frac{N_{mg}\,(N_m \,.\, C_l)}{\rho} \tag{3}$$

and the local update cost is;

$$C_l = (pbu + pba)\,.\,\tau\,.\,d_{lm} + pc_m + pc_l \tag{4}$$

Therefore the total signaling cost for base and CT, $\beta_{c\text{-BASE}}$ and $\beta_{c\text{-CT}}$ consist of all the above parameters. However in case of CTMFR-PMIPv6, the total signaling cost, $\beta_{c\text{-CTMRF}}$ the processing cost at LMA is excluded.

4. Results and Discussions

Figure 8 shows the result for the base, the CT and the advance technique total signaling cost versus location update cost. The total signaling cost for the proposed technique is much lower compared to the based technique. Figure 9 shows the result for total signaling cost versus number of multicast group. Compared to the base solution the location update increases as the total signaling cost increases. As in Figure 10 as the number of mobile node increases the signaling cost increases for the base and CT technique. The total signaling cost for the proposed technique remains the same in Figure 9 and Figure 10 regardless of the location update and the number of mobile node involved. While in Figure 11 shows the packet delivery versus hop distance. The packet delivery time for the base technique and the CT technique increases significantly compared to the proposed technique.

The CTMFR reduces the frequency of changing the sub-network because the movement is localized. So the total signaling cost is minimized by localizing the movement of the MN. The fast reroute and context transfer methods simplify the path, and this leads to reduction in the total signaling cost.

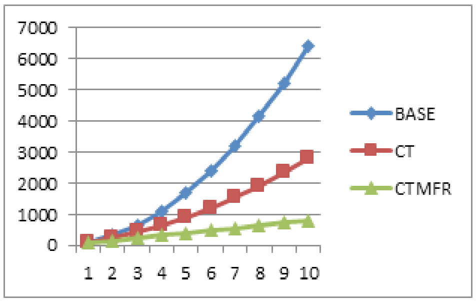

Figure 8. Total signaling cost versus hop distance.

This integration of CTMFR enables two-path context transfer design in PMIPv6 multicast. Multicast traffics, especially for the real-time video applications which are densely watched channels, typically flow along both the path in the network. This integration helps to eliminate increasing total signaling cost. Since both MAGs are already in the same multicast group. Therefore as soon as the MN attached to the nMAG the multicast session remain continuous. Hence by using this mechanism, multicast mobility achieves better signaling cost.

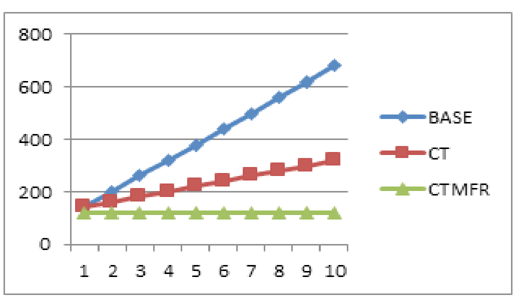

Figure 9. location update versus number of multicast group.

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5. Conclusion

This paper integrates two different concepts and implements the concepts in multicast mobility network management. The mathematical results show that the integrations have an improved version of total signaling cost. This builds up the objective of this paper which is to integrate MFR and CT with multicast PMIPv6 eventually provides an improved multicast communication performance. Experimental approach using network simulator is considered as future study.

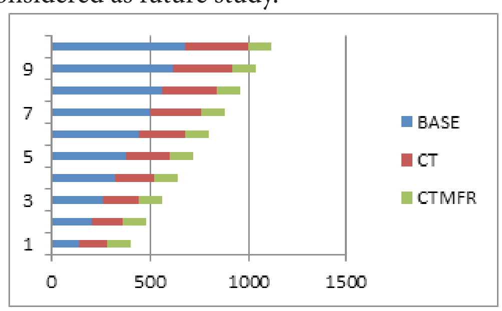

Figure10. signaling cost versus number of mobile node.

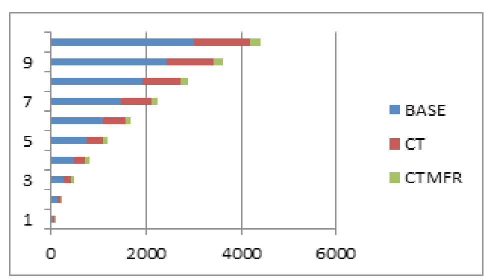

Figure 11. Packet delivery versus hop distance.

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