An Enhanced Method to Improve Proxy Mobile IPv6 Efficiency through Software-Defined Network

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Abstract: - This suggested method, called the Software Defined Open-Flow Mechanism of PMIPv6 (SD-PMIPv6), modifies the Proxy Mobile IPv6 protocol to match the Augmented Open-Flow architecture. The flexibility aspects of the PMIPv6 components, including the Mobile Access Gateway (MAG) and Local Mobility Anchor (LMA), are broken apart and rebuilt to make use of the Open-Flow strategy. The LMA components, which serve as the network's Open-Flow controller for the switches, maintain the mobile node's (MN) location. The contact access entities that are capable of managing MAG signals interact with the MN. The recommended approach has two primary objectives: (a) separating the control and data planes; and (b) shortening the handover delay.

Key-Words: - Software Defined Network, Control Plane, Data Plane, Local Mobility Anchor (LMA), Mobile Access Gateway (MAG), Proxy Mobile IPv6 (PMIPv6), Open-Flow (OF), Software Defined PMIPv6 (SD-PMIPv6).

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1 Introduction

Based on their geographic location, Internet Protocol (IP) addresses are used to identify nodes on the Internet, [1]. Networks need to be re-designated since IPv4's limited address space makes it difficult to deal with impending demands. mostly as a result of the daily increase in the total amount of users. The switch from Internet Protocol version 4 (IPv4 32 bits) to Internet Protocol version 6 (IPv6 128 bits) was also required due to the end of the lifespan of IPv4 addresses, [2]. The Mobile IPv6 (MIPv6) technology was developed to facilitate portability based on IPv6, [3]. MIPv6 is executed in the Linux environment using the Unified Mobile Internet Protocol (UMIP), [4].

The ground-breaking technology known as Software-Defined Networking (SDN) provides active, controlled, valuable, and adaptable options. This makes the environment ideal for the high-bandwidth and dynamic nature of today's activities. Utilizing the Open-Flow protocol is necessary while developing SDN solutions, [5]. The Open-Flow Technique (OFT) is a novel technology that improves network finding routes using the Open-Flow technique in PMIPv6. The division of network device responsibilities—access points utilize control and data operations about forward packets—is the fundamental component of the Open-Flow concept.

Although software-defined networking has been effectively applied in data hubs and campus links, [6], solution for the telecom industry still requires minimal influence on static landline and mobile telecom areas. Future PMIPv6 positioning strategy by Devarapalli, [7], involves dividing plane control and data endpoints meant for the MAG. The device that encapsulates and decapsulates internet traffic to and from the mobile node, as well as the one that transduces Proxy Mobile IPv6 signaling packets, are both assigned distinct IP addresses. The IP address, commonly referred to as the Proxy Care-of Address (PCoA), is contained in the proxy binding cache element in the LMA, according to [8] and [9].

Consequently, the LMA uses the same IP address as the MAG for data transfer as well as signaling messages. A Unification Plane (UP) through a system organization based on PMIPv6 was described in [10]. According to [11], there are several techniques in the field for mobility management in IP networks that give mobile nodes spanning heterogeneous wireless networks session continuation. A method for OpenFlow-based PMIPv6 in SDN in flexible networks was proposed by [12]. The goal of Proxy Mobile IPv6 is to replace locally directed network mobility with the IP tunnel idea. However, this strategy is limited because the data and control planes use the same channel and tunneling above it.

2 Layout of SD-PMIPv6

PMIPv6 signaling can be eliminated owing to the co-location of the LMA and MAG activities in the Augmented Controller, as shown in Figure 1.

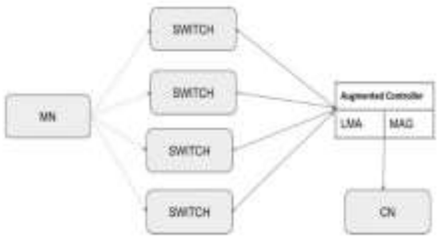

Fig. 1: Control plane Configuration in SD-PMIPv6

As shown in Figure 1, the proposed SD-PMIPv6 design isolates the control plane from the data and control planes and co-locates the LMA and MAG functions in the Augmented-Controller. The flow tables and switches are configured, and packet forwarding based on policies is supported, thanks to the enhanced information of Open-Flow. By examining the link layer status data, the PMIPv6 with the MAG detects the MN connection and disconnection. The device's MAG function receives the link layer status with SD-PMIPv6, and it can identify the establishment of the link layer relationship just like it can with PMIPv6.

2.1 Data Plane Topology in SD-PMIPv6

According to Open-Flow PMIPv6, the data route in SD-PMIPv6 has the LMA and MAG actuators situated in the Augmented Controller as depicted in Figure 2. Once the migration of the MN is detected, the LMA and MAG controllers update the flow tables of the transitional devices on the network between the entry point and the portal to reflect the change. Technology allows bandwidth balancing depending on network status without requiring an IP tunnel.

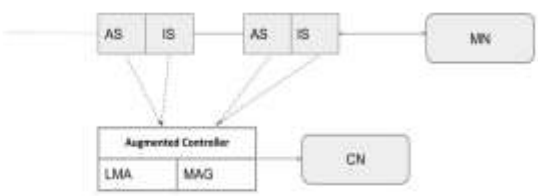

Fig. 2: Data-plane Packet Forwarding in SD-PMIPv6

Here is one mobility control entity, two gateway routers, and three access routers in this network architecture. The intermediate switches link the interface routers to the gateway routers. The mobile node's mobility is managed by the mobility administration entity, which is also in charge of updating the flow tables in the intermediate switches as necessary. The mobility management entity controls the mobile node's link as it roams between several accessibility networks.

The successful implementation of the suggested SD-PMIPv6 procedures were evaluated using a variety of parameters, including handover delay, packet loss rate, and end-to-end suspension, all of which are quantified and correlated with the parameters for PMIPv6 and OPMIPv6. The network switching of the MN is directed by the handover latency. The dropped packet quantity is represented by the packet loss measurement throughout the handover. The total handover latency of the packet is calculated by the time from MN host to destination.

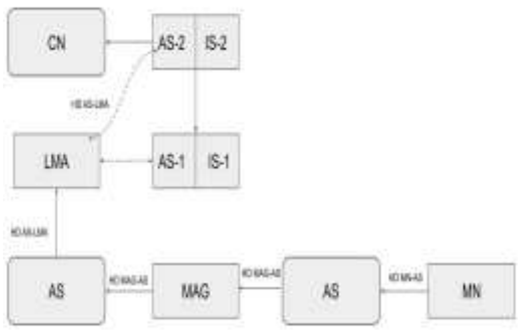

Fig. 3: SD-PMIPv6 Topology

Evaluating the handover time and packet loss rate of PMIPv6, OPMIPv6, and SD-PMIPv6 is the main Comparing the handover time and packet loss rate of PMIPv6, OPMIPv6, and SD-PMIPv6 is the main approach used to assess the recommended strategy. The amount of time that passes among an MN starts to migrate to a new get entry to the network and whilst it connects to the brand-new network and resumes data transmission is called the handover put-off. The range of packets misplaced all through the handover manner divided by using the entire amount of packets transferred is known as the packet loss charge.

To assess the effectiveness of the 3 strategies, a simulation is administered with the usage of distinct values for 's and HD_{LMA-CN}. The effect of the session delivery fee and the hop distance among the LMA and CN at the handover put-off are ascertained by comparing and analyzing the consequences of the simulation. The simulation's findings suggest that

SD-PMIPv6 operates better inside the regions of packet loss rate and handover delay than each PMIPv6 and OPMIPv6, indicating the efficacy of the suggested strategy in improving cell network performance.The above said concept is represented in Figure 3.

3 Handover Analysis of Proposed Work

This segment clarifies different PMIPv6 handover mechanisms and their concerned recreation analysis.

3.1 Investigation of Different PMIPv6 Hand-over mchanisms

The taking after segment clarifies the handover analysis of the proposed work with other existing work

3.1.1 Investigation of PMIPv6 Handover Mechanism

The Router soliciting delay (t_{RS}) and the Router Advertisement Delay (t_{RA}) are characterized, consequently. The Data Transfer Time (T_{TD}) between MN and CN during the handover procedure is represented by this data.

$$H_{PMIPV6} = \text{Layer 2 connection} + (t_{PBA} + t_{PBU}) + t_{RS} + t_{RA} + (t_{AAAreq} + t_{AAAres}) + TTD_{Data} \quad (1)$$

In this instance, the Layer 2 link shows how much time has passed between AP-MAG and MN-AP. The suspension of the control signal is indicated by (t_{PBU} + t_{PBA}), and the confirmation signal interruption is denoted by equation (t_{AAAreq} + t_{AAAres})

3.1.2 Analysis of OPMIPv6 Handover Mechanism

Both Open-Flow and PMIPv6 signals are used by O-PMIPv6. It is anticipated that even before AS receives the PBA message, the ISs will be finished via Open-Flow signaling. It happens because the AS is situated at the farthest distance and Open-Flow signaling is effectively carried out across a secure channel. OPMIPv6's handover latency is therefore equivalent to PMIPv6's. However, HOPMIPv6 is different from HPMIPv6 in that data packets are transmitted through OPMIPv6 without the need for an IP tunnel. Thus, it can be expressed as follows.

PMIPv6-like handover procedures are used. The difference is in the signaling and control messages. The suspension of control signals is signified as (t_{PBU} + t_{PBA}) and authentication suspension is signified as t_{AAAreq} + t_{AAAres}. The delay of the control messages is considered in the following equation.

$$H_{OPMIPV6} = \text{Layer 2 connection} + (t_{PBA} + t_{PBU}) + t_{RA} + (t_{AAAreq} + t_{AAAres}) + TTD_{\,Data} \quad (2)$$

3.1.3 Analysis of SD-PMIPv6 Handover Mechanism

Compared to PMIPv6 and OPMIPv6, the handover procedure in SD-PMIPv6 is distinct. The LMA and MAG controller are built inside the router, and the MN is linked to the Open-Flow switch. The following equation is the design for the control message latency.

$$H_{SD\text{-}PMIPV6} = \text{Layer 2 connection} + t_{PBU} + (t_{AAAreq} + t_{AAAres}) + TTD_{\,Data} \quad (3)$$

SD-PMIPv6 has a lower handover latency than PMIPv6 and OPMIPv6, as authentication and control messages are transmitted immediately to the gateway, with the Open-Flow switch updating the flow table solely in response to the route's input

3.2 Simulation Analysis of Various PMIPv6 Handover Mechanisms

Next, an analysis is conducted to compare the performance of OPMIPv6, PMIPv6, and AU-PMIPv6. The efficiency metric used in this assessment is handover latency.

Scalability: The system's capacity to manage a high volume of MNs and handovers, [13].

In comparison to PMIPv6 and OPMIPv6, the simulation's outcomes should show that SD-PMIPv6 can more effectively minimize handover latency and offer superior scalability.

It is crucial to remember that the simulation findings might not accurately reflect real-world situations and could have been inflated by several factors, including hardware constraints, network issues, and execution specifics, [14]. To properly assess SD-PMIPv6's efficacy, more evaluation and verification in a real-world setting are required.

According to the simulation structure, the initial standards of the system values are set for the SD-PMIPv6 cost analysis. The simulation lasts for thirty seconds. The mobility session is moving at 100 Mbps. Furthermore, the several interfaces in the simulation reflect in different amounts of seconds. According to the available research, [8], the simulation's, [15], settings are configured.

3.2.1 Analysis of PMIPv6 Simulation

The WLAN is the current interface that the MN uses to start the simulation. In the simulation, Wi-Max connects at second 11, but the MN sends a signal to Wi-Max in second 13.9. The simulation indicates that the MN transmits its signal to 3G at 28 seconds, whereas 3G begins to function at 24.5 seconds. Figure 4 shows the PMIPv6 handover graph.

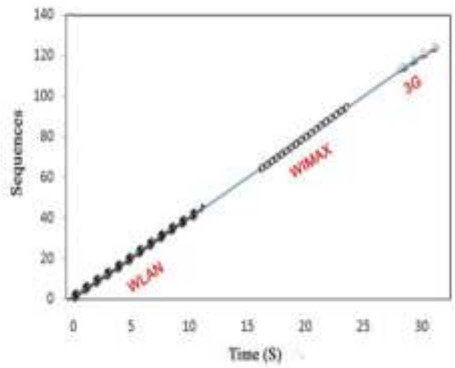

Fig. 4: Simulation Handover Result of PMIPv6

3.2.2 Analysis of OPMIPv6 Simulation

In the simulation, the MN starts off using its original interface, which is WLAN, and at the eleventh second, it switches to Wi-Max. However, the MN connects to Wi-MAX at the thirteenth and twenty-sixth seconds, respectively, before transitioning to 3G (Figure 5). The findings of the O-PMIPv6 handover simulation are displayed graphically.

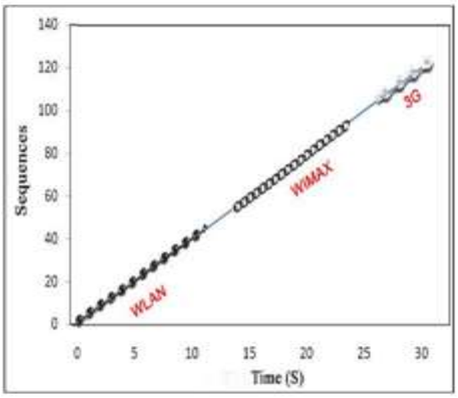

Fig. 5: Simulation Handover Result of OPMIPv6

3.2.3 Analysis of SD-PMIPv6 Simulation

In this case, the MN first utilizes WLAN and then, at the eleventh second, switches to Wi-Max. But in the thirteenth second, the MN enters Wi-MAX, and at the twenty-sixth second, it transitions to 3G. The OPMIPv6 changeover simulation result is displayed in Figure 6, although at the 25th second, the MN switches to 3G. The outcomes of the SD-PMIPv6 handover scenario are also shown in Figure 6.

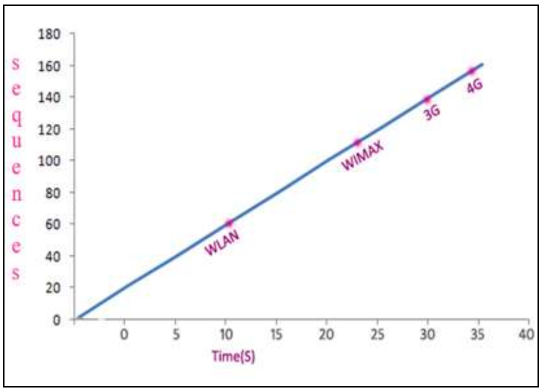

Fig. 6: Simulation Handover Result of SD-PMIPv6

3.2.4 Comparison of Handover Latency of SD-PMIPv6

Handover latencies can be compared between AU-PMIPv6, PMIPv6, O-PMIPv6, and SD-PMIPv6 to observe how they differ. The outcomes are displayed in Figure 7. Compared to other methods, PMIPv6 has a longer hand-over latency since it doesn't fully utilize Open-Flow signalling.

Compared to SD-PMIPv6, O-PMIPv6 appears to have a longer hand-over latency because it has separate Open-Flow devices for LMA and MAG. This analysis clearly shows that the SD-PMIPv6 has a lower hand-over delay than the methods currently in use.

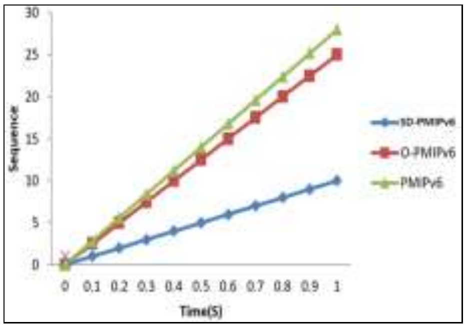

Fig. 7: Comparative Analysis of Simulation Handover Result of Various PMIPv6 protocols

4 Conclusion

SD-PMIPv6 is a version of PMIPv6 for the open-flow architecture. To enable flexibility in the OF design, portable activities are placed in the control units and switches and detached from the PMIPv6 parts. Furthermore, because of its augmented controller, its proposed technique provides an even more flexible formation architecture that may increase management volume and endure letdown. The results of the effectiveness assessment indicate that SD-PMIPv6 is superior to PMIPv6.

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Conflict of Interest

The authors have no conflicts of interest to declare.