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Evaluation of L2 Trigger Impact on Fast Mobile IPv6 Handover

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Abstract- Mobile IPv6 with fast Handover enables a Mobile Node (MN) to quickly detect at the IP layer that it has moved to a new subnet by receiving link-related information from the link-layer; furthermore it gathers anticipative information about the new Access Point (AP) and the associated subnet prefix when the MN is still connected to the previous Corresponding Node (CN). The aim of this paper for the fast Mobile IPv6 handover (FMIPv6) protocol is to allow an MN to configure a new Care-of-Address (nCoA), before it moves and connects to a new network. Furthermore, the FMIPv6 protocol seeks to eliminate the latency involved during the MN's Binding Update (BU) procedure by providing a bi-directional tunnel between the old and new networks while the BU procedures are being performed

Keywords- Mobile IPv6; Fast Handover; L2 Information; L3; Handover Latency; Packet Loss;

I. INTRODUCTION

Mobile IPv6 specification defines how an MN can maintain connectivity to the Internet when its AP changes from one AR to another one. It allows an MN to communicate with other nodes (stationary or mobile) after changing its L2 point of attachment from one IP subnet to another, yet without changing the MN's IPv6 address [1, 2]. An MN is always addressable by its home address, and packets may be routed to it using this address regardless of the MN's current point of attachment to the Internet [3, 4]. During the handover procedure, there is a period of time in which an MN cannot send or receive packets, because of the link-switching delay. This period of time is known as handover latency; it is the primary cause of packet loss. Moreover; there is a high Mobile IPv6 handover delay because of the agent discovery and registration periods; eventually Mobile IPv6 handover can cause significant performance degradation, especially in large scale mobility environments [3, 5]. Fast handover addresses the following problems: how to allow an MN to send packets as soon as it detects a new link, and how to deliver packets to an MN as soon as its attachment is detected by the nAR [6, 7]. The protocol enables an MN to quickly detect that it has moved to a new subnet by providing the nAP and the associated subnet prefix information with the L2 information when the MN is still connected to its current oAR. For instance, an MN may discover available APs using L2 specific mechanisms, and then request subnet information corresponding to one or more of these discovered APs [8, 9]. The MN may do this after performing router discovery or at any time while connected to its current router. This paper proposes an enhancement to the Fast Mobile IPv6 handover (FMIPv6) using L2 information, also present performance evaluations in terms of the handover latency and packet loss using evaluation models.

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II. RELATED WORKS

Fast handovers for Mobile IPv6 [10] is proposed to reduce the handover latency by executing those time consuming processes when aMN is still present on the current link with the help of timely generated L2-trigger.TheL2-trigger is generated from the link layer to indicate that the MN will be likely to per- form aL2 handover soon. Upon receiving L2-trigger, MN initiates FMIPv6 handover procedure and completes the CoA configuration before L2 handover. This leads to waste of time, because there is no way to know which one accrue first either L2 or L3 handover after the completion of newCoA. Several extensions [11] have been proposed to improve the performance of FMIPv6, but these studies did not consider reducing the anticipated handover delay that limits the time for the MN to perform fast handover procedure in predictive mode. An Early Binding Fast Handover (EBFH) [12], in which an MN performs an early fast BU with its current AR before a trigger that signals MN is closed to handover. The FMIPv6 initiates movement detection through a link-going-down trigger, whereas EBFH completes its BU for the nCoA before the link-going-down trigger. The idea of EBFH is to provide a fast handover for fast-moving nodes. If the MN moves at high speed, it is turn to the FMIPv6. This requires that , EBFH issues many signalling messages before the link-going-down trigger, so it consumes a large amount of network performance and creates significant useless overhead. A new message proposed in [13], the Router Solicitation for Proxy Advertisement (RtSolPr) message is utilized by the MN and sent to its current AR to request this information about likely candidate APs. The response by the present AR is called a Proxy Router Advertisement (PRtAdv) messages, containing the neighbouring router's advertisement (including its prefix). As the MN receives this information, it can immediately formulate a prospective new CoA for the new AR, while still present on the old AR's link. FMIPv6 tries to reduce handover delay by providing fast IP connectivity as soon as MN attaches to a new subnet. To realize this, MN must launch the passive or active scanning process to discover the available AP [14].

According to the probe results, AR provides MN with the corresponding subnet prefix information, and then MN could generate an nCoA when it is still connected to its current subnet. To minimize packets loss, a bidirectional tunnel is setup between oAR and nAR. Utilizing this tunnel, oAR forwards the packets destined to MN's old CoA to its nCoA, MN could also continue to send packets to CN through oAR. Such tunnel remains active until MN completes a BU with its CNs. However, there are two mains shortcomings in the FMIPv6 protocol. First; MN could'nt receive or send the data during the probe phase, while it lasts minimum 350 ms [15], furthermore, MN must spend time to re-switch the channel and re-associate with its oAP to exchange the messages with oAR; Second; DAD process could not be completely avoided if MN's nCoA is not validated by the nAR before MN disconnects with its oAR.

III. PROPOSED LOW-LATENCY FMIPv6 HANDOVER

While the MN is connected to its oAR, and is about to move to the nAR, fast handover in Mobile IPv6 requires:

1. The MN to obtain an nCoA at the nAR while being connected to the oAR;
2. The MN to send a BU message to its oAR to update its binding cache with the MN's nCoA;
3. The oAR to start forwarding packets destined for the MN to the nAR

As shown in Figure 1, the sequence messages of the fast handover protocol in Mobile IPv6, either the MN or the oAR may initiate the handover procedure by using the L2 trigger. The L2 information indicates that the MN will soon handover from one AP to another one, with these two APs being attached to the oAR and nAR, respectively.

If the L2 trigger is received at the MN (mobile-initiated handover) the MN will initiate L3 handover by sending an *RtSolPr* message to the oAR. On the other hand, if the L2 trigger is received at the oAR (network-controlled handover), then the oAR will transmit *PrRtAdv* messages to the appropriate MN, without any solicitation messages [7].

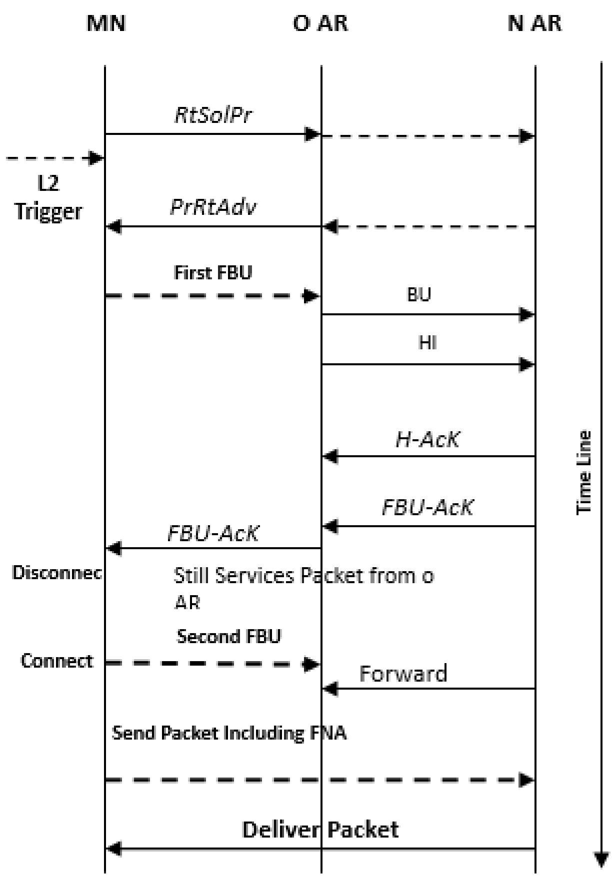

Figure 1: Fast Mobile IPv6 Handover Protocol Message Flow

Handover system

The handover system is made up of the MN and access routers as follows:

$$System \overset{def}{\equiv} \text{MN} \langle CoA \rangle \mid \text{oAR} \mid \text{nAR}$$

The FMIPv6 handover system is made up if parallel compositions of a MN primitive to (CoA) communicate with both oAR and the nAR

Mobile Node (MN)

The MN will receive a link from the nAR, which is used to communicate with it. Then, the MN sends *RtSolPr* to inform the oAR that it is going to handover to the nAR

$$MN(CoA) \overset{def}{\equiv}$$
$$\overline{RtSolPr}\langle CoA\rangle .$$
$$PRtAdv(nCoA, Link\ Information, Link\ Identifier)$$
$$\overline{BU}\langle first\rangle . FBU\text{-}AcK. \overline{BU}\langle second\rangle .$$
$$\overline{FNA}\ MN\langle nCoA\rangle$$

The MN obtains an nCoA while still being connected to the oAR, by means of RA from the nAR containing network information.

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When the MN receives a *PrRtAdv* message, it should send an FBU message, prior to disconnecting its link.

Old Access Router (oAR)

The oAR is made up of the following components:
RtSolPr: an action utilized by the MN, sent to its current AR to request information about likely candidate APs and handle the MN initial request for the handover.
Forward: an action which passes both new and old CoAs.
HI: a request message sent to the nAR to make the handover process.
The oAR first receives the handover request from the MN, and then sends it directly to the nAR:

$$oAR \overset{def}{\equiv}$$

$$\mathrm{RtSolPr}(\mathrm{oCoA}).\,\overline{\mathrm{Forward}}\langle \mathrm{oCoA}\rangle\,.$$

$$\mathrm{Pr}\,RtAdv\big(nCoA, Link\ Information, Link\ Identifier\big)$$

$$\overline{PRtAdv}\langle nCoA, Link\ Information, Link\ Identifier\rangle.$$

$$BU(\ first\ ).\overline{BU}$$

$$\overline{HI}\ .\ H-AcK\ .\ FBU-AcK.\overline{FBU\text{-}AcK}.$$

$$BU(\ \mathrm{second}\ ).oAR$$

The oAR will validate the nCoA and initiate the process of establishing the bi-directional tunnel between the oAR and nAR, by sending a HI message to the nAR.
When the oAR receives an FBU message, it must verify that the requested handover is accepted by the nAR as indicated in the H-AcK message status; then it will start forwarding packets intended for oCoA to the nAR and send an FBU-AcK to the MN.

New Access Router (nAR)

The nAR is made up of the following components:
Forward: an action which passes both new and old CoAs.
PRtAdv: the response by the present AR, containing the neighbouring router's advertisement for the link information and network prefix.
H-Ack: a confirmation sent back to the oAR to make the handover to the nAR.

$$nAR \overset{def}{\equiv}$$

$$Forward\ (\ oCoA\ )$$

$$\overline{PRtAdv}\ \langle\ nCoA, Link\ Information\ , Link\ Identifier\ \rangle.$$

$$\mathrm{BU}.\ HI.\ \overline{H\text{-}AcK}.$$

$$\overline{FBU\text{-}Ack}.\ \langle\ Forward\ Packets\ \rangle.\ FNA.\ nAR$$

The nAR verifies that the nCoA can be used on the nAR's link. Moreover, in response to the HI message, the nAR sets up a node route for the MN's oCoA, and responds with a H-AcK message [9, 16].
Upon verification of the variables, nAR will send the Acknowledgment (*ACK*) to confirm its acceptance; then the oAR will start sending the buffered packets to the nAR distend to the MN.

IV. EVALUATION ENVIROMENT

The fast handover scheme is implemented in ns-2 version ns-allinone 2.31 with the Mobile IPv6 model from Columbia IP Micro-mobility Software (CIMS) [17]. We evaluate the performance of the fast handover in the FMIPv6 based link layer information algorithm. We compare the proposed algorithm against a Mobile IPv6 and Mobile IP. The performance metrics for comparison include the handover latency, packet loss, throughputs and handover delay [18].

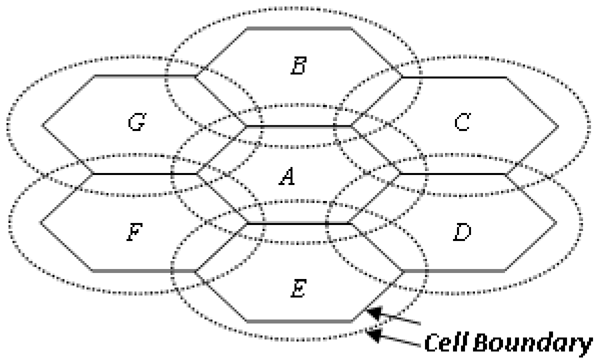

Figure 2: Overlapping Coverage Area

For simplicity we assume that there is no change in direction while the MN moves inside the overlapping area. The best possible handover point occurs at position A, as shown in Figure 2. The coverage area can be defined in terms of signal strength; the effective coverage is the area in which MNs can establish a link with acceptable signal quality with the AP. The coverage radius is defined as the distance from an AP to its coverage boundary. The cell radius is the distance from an AP to its cell boundary. In our simulation, we use a 400m × 500m and a 4000m × 1000m area with a 5 to 12 MNs. The network bandwidth is 2 Mbps and the medium access control (MAC) layer protocol is IEEE 802.11 [5]. The packet size is 10p/s which will generate enough traffic when we increase the number of connections for example at 40 connections of source-destination pairs, it will generate 400 packets per second for whole scenario. The main purpose behind the proposed approach of the FMIPv6 is to reduce the signalling overhead, handover latency and the number of packets loss.

V. PERFORMANCE EVALUATION

We use network simulator CIMS NS-2 version ns2-allinone-2.31 as a simulation tool in order to simulate FMIPv6 handover [19]. It supports for routers set in order to reduce unsolicited RA intervals and the addition of the RA interval option as defined in the MIPv6 draft. This will enable CN support for route optimization. Figure 3 and Figure 4 shows the increase in handover latency and the packet loss due to an increase in the number of MNs sharing the wireless channel. The results gained for up to 10 MNs indicate that the dominating factor of the handover latency is the wired link delay for a small number of MNs

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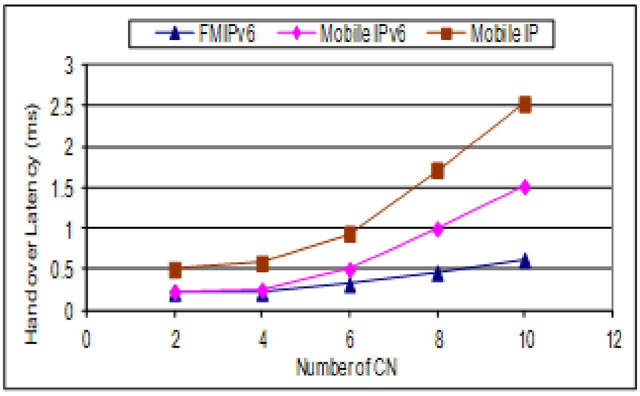

Figure 3: Impact of Handover Latency

As can be seen, the FMIPv6 approach performs better in terms of the handover latency and packet loss, although the fast handover protocol is designed to minimize packet loss and latency during a handover; a worse performance is observed with respect to the Mobile IP and Mobile IPv6 protocols when channel availability arises. Under high load conditions, the additional signalling messages of fast handover schemes in the local domain result in reaching the saturation level on the wireless channel earlier.

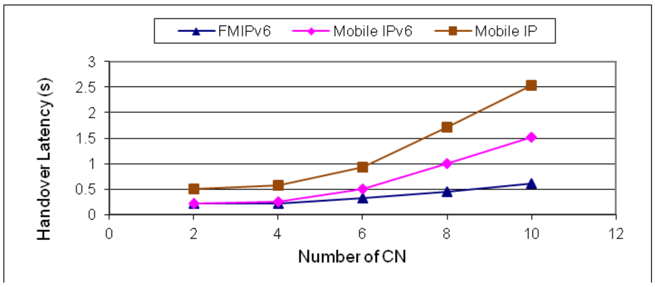

Figure 4: Impact of Packet Loss

Figure 5 shows the uplink MN to CN handover delay of Mobile IP, Mobile IPv6 and FMIPv6 over the handover rate. The total handover delays versus handover rates reveal how the handover delay of each handover protocol reacts when the scale of mobility varies. The total handover delays of Mobile IP and Mobile IPv6 increase as expected; in contrast, FMIPv6 handover does not incur any delay, irrespective of the handover rate. This is due to the fundamental difference between the FMIPv6 handover registration procedure and other schemes procedures. Handover delay of Mobile IP and Mobile IPv6 becomes more significant as handover rate increases.

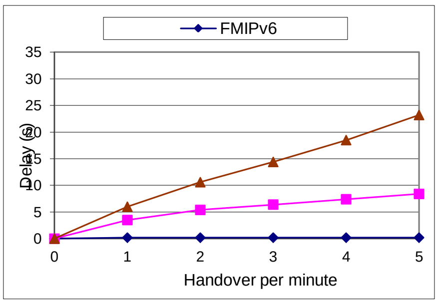

Figure 5: Handover Delay

As we can see, handover delay and the handover rate product directly affect the end-to-end throughput and packet loss. Thus, Mobile IP and Mobile IPv6 cannot be used as proper handover approaches in large-scale mobility environments. On the other hand, FMIPv6 does not incur any significant throughput decrease nor packet loss by keeping handover delay zero, regardless of the handover rate

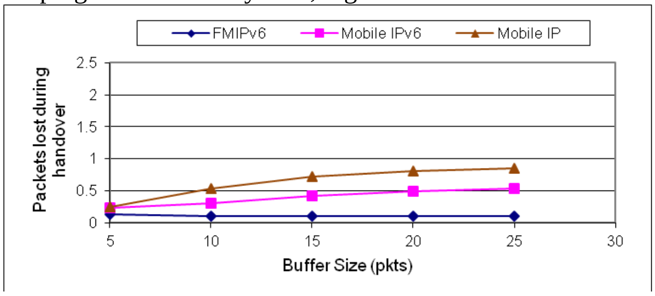

Figure 6: Packet Loss vs Buffer Size

The partially better behaviour for Mobile IPv6 is a consequence of the higher wireless load of the fast handover approach. A higher number of signalling messages sent via the wireless medium yields to a higher channel access delay and higher collision rate, resulting in a lower bandwidth being achieved. In order to offer smooth handover in the simulation the buffer size is set to be able to recover all misrouted packets during the handover. The number of packets lost depends on both the size of buffer used to store packets for potential handovers and the sending rate, as seen in Figure 6. The number of packets lost increases for Mobile IP, since no buffer is used, and increases as the sending rate increases since more packets are sent while the MN is unable to receive them during handover. On the other hand, the number of packets lost decreases as buffer size increases for FMIPv6. This means that the packet loss can be totally eliminated if the buffer size chosen is large enough. Furthermore, this buffer size can be adjustable according to the sending rate, since the number of packets lost increases as the sending rate increases for constant buffer size.

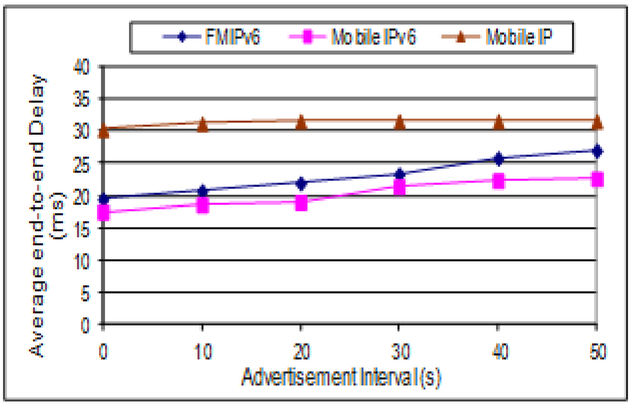

Figure 7: Average End-to-End Delay

Figure 7 shows the average end-to-end delay with advertisement intervals between 2 and 45 seconds. As the result graph shows, the average end-to-end delay is less for the FMIPv6 and Mobile IPv6 than for the Mobile IP approach.

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The reason is that the periodic AR information sent by the n AR allows the MNs to update their route entries for the n AR more often, resulting in fresher and shorter routes. The result also shows that the average end-to-end delay decreases slightly for short advertisement intervals when the advertisement interval is increased. At first thought this might seem unexpected. However, it can be explained by the fact that very short advertisement intervals result in a lot of control traffic, which leads to higher processing times for data packets at each node. Moreover, since the Mobile IP messages for all schemes are prioritized over data packets, these have to wait in the routing queue until the mobile messages are sent, resulting in higher end-to-end delay

VI. CONCLUSION

The usage of link-layer information at the IP layer is an open question and is still in progress in the IETF community, while it is commonly accepted that the usage of link-layer information can result in a more efficient IP packet transport. This paper presented an investigation into the FMIPv6 handover scheme in order to provide rapid handover and reduce packet loss, signalling traffic and lengthy latency for handover management. This scheme is used to achieve rapid handover and reduce packet loss during the handover. The fast handover proposal anticipates the movement of an MN allowing the MN to register with the nFA prior to L2 connectivity being established. Basically, FMIPv6 tries to perform nAR discovery and nCoA configuration before the L2 handover starts, and sets up a tunnel between the oAR and nAR for smoothing the handover and minimizing the handover disruption time. It is noted that the simulation proposed scheme has many desirable properties, such as rapid handover and low packet loss compared to the other handover scheme

REFERENCES

1. D. Johnson, C. Perkins and J. Arkko, "Mobility Support in IPv6", RFC 3775, June 2004.
2. G. Dometty, A. Yegin, C. Perkins, G. Tsirtsis, K. El-Malki and M. Khalil, "Fast Handovers for Mobile IPv6", Internet draft, work in progress, http://www.ietf.org/internet-drafts/, July 2001.
3. S. Deering and R. Hinden, "Internet Protocol, Version 6 (IPv6) Specification", RFC 2460, December 1998.
4. China Education and Research Network, CERNET2 Milestones, http://www.edu.cn/cer2_1556/20060323/t20060323_158680.shtml, updated January 2006.
5. R. Koodli, "Fast Handovers for Mobile IPv6", Internet Engineering Task Force, http://www.ietf.org/rfc/rfc4068.txt, July 2005.
6. D. Johnson, C. E. Perkins and J. Arkko, "Mobility Support in IPv6", Internet Engineering Task Force RFC3775, 2004.
7. M. Alnas, I. Awan and R. D. W. Holton, "Fast Handoff in Mobile IPv6 Based Link Layer Information", 9th IEEE Malaysia International Conference on Communications, IEEE Computer Society, 2009.
8. R. Droms, J. Bound, B. Volz, T. Lemon, C. Perkins and M. Carney, "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)", RFC 3315, July 2003.
9. H. Chung-Ming, C. Meng-Shu and L. Jin-Wei, "A Link Layer Assisted Fast Handoff Scheme Using the Alternative Path Approach", 20th International Conference on Advanced Information Networking and Applications, 2006
10. M. Liebsch, A. Singh, H. Chaskar, D. Funato and E. Shim, "Candidate Access Router Discovery", *RFC 4066*, July 2005.
11. G. Pollini, "Trends in Handover Design", IEEE Communications Magazine, 34, 3, 80–90, March 1996.
12. The Network Simulator ns-2, http://www.isi.edu/nsnam/ns.
13. R. Koodli, "Fast Handovers for Mobile IPv6", Internet Engineering Task Force, July 2005, http://www.ietf.org/rfc/rfc4068.txt.
14. D. Johnson, C. Perkins and J. Arkko, "Mobility Support in IPv6", Internet Engineering Task Force RFC 3775, June 2004.
15. S. Oh, H. Song and Y. Kim, "Seamless Fast Handover in Mobile IPv4 Using Layer-2 Triggers," in Systems and Networks Communications, ICSNC 2007, 2nd International Conference, pp. 16-16, 2007.
16. H. F Chen and J. Zhang, "Prep-binding of Fast Handovers for Mobile IPv6", draft-chen-mipshopfast-handovers-prep-binding-02.txt, IETF, April 2006.
17. A. T. Campbell, J. Gomez, K. Sanghyo, W. Chieh-Yih, Z. R. Turanyi and A. G. Valko, "Comparison of IP Micromobility Protocols", Wireless Communications, IEEE, vol. 9, pp. 72–82, 2002
18. (Ramani) J. Puttonen, "Using Link Layer Information for Improving Vertical Handovers", *16th International Symposium on Personal, Indoor and Mobile Radio Communications IEEE*, 2005 Columbia University, *Columbia IP Micro-Mobility Software*,
19. http://www.comet.columbia.edu/micromobility/.index.html.

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