Enhancement of Binding Update for Mobile IP

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Abstract

The mobile IP analysis model does not give much investigation on the situation when correspondent node (CN) is also a mobile node. Triangle routing reflects the assumption of a stationary CN. When CN is also mobile, the routing path is not triangle any more. Moreover, binding update (BU) between two mobile nodes is more complex than binding update from a mobile node to a stationary node. When two mobile nodes transfer bulk data between them, the efficiency will be greatly affected by the binding update mechanisms. This paper presents our study on bulk data transfer between two mobile nodes. We present a comprehensive list of possible BU transmission methods, and we show our performance evaluations of them. By analyzing the results, we found several important factors that affect efficiency in terms of traffic load and average bit rate. Finally, we present our improvement on BU transmission method and its evaluation results. The results showed that our improvement is very helpful when CN is mobile.

1. Introduction & Related Work

MIP does not give much attention to the type of CN, and in most cases, it assumes CN is a stationary node. The well-known triangle routing is a very good example that reflects this assumption. If the CN is also mobile, the communication path will not be triangle because two home agents will be involved. On the other hand, bulk data transfer from MN to CN is sensitive to temporary break of the communication path, and it requires reducing the negative effect of handoff as little as possible. When CN is also mobile, it equals to require effective and efficient tracking between MN and CN. Effective and efficient tracking is dependent on the methods of BU transmission and handoff techniques. In this paper, we show our improvement on BU of mobile IP.

In the context of bulk data transfer from MN to CN, both registration-delay and packet loss have negative impacts. With a long registration delay, MN has to wait a long time before it can send/receive data from NFA. Although regional registration [2] can reduce the handoff delay within an administrative domain, it cannot solve inter-domain handoff delay because the difficulties of building security associations (SAs) between OFA and NFA in different administrative domains. Packet loss is also bad. Loss of BU is easy when CN is stationary, but it is tricky when CN is mobile, since CN may move to anywhere. Many BU lost will leads to a longer delay for detecting an obsolete binding cache entry, which in turn will cause more packets being sent to wrong destination.

2. Performance Evaluations

By investigating the smooth handoff method in [1], we found the handoff delay is significant. In the method, new foreign agent (NFA) will notify old foreign agent (OFA), so that those packets that are in flight to OFA can be forwarded to NFA. Although the packet loss is reduced, the handoff delay makes MN unable to send/receive packets for a long time. It will decrease the average bit-rate of transmission. Requesting OFA to forward packets to NFA involves many security issues, and these issues are not solved until now.

![Table: Data Transmission Schemes](image)

**Figure 1: Data Transmission Schemes**

By eliminating the contact with OFA, we can increase the speed of handoff. We call it simple handoff. It aims to reduce the handoff delay, but it causes more packet loss than smooth handoff. Fast handoffs that take
advantage of link/physical layer techniques are not
address here, because it is dependent on the physical
media or link layer protocols.

We have different choices for BU transmission,
HOME-BU is to send BU to the receiver through its
home agent. DIRECT-BU is to send BU through the
receiver's foreign agent. NO-BU does not perform
routing optimization at all. DIRECT-BU requires the
sender has a binding cache of the receiver's care-of
address. BU might be lost, and MN/CN might lose the
tracking of its peer. If either node detects the failure of
tracking, it will send packets through the home agent of
its peer unless next BU is received. NO-BU means all
packets are delivered through home agents.

Through combining the different methods of handoff
and BU transmission, we can obtain a number of
methods, as listed in figure 1. Some combinations are
invalid, and they are marked with cross lines. Valid
combinations are numbered, and altogether 14 possible
methods are available for bulk data transfer between two
mobile nodes.

![Graph](image1)

**Figure 1:** Fourteen Methods

![Graph](image2)

**Figure 2:** Evaluation Results

We evaluated the efficiency of the 14 methods in
terms of the total traffic load (TNH) and average bit-rate.
Total traffic load is defined as:

\[ TNH = \sum_{n}^{N} \text{Hops}(P_n) \]

where \( \text{Hops}(P_n) \) is the number of hops traveled
by Packet \( P_n \), and \( N \) is the total number of packets
appeared on the network. Average bit rate is the average speed of data
transfer between two mobile nodes. It is calculated based on the total time cost of transferring certain amount of
data. The evaluations results are show in figure 2.

With regard to the traffic load, the first point we shall
notice is that passing home agent will cause a high traffic
load regardless of handoff techniques. The total traffic
load of method 1, 8, 2, 3, 9, and 10 are much higher than
others. Packets travels longer path. The second point is
that simple handoff always has much higher traffic load
than smooth handoff with identical BU transmission
method, as the TNH of method 8-14 are much higher
than their counter part in 1-7. Simple handoff has more
packet loss, because those packets on the way to OFA
have all been dropped. And the packet loss results in
serious retransmissions of the packets. With regard to
the average bit rate, Simple handoff has lower time cost
than smooth handoff, as method 8-14 has smaller time
cost than their counter parts in method 1-7. Simple
handoff do not contact OFA, thus it has a shorter delay.

3. Enhancement & Conclusion

To achieve both low traffic load and high bit-rate, we
can either reduce the time cost for smooth handoff or
reduce traffic load for simple handoff. We choose the
later because reducing the delay of smooth handoff is not
easy because of security issues. To reduce the traffic
load for simple handoff, we need to reduce the packet
loss. During the movement of MN, CN has two states, i.e.,
stationary or simultaneous movement. If CN keep
stationary, then DIRECT-BU for MN→CN will be much
faster than HOME-BU for MN→CN. If CN knows the
new care-of address of MN in a shorter time, less
packets will be sent to wrong destination. Accordingly,
the packet loss is reduced. We enhance method 14,
which has the lowest total time cost, by doing DIRECT-
BU in parallel with HOME-BU. The evaluation results
show a reduced traffic load comparable to method 7
that has the lowest load in the 14 methods.

![Graph](image3)

**Figure 3:** Traffic load of Method 14

With double-path-BU method, the traffic load and
the bit rate would be well balanced, and it should greatly
benefits the bulk data transfer between two mobile nodes.

References


IPv4 Regional Registration, IETF, Internet Draft, March,
2002