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Freeze DeadLine Method for Vertical Handover in Heterogeneous Wireless Networks

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Abstract. In this paper, we propose a FDL(Freeze DeadLine) algorithm to solve handover problems in heterogeneous wireless networks. Many previous studies concentrated on low level layer to solve handover. In this paper, however, we concentrate on high level handover problems such as network layer and transport layer. We analyze handover problems of transport layer in Heterogeneous wireless network, propose the FLD algorithm for better performance than others studies. The proposed method is analyzed by theoretical frames and we verify the propose method using the NS-2(Network Simulation – 2).

Keywords: FDL, Vertical Handover, Heterogeneous Wireless Networks

1 Introduction

Recently, LTE-A (Long Term Evolution Advance) is launched on the commercial scale in Korea. In theory, LTE-A has rapid network transmission speed about 150Mbps. It is shown that the wireless technique has developed greatly compared to the past when 3G networks used. However, wireless networks are used not only by the Best transmission speed but also by others parameters for each environments. By the way, the latest MT (Mobile Terminal) can use not only a network but also multiple networks. It is named as Heterogeneous Wireless networks. Each network offers a service to each user for their purposes.

2 Related Work

Freeze – TCP [1] is a method to improve throughput in the hand-off situation. If a node is aware that hand-off has occurred, it sends a message to the server that sets window size to be “0”. When the server receives this message, it stops sending packets. When hand-offends, the node sends a message to the server that sets the window size to its value before handover. However, Freeze-TCP causes some

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adaptation problems. In upward handover, the node should wait to use full bandwidth. In downward hand-off, the node lost packets because of low bandwidth.

The improvement of Freeze-TCP are proposed[2]. This method is that calculates new RTT for a time-out solution after hand-off. However, this method concentrates a situation of hand-off ended. Another study is Freeze-TCP+[3]. This way is that predicting bandwidth changes using remained packets for throughput after hand-off, however, It is not mentioned about hand-off start time and hand-off end time.

The IEEE 802.21 MIH [4] standard defines media-access independent mechanisms that enable the optimization of hand-off between heterogeneous IEEE 802 systems and may facilitate hand-off between IEEE 802 systems and cellular systems, but it has some problems because it does not consider the transport layer hand-off. [5].

3 Freeze DeadLine Method for Vertical Handover in Heterogeneous Wireless Networks

If Freeze-TCP is used, many hand-off problems of transport layer in wireless networks are solved, however, Freeze-TCP is designed for horizontal network, so, another problem are occurred when Freeze-TCP used heterogeneous wireless networks.

(Fig 2) shows fast freeze problem. If apposite Freeze time is FDL(Freeze DeadLine), fast Freeze cause waste of time of packet transmission. In Fig 2, deviant crease lines mean that if Freeze is normal, data transmission is possible, however, transmission is impossible because of Fast Freeze. If Freeze-TCP know exact freeze Time, data transmission are transmitted economically.

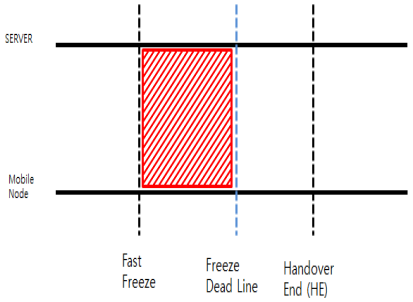

Fig. 1. Early Freeze

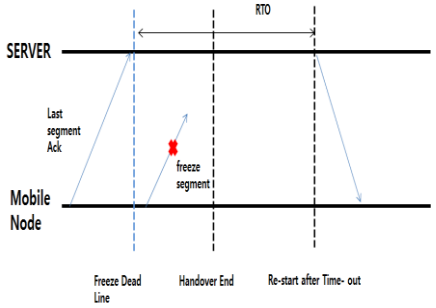

Fig. 2. Late Freeze

(Fig 3) shows late freeze problem. We suppose packet that transmit after FDL are all lost. If a mobile node sends a freeze request packet after FDL, the packet must have lost. It cause that a server do not know hand-off occur or not. Server sends a packet to mobile node because it do not know hand-off. It cause timeout event.

We discuss hand-off problems, to solve it, we propose Freeze Deadline method. We supposes that bottom layer send messages that have hand-off start time and hand-off end time. MIH and Cross layer method is used to calculate the hand-off start time and hand-off end time. Also, all packets are lost from hand-off start time to hand-off

In this paper, FDL is a time of RTT/2 befoer hand-off end time in current networks., which is described by the following,

$$FDL_{time} = T_{Handover\ End} - \frac{RTT_{current}}{2} \quad (1)$$

Mobile nodes are gathering others network parameters and monitoring hand-off. If hand-off are occurred. Mobile node calculated hand-off end time(HE) using past information, and send a freeze request message to server before FLD. It is because that the packet of freeze request can alive(We suppose that all packets are lost from hand-off start time to hand-off end time) and safely arrive to server.

FDL show better performance than other fast freeze. Suppose throughput is G, G is Congestion Window divided by RTT(Round Trip Time), which is described by the following,

$$G = \frac{CWND}{RTT} \quad (2)$$

The benefit of FDL is a value of FDL time minus early freeze time and multiply throughput, G, which is described by the following,

$$FDL_{benefit} = (FDL_{time} - T_{earluFreeze}) \times G \quad (3)$$

FLD_{time} is hand-off start time and $T_{FastFreeze}$ is early Freeze time. The $FDL_{benefit}$ is always positive number because hand-off start time minus fast freeze time is better than 0. (Equation 3) means that FDL method has better performance than fast freeze.

Proposed method is knows hand-off end time using bottom layer's information. When mobile node sends a message of freeze network, mobile node sends hand-off end time together to the server in FDL. However, transport layer do not know that hand-off is occurred or not, in late Freeze situation, so, the server waits long time from time of last received ACK to time-out event occurred. FDL benefit is (equation 4) compare to late freeze.

$$FDL_{benefit} = (RTO - (T_{handover\ end} - FDL_{time})) \times G \quad (4)$$

RTO is term of Time out by TCP, $T_{handoverEnd}$ is hand-off end time. FDL benefit is shown (Fig 5) compare to late Freeze. In late Freeze, TCP do not know when transmission is started. Although server can transmit the packet to client, they do not because server waits the end of time-out.

4 Experiment

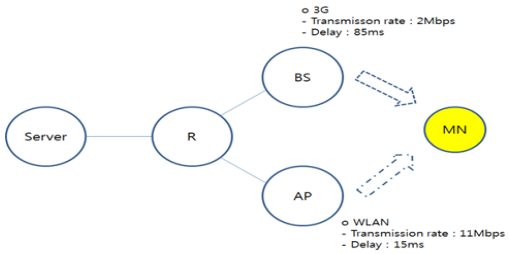

Fig. 3. Simulation Topology

We simulates FDL in NS-2(Network Simulator -2)[6]. (Fig. 3) shows experiment environments, it consist of a server, a Router, Base-station for 3G network, and a Access Point. the server, router, BS(Basement), AP are connected with wire, mobile node and access point are connected with wireless. We simulate 4 protocols, Freeze-TCP, TCP-Reno applied FDL, TCP-Reno, TCP-SACK. TCP-SACK is used error environments. Error rate is 1%. We simulated two situations, first is downward handover(3G to WLAN) situation, second is upward hand-off (WLAN to 3G).

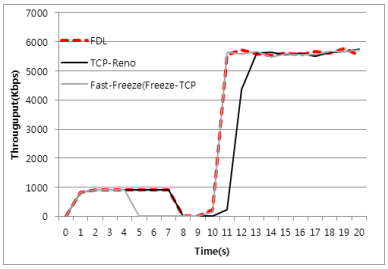

Fig. 4. Throughput in Downward Vertical Handover

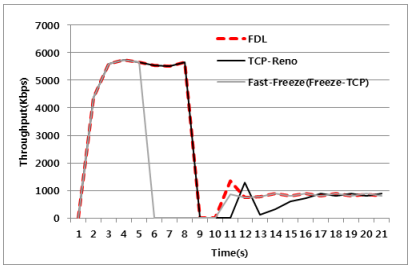

Fig. 5. Throughput in Upward Vertical Handover

(Fig. 4) shows throughput in downward hand-off environment using FDL, TCP-Reno and Fast-freeze. After 5 second, we can see fast freeze problem. fast freeze cause bandwidth waste. Even though sever can transmit data, they do not it, because fast freeze is occurred. However, FDL knows hand-off end time and when last packet is sent, so, FDL continually transmit packet. After 10 second from simulation started, FDL transmit packet faster than TCP-Reno. TCP-Reno do not kwon, when hand-off started and ended. TCP know last packet and RTO, so, TCP just perform the Time out event. Compared to FDL, TCP transmit is later than it.

(Fig. 5) shows throughput in upward hand-off environment using FDL, TCP-Reno and Fast-freeze. After 5 second, we can see fast freeze problem. fast freeze cause bandwidth waste. Even though sever can transmit data, they do not it, because fast freeze is occurred too. However, FDL work ordinarily.

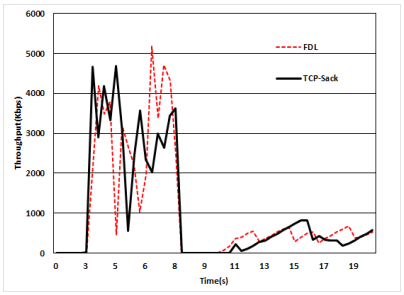

Fig. 6. Throughput in Upward handover when errors are occurred

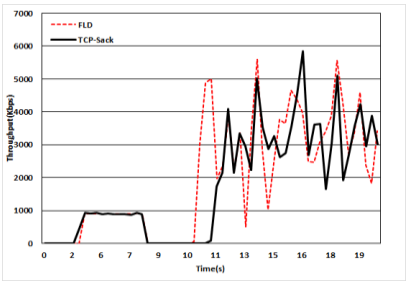

Fig. 7. Throughput in Downward handover when errors are occurred

We simulate error environment it same condition above simulations. This experiment purpose is that real-world has many packet loss due to diffraction,

interference or collision . We set error rate about 1%. (Fig. 6) shows upward hand-off situation when packet are lost using TCP-SACK and FDL. Front of the (Fig. 6) shows same but only different throughput, however, FDL is more performance than TCP-Sack after hand-off ended, because FDL knows hand-off end time.

(Fig. 7) shows downward hand-off situation when packet are lost using TCP-SACK and FDL. It is also shows that FDL is better performance than TCP-SACK. FDL transmits packet in advance of TCP-SACK, because FDL know hand-off end time.

5 Conclusion

In heterogeneous wireless networks environment, hand-off problems is considered by many dimensions. However, lately researches are concentration on the physical and link layer. So, we concentrates transport layer. In hand-off situation, transport layer is sensitive such as packet loss or throughput down, so must have to control this problems. There is a Freeze-TCP for transport layer hand-off however, Freeze-TCP do not know when network are freeze or unfreeze. So, this paper proposed Freeze DeadLine. Proposed method is analyzed theoretical frames and verified that the propose method using the NS-2(Network Simulation – 2).. Also, We shows better performance to compared CWND each networks.

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