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反應式 FHCoP-B 快速換手的流程最佳化與效能分析

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摘要

過去對於單一行動節點(Mobile Node, MN)執行快速換手的研究集中在 IETF 所提出的 Fast Mobile IPv6 (FMIPv6)與延伸的論文。FMIPv6 的概念是透過 MN 第二層(L2) 收到訊號的強弱變化,預測 MN 是否即將換手至另一網路。如果訊號強度降至門檻植以下,透過第二層的事件來通知第三層(L3)提早執行 MIPv6 換手流程,讓 MN 可以儘早收到封包,降低換手延遲。為了因應未來無線車輛網路快速的發展,我們所要探討的網路不再只是侷限於單一行動節點,而是整群巢狀式行動網路(Network Mobility, NEMO)的高速移動。由於巢狀式行動網路換手時要執行比 MIPv6 更複雜的換手流程,因此會更加延長換手延遲時間。所以為了維護 MN 執行中的即時多媒體服務與 TCP 連線,如何減少巢狀式行動網路的換手延遲時間,達成沒有封包遺失的快速換手是非常重要的。因此在去年的計畫中,我們整合了 L2 (802.11 與 802.16) 的換手事件與過去我們所提出 L3 巢狀式行動網路路由最佳化的方法(HCoP-B),提出預測式(Predictive) Fast HCoP-B (FHCoP-B) 跨層式(cross-layer)的巢狀行動網路架構來達到快速無縫式換手。在今

年的計畫中，我們將提出反應式(Reactive) FHCoP-B 跨層式的巢狀行動網路架構，以達成以下的目標：1. 支援第二層的 802.11 與 802.16 兩種異質性無線網路協定：藉由這兩種主流無線網路 L2 事件的幫助，可以提供反應式巢狀行動網路對於 802.11 與 802.16 兩種異質性無線網路的存取能力。2. 修改第三層 FHCoP-B 預測式快速換手模式的流程與架構，設計反應式快速換手模式流程：在去年的計畫中，我們藉由 L3 HCoP-B，提供巢狀式行動網路環境下封包傳送的路由最佳化、減少換手延遲與 BU 連結更新訊息負擔的優點，在結合第二層 L2 快速換手機制後，改進原本 HCoP-B 流程，成為預測式 FHCoP-B 架構。因此整個巢狀式行動網路能在舊的第二層鏈結斷線前提早執行原本需要在新的第二層鏈結連線後執行的 L3 HCoP-B 流程，包含取得 Care of Address (CoA)，執行 CoA 重複位址偵測(DAD)，同時向所有 HA 進行全域連結更新，並與連線中的 CN 完成 Return Routability (RR) 身份驗證與全域連結更新等，大幅度的縮短換手延遲的時間。但是對於預測式 Fast HCoP-B 失敗的三種情況(前兩種是因為行動網路快速移動，導致預測式流程無法完成；第三種情況是發生於換手的目的地預測錯誤)並無法處理，所以本計畫的重點在於設計出「Fast HCoP-B 反應式快速換手模式」，對於上述的三種情況能執行有效率的流程。3. 完成反應式巢狀行動網路的無縫式換手：在巢狀式行動

網路換手期間，藉由本計畫設計出的利用相關網路節點暫存封包的功能，加速轉送封包到行動網路目前的位置，避免封包遺失(packet loss)，更可以支援反應式巢狀行動網路環境下即時多媒體應用與 TCP 連線的快速無縫式換手。本計畫為一年期計畫，重點為設計出「Fast HCoP-B 反應式快速換手模式」，以因應巢狀式行動網路各種可能換手情況下的運作，配合去年計畫的成果，完整的支援巢狀式行動網路於預測式與反應式環境下的快速無縫式換手，接著進一步分析反應式模式下的效能項目，進行模擬實驗與測試的環境建立。

關鍵字：車輛網路;巢狀式行動網路;無縫式換手;預測式快速換手;反應式快速換手

Fast Handover Flow Optimization and Performance Analysis of Reactive FHCoP-B

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Abstract

Traditional fast handoff approaches for a single mobile node (MN) are focused on the IETF Fast Mobile IPv6 (FMIPv6) protocol and its extensions. Based on the received layer 2 (L2) signal strength of the MN, FMIPv6 can predict whether the MN will hand over to a new network. If the L2 signal strength falls below than a predefined threshold, L2 will notify the layer 3 (L3) with an event to trigger MIPv6 handoff operations before the old link breaks down. In this way, the MN can receive packets as soon as possible, which in turn reduces the handoff latency. For fulfilling rapid developments of the vehicular ad hoc network (VANET), we need to support high-speed movement of a whole network, which contains a group of MNs in a hierarchical structure, with network mobility (NEMO) management protocols. Because traditional NEMO protocols have to execute their complex procedures when the nested NEMO hands over to a foreign network, they suffer from long handoff latencies such that ongoing real-time services executed by MNs may be interrupted during the handoff process, which in turn degrades quality of services (QoS) of these applications. Hence, it is very important to reduce the handoff latency of the NEMO protocol to maintain seamless real-time and TCP-based services in the nested NEMO. In the last-year project, we have proposed a cross-layer architecture to integrate L2 (802.11 and 802.16) handoff events into our L3 HCoP-B, which supports optimized transmission routes for packets destined to MNs in the nested NEMO efficiently, as the predictive Fast HCoP-B (FHCoP-B) scheme to fully support the fast and seamless handoff of ongoing services in the nested NEMO. By extending predictive FHCoP-B, this one-year project will work on the following issues: 1. The support of 802.11 and 802.16 L2 protocols: With helps of L2 triggers in these two popular wireless networks, the L3 HCoP-B protocol can enhance their capabilities for reactive fast handoff over them. 2. Modification of the predictive FHCoP-B as the reactive FHCoP-B: In the past three years, we have proposed our HCoP-B schemes to achieve route optimization (RO) with significantly reduced handoff latency and signaling overhead for packet transmission in the nested NEMO. We have integrated HCoP-B with the fast handoff mechanism incurred by L2 802.11 and 802.16 triggers as the predictive FHCoP-B last year. With the predictive FHCoP-B, all MNs and MRs of the whole nested NEMO during handoff can acquire their new care-of addresses (CoA), perform duplicate address detections (DAD) for these CoAs and execute global binding updates and return routability (RR) to their home agents (HA) and correspondent nodes (CN) before the nested NEMO has completed its association with the new L2 link. In this way, the predictive FHCoP-B can further reduce its handoff latency significantly. However, there are three cases that the predictive FHCoP-B cannot complete its operations. The first two cases result from fast movements of the NEMO and the last one is due to the wrong prediction of destination network after handoff. Consequently, we will design efficient corresponding reactive FHCoP-B flows to support fast and seamless handoffs on these three cases. 3. Seamless handoff mechanisms for the nested NEMO: During the handoff period of the nested NEMO, all on-the-fly packets will be buffered at some related network nodes and forwarded through them to the NEMO at its new location as fast as possible. In this way, the proposed reactive FHCoP-B incurs no packet losses and further achieves fast and seamless handoff for all ongoing real-time and TCP-based applications. In this one-year project, we will extend the predictive FHCoP-B as the reactive one to handle all fast handoff scenarios and support seamless handoff of real-time and TCP-based services for the nested NEMO. We will further analyze values of several performance metrics, execute simulations and configure real network environments for the reactive FHCoP-B during the project duration.

Key words：Vehicular Ad Hoc Network;Nested Mobile

Network;Seamless Handoff;Predictive Fast Handoff;Reactive Fast Handoff