行政院國家科學委員會專題研究計畫成果報告

行動計算之研究

計畫類別：□：別研究　　☑整合計畫

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整合3 計畫：

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處理方式：（請打✓打

－－　☑可立即對外提供參考

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執行單位：國立交通大學資訊工程系

中華民國－八十八－7 －十－7 －

●中文摘要

由行動通訊 (mobile communication)與分散式計算整合而成的行動計算系統(mobile computing system)開啓了不受時間與地點限制的計算之門，也將資訊與通訊界帶進新的世紀。行動計算具有下面兩種意義：就電信方面而言，伴隨分散式計算所引進的智慧使得行動通訊能提供更高層次的服務；就分散式系統而言，具備行動通訊能力的終端電腦將大大地提昇使用上的彈性。

一般而言，一個行動計算系統包含無線系統、主幹網路、系統軟體以及應用軟體四層，根據此一階層分類，我們依現有人力規劃，提出一整合型計畫來進行行動計算研究，此整合計畫包含下列四個子計畫：

子計畫一：電路交換式行動計算之漫遊管理

子計畫二：分封交換式行動計算之漫遊管理：行動式網際網路協定

子計畫三：行動雙階閘道系統之多頻道轉接研究

子計畫四：行動網際網路之群播服務

本群體計畫的主要目的在於發展行動計算的核心技術，我們提出一些新的行動資源及漫遊管理的演算法，藉以改良現有行動通訊系統的效能，並透過子計畫的整合，建構行動計算系統雛型，並在此架構下建立高層之群體通訊。

●立文摘要

The integration of mobile communication and distributed computing provides anytime, anywhere (ubiquitous) computing services. The integrated system is referred to as the mobile computing system. Mobile computing can be viewed from two aspects. From the view point of telecommunication, distributed computing provides intelligence so that mobile computing networks can offer advanced communication services. From the view point of computing, mobile communication significantly extends the flexibility of the end terminals of a distributed computing system.

Generally, a mobile computing system consists of four layers including the radio system, the backbone network, the system software, the applications. According to the layer structure, we propose four sub-projects to study the mobile computing issues.

(1) Roaming management for circuit switching

(2) Roaming management for packet switching

(3) Multi-channel handoff of a two-tier mobile communication gateway

(4) Mobile IP-based Multicast Services

The objective of this project is to develop a prototype of a mobile computing system. We will propose some algorithms to improve the performance of the existing wireless systems.

●研究群介紹

計畫總主持人暨計畫三主持人: 陳榮傑教授

陳榮傑教授於 1987 授於 University of Wisconsin. 獲得博士學位.陳教授研究位域包括計算方法、計算理論、DNA 計算、聯結網路、行動計算、網路優化、組合優化.現任國立交通大學資訊工程系教授.

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楊竹星教授於 1987 授由成功大學獲得電機博士學位.楊教授研究位域包括機行/分散式作業系統, 作業系統, Web server. 現任國立成功大學資訊工程所所業.

計畫二主持人: 曾建超教授

曾建超教授於 1981 授由清華大學畢業, 並於 1989 授於 Southern Methodist University 獲得電腦畢學博士學位.曾教授研究位域含 Mobile Computing, Computer Architecture, Distributed Systems, 現任國立交通大學資訊工程系教授.

計畫四主持人: 簡榮宏教授

簡榮宏教授研究位域包括計算方法、電腦網路、網路可靠度分析、作業研究等. 現任國立交通大學資訊畢學系主任.

The leader of the integrated and plan 3: Professor Rong-Jaye Chen

Rong-Jaye Chen received the Ph.D. degree from University of Wisconsin . His research interests include algorithm design, theory of computation, DNA computing, interconnection network, mobile computing, network optimization, combinational optimization. He is now a professor in the Department of Computer Science and Engineering in Chiao-Tung University.

The leader of plan 1: Professor Chu-Sing Yang

Chu-Sing Yang received the Ph.D. degree in Electrical Engineering from Cheng-Kung University, in 1987. His research interests include Parallel Compiler,

Computer Architecture, Distributed System, Fault-Tolerant Computing and Web Server Design. He is now the chairman of the Department of Computer Science and Engineering in Cheng-Kung University.

The leader of plan 2: Professor Chien-Chiao Tseng

Chien-Chiao Tseng received the Ph.D. degree in Computer Science from Southern Methodist University , in 1989. His research interests include Mobile Computing, Computer Architecture, Distributed Systems. He is now a professor in the Department of Computer Science and Engineering in Chiao-Tung University.

The leader of plan 4: Professor Rong-Hong Jan

Rong-Hong Jan received the B.S. and M.S. degrees in Industrial Engineering, and the Ph.D. degree in Computer Science from National Tsing Hua University, Taiwan, in 1979, 1983, and 1987, respectively. His research interests include computer networks , distributed systems, network reliability , and operations research.

●研究群論文、技術報告及其他可對外公開的成果

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以下附上各子計畫的中立文摘要、簡介、及成果報告。

子計畫一　電路交換式行動計算之漫遊管理

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中文摘要：：

個人通訊服務行動網路持續追蹤行動終端機的位置,因此打給行動終端機的電話可以被成功的轉接至行動終端機。一般而言，通常用兩階的資料庫來儲存行動終端機的位置訊息。一旦當資料庫發生錯誤無法運作時，打給行動手機的電話便會被轉接至錯誤的位置。這個報告將先敘述標準的GSM資料庫錯誤恢復的程序,此程序可被用來減少錯誤接續電話的機率。 接著，我們會提出一針對HLR恢復程序設計的 計HLR辨識演算法。此演算法會利用行動終端機環境來縮短恢復HLR的時短。 :

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短文摘要：:

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A Personal Communications Service (PCS) network constantly tracks the locations of the mobile stations so that incoming calls can be delivered to the target mobile stationsd dn generald a twodlevel data abase system is used to store location information of the mobile stationsd dhen the location databases faild incoming calls maybe lostd dhis dader describes the standard GSM database failure restoration drocedure that reduces the number of lost callsd dhen we drodose an efficient 計HLR identification algorithm for the HLR failure recovery Procedured which utilides mobile station movement information to sdeedud the recovery drocedured

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進度報告：:

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在去年度所提出的計畫報告申請書中我們規劃第二年預期完成之工作項目如下下:

一、完成新漫遊驗證技術之行動資料庫研究分析。:

二、改進評估系統的數學模式。:

三、以所開發的數學模式完成對dSd式下式GSM式其它系統的評估，比較其效能差異。:

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目前已完成之工作項目下:

:

本學期完成了針對GSM網路資料庫所設計的改進式容錯系統。爲了讓個人通訊服務網路能正確爲行動終端機定址，通常行動網路服務區域會被分爲幾個位置區域(Location Area，LA)，幾個LA包含了數個基地台(Base Station，BS)，這台基地台透過無線電式行動終端機作溝通。而在這樣的架構下，最主要的定位工作就是能在當手機是一個LA移至另一個LA時，網路能正確的做位址更新的動作。所有行動終端機的位址均會存在行動網路的資料庫中。而一旦存放行動終端機位址的資料庫損毀時，位址資訊的消失或錯誤將會使得行動網路的服務品質嚴重降低。因此行動網路中的資料庫的容錯能力將會在行動網路中扮演極重要的角色。所以在本學期的計畫中我們便針對此以主題來探討，先對行動網路中標準的資料庫恢復程序做深入的瞭解，接著我們提出了一演算法來縮短HLR資料損毀時解重新恢復的時短:。 :

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下行動資料庫解所放的資料 :下:

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：：解先針對行動網路中幾個行動資料庫所放的資料作一瞭解。HLR 針對行動終端機的位址訊息記錄爲下註R 的 dSDN 號碼，行動交換中心所MSG率的 dSDN 號碼。註R 針對行動終端機的位址訊息記錄爲下MSC 的 dSDN 號碼，位置區域識心碼 ;下Ad率。注意：下在行動網路資料庫中：，位址訊息是最容易作更改變動的 ;當行動終端機變一 LA 移至另一個 LA 時率。因此當資料庫損毀時：，行動終端機的位址訊息是我們要恢復變來的。另外我們可以注意到 註R 式 HLR 解到有存放著 MSC 的 dSDN 號碼。這個重到的資訊是我們用來作爲資料庫恢復時所到要的資訊。：

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析恢復程序：下：

關於位置更新以及接化程序的程序將會利用 HLR 作註R 中的資料來作。如化資料庫損毀了：，行動網路將無法正確的追蹤到行動終端機。依照上面所述的資料庫所存放的訊息，來作資料庫損毀的恢復程序。一般而言 HLR 式 註R 的恢復程序均依照：Needdtod面ow 準面。而 HLR 的恢復程序亦較難作：。：

子計畫二　分封交換式行動計算之漫遊管理：行動式網際網路協定

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一、中文摘要

隨著無線通訊技術及可攜式電腦功能的進步，使得無線的資料存取、檔案傳輸不再是夢想，這種便利的計算環境稱為行動計算（mobile computing） 環境。在行動計算的環境和傳統的網路環境最大的不同就是行動性（mobility），因為行動電腦隨時隨地的移動，因此必須有效的提供漫遊處理（roaming management）[1, 2, 3, 4]，以順利完成行動計算的通訊。

在今年的計劃中，我們將實做完成的 I-TCP 程式整合在所架設的行動計算環境中，並實際測試所修改的 wavelan 驅動程式對 inter-subnet handoff 支援的程度及效能，使得所架設的行動計算環境更趨於穩定、成熟。另一方面，也訂定了階層式繞路及註冊的模擬模型，評估此架構的可行性及效能。

在本計劃中，我們實際架設一個行動計算環境，並以此環境做基礎，改進 TCP、IP 和資料鏈結層（data-link layer）在行動計算環境中的執行效率，以順應未來高行動性的要求，提供一個有效率的行動計算網路環境。

關鍵詞：行動計算、漫遊管理、行動式網際網路通訊協定、階層式繞路和註冊

Abstract

Along with the development of portable communication technologies, internetworking has been extended to a mobile computing environment. A mobile host might thus retain its connections to Internet while in the course of its migration. Since the mobile host can migrate everywhere. It is thus necessary to provide an efficient roaming management for mobile hosts.

In this year, we have integrated I-TCP package into the mobile computing environment we've setup. And test the supports and efficiency of modified AT&T wavelan driver on inter-subnet handoff. By means of creating a more stable and efficient mobile computing environment. We also provide a simulation model to evaluate feasibility and performance of hierarchical routing and registration architecture.

In this project, we truly setup a mobile computing environment to support host mobility. Based on the environment, we improve TCP, IP and data-link layer performance to adapt to demands of high user mobility in the future.

Keywords：mobile computing, roaming management, Mobile-IP, hierarchical routing and registration

二、緣由與目的

由於蜂巢式行動電話系統（cellular phone system），與無線區域網路（Wireless LAN）的發展，不久的將來，行動使用者將可以在可攜式電腦加上無線界面，就可以在任何時刻任何地點（any time, any where）連上網路，進行資料存取、檔案傳輸...等工作。我們將這種便利的計算環境稱之為行動計算（mobile computing）環境。並且由於近來行動通訊服務的需求增加，所以在現有的網際網路環境下提供行動計算服務，就成為當前極為重要的課題。

簡單地說，行動計算是屬於分散式計算的一個分支；但是因為其系統中的每個行動電腦會隨時移動，並且在移動的過程中仍繼續進行資料處理、存取，這是與一般所見的分散式系統最大不同之處。因此，相較於傳統的分散式系統，行動計算環境可以提供更

多樣的新資料服務型態與應用；但另一方面，卻也產生出許多的問題。其中最重要的是必須針對使用者之移動性，提供漫遊（行動性）管理（roaming / mobility management），以提供行動式計算的環境完成其行動通訊。

在國內，行動計算是個蠻新的領域，在欠缺行動計算環境雛形的情況下，我們就考慮先採用國外發展出來的 mobile-IP 來架設行動計算雛形環境，研究此環境的可行性及未來的發展性。經過各方面的研讀之後，覺得一套行動計算的環境發展是迫切需要的，有了這套雛形環境之後，才會發現更多的問題，也才有改進和繼續探討的空間。

本計畫之目的在發展一套 Mobile IP [5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19] 系統平台。因為現有的行動計算環境在效能上有其不足之處。在 TCP 層方面，因為無線和有線端有不同的傳輸性質，為了傳輸效能的考量，有必要深入研究；另外，現行運作的 Internet 有著某種階層式的組織，但現有 mobile-IP 未考慮階層式的觀念，為了提昇 mobile-IP 的註冊和資料繞送效能，有必要改進現有 mobile-IP 的註冊和資料繞送程序；現有 AT&T wavelan driver 對於資料鏈結層（data-link handoff）的處理上仍有問題，為了掌握整套 mobile-IP 系統的技術及發展環境，我們將針對系統不足之處加以改進。

三、結果與討論

在去年的計劃中，我們實做及測試一套 I-TCP（indirect TCP）程式，並實際修改 AT&T wavelan 驅動程式，使之可以依據基地台的訊號強弱，適時轉換到訊號較強的基地台，減少資料在無線介面傳輸的錯誤率；同時繼續 Mobile-IP 雛形環境的架設工作，完成階層式繞路及註冊架構、通訊協定及模擬模型。

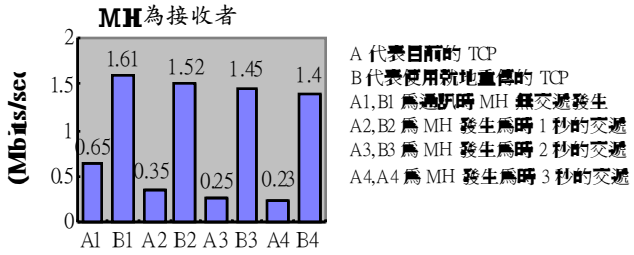
在今年的計劃中，我們將實做完成的 I-TCP 程式整合在所架設的行動計算環境中，測試在行動計算環境中的 TCP 傳輸效能；並實際測試所修改的 wavelan 驅動程式對 inter-subnet handoff 支援的程度及效能，使得所架設的行動計算環境更趨於穩定、成熟。另一方面，訂定階層式繞路及註冊的模擬模型，評估此架構在資料繞送、註冊上的效率及架構的可行性。以下將扼要說明各方面的結果。

在 I-TCP 方面，我們提出一個新方法，修改目前的 TCP/IP 網路通訊協定以增進 TCP 在無線環境下的效能，並且保留 TCP 原有端點對端點的特性。針對無線環境的高錯誤率、高遺失率以及行動主機交遞造成的通訊終止，我們主要採取兩種措施，來防止 TCP 效能降低。第一，我們在行動支援路由器（mobile support router）實作一個監督模組，此監督模組會暫存所有由 TCP 傳送者傳來，而 TCP 接收者尚未認可的封包，若資料封包在無線環境中遺失或發生錯誤，則此模組會執行就地重傳（local retransmission），而不需由原 TCP 傳送者再重新傳送一次遺失或發生錯誤的封包，如此可以解決無線環境下高傳送錯誤率造成的問題。第二，當 MSR 的監督模組在收到行動主機的交遞要求時，MSR 便會記錄 MH 已經進入交遞狀態，之後當有任何 FH 送往 MH 的資料封包到達 MSR 時，監督模組便會向 FH 發出一個 ICMP 無線交遞訊息（ICMP wireless handoff notification），通知 FH 此時與他通訊的 MH 正在進行交遞，並將固定主機與與此行動主機相關之 TCP 控制區塊中的重傳計時器先清除為零，然後再根據最近的 RTT（round trip time）值，重新計算重傳計時器的值並且啟動它，讓計時器沒有終止的機會。在行動主機交遞完成後，監督模組才恢復正常運作，FH 也仍然以交遞前的傳輸窗傳送資料給 MH。這個方法使得 FH 不會因為 MH 交遞所造成短暫的通訊中斷，而啟動壅塞控制程序，壅塞窗就不會因此縮減，避免了許多不必要的重傳，也達

到防止移動 MH 交遞時 TCP 效能低落的現象發生。

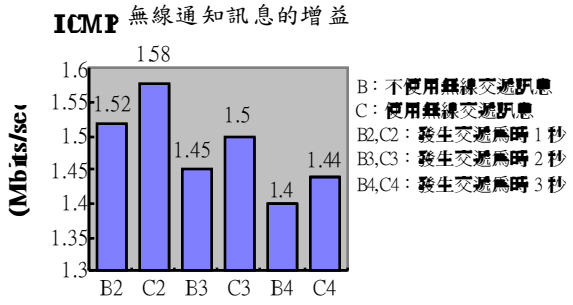
根據我們提出的方法，我們實作出一個 I-TCP 的模組。我們以 FreeBSD 2.2 作為 FH、MH 與 MSR 的核心作業系統。而行動主機使用 Lucent PCMCIA 介面的 wavelan 無線傳送接收器，MSR 則使用 ISA 介面的 wavelan 無線傳送接收器。至於 MH 交遞的情況，我們是採用模擬的方法，所以並沒有使用多個 MSR。我們利用可以測量 TCP 效能量測基準（Benchmark）的 netperf 以及可以監看 TCP 封包的 tcpdump 等工具程式，來評估實驗環境中行動主機與固定主機之間的 TCP 效能，以及觀察封包在行動支援路由器之中的行為。

實驗的過程當中，我們分別在本地子網路以及外地子網路測試，兩次測試分別都包含了 FH 往 MH 的資料傳送，與 MH 往 FH 的資料傳送。在這兩種情況下，我們也模擬 MH 交遞的行為。



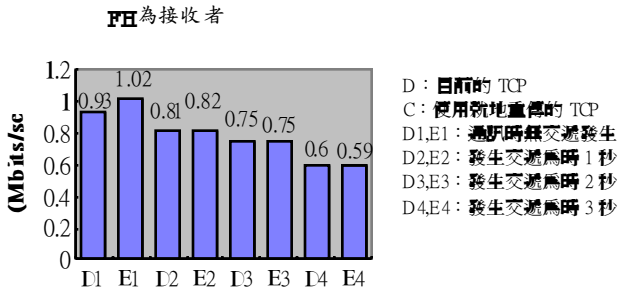
圖表 1 本地 LAN 上 MH 為接收者(a)

當 MSR 上的監督模組只使用就地重傳功能時，如圖表一所示，TCP 的效能比原本高出了 1.5 倍。當 MH 進行交遞時，TCP 的效能更顯著地增加了將近 5 倍。表示當 MH 進行交遞時，監督模組的就地重傳對於 TCP 的效能提昇有很大的幫助。



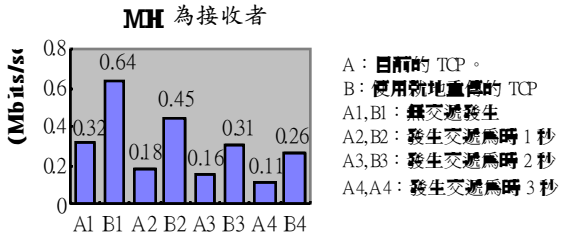
圖表二本地 LAN 上 MH 為接收者(b)

監督模組再加上 ICMP 無線交遞訊息之後，如圖表二所示，TCP 的效能改善的幅度並不大，最主要的原因是 MH 與 FH 都位於本地的子網路當中，資料封包的傳送速度快、可靠度高，即使沒有使用 ICMP 無線交遞訊息，TCP 的壅塞窗也可以很快的恢復，對於 TCP 的效能影響不大。



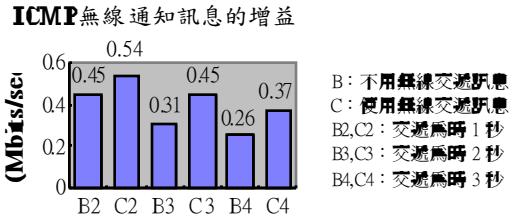
圖表 3 本地 LAN 上 FH 為接收者

在本地子網路上以 FH 為資料封包接收者的測試當中，由於 MH 到 MSR 這一段是無線傳輸媒介，資料封包遺失之後即無法恢復，MSR 既然沒有收到封包，監督模組也就無法使用就地重傳或者是其他的方法，來恢復、重傳已經遺失的封包，因此在這種情況之下，MSR 中的監督模組並不能有效的提升 TCP 在無線通訊上的效能。



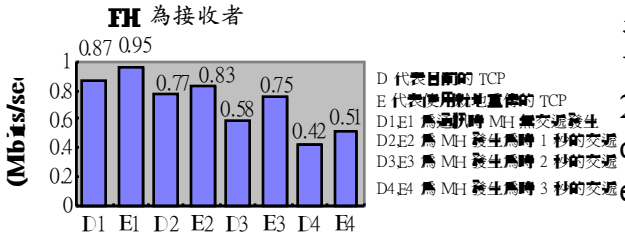
圖表 4 B 端 LAN 上 MH 爲接收者(a)

當 FH 是位於 WAN 另一端的子網路時，資料封包的傳送會受到很多因素影響而使得封包的傳送遭到延遲或者是遺失。若封包遺失時需要由 FH 重傳，不但會造成嚴重的延遲，也會對 TCP 的效能造成相當大的影響。然而從圖表四中我們可以輕易的看出，透過 MSR 監督模組的就地重傳功能，我們在行動計算的環境當中，將 TCP 的效能提升了一至兩倍。



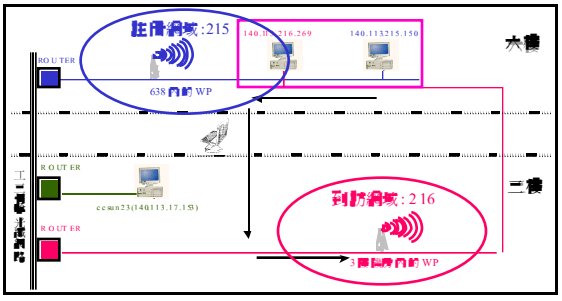
圖表 5 B 端 LAN 上 FH 爲接收者(b)

在 WAN 的環境中，使用 ICMP 無限交遞訊息，由圖表五的數據我們可以看出，TCP 的效能平均都有 0.1Mbps/sec 的改善，相較於在本地子網路的測試結果，ICMP 無線交遞訊息在 WAN 的環境之中，可以明顯的改善 TCP 的效能。



圖表 6 B 端 LAN 上 FH 爲接收者

在 WAN 上，因為通訊環境不穩定，TCP 接收者需要 TCP 傳送者重傳的機會較多，所以就地重傳的優勢比在 LAN 上的測試要來得明顯些。不過，與在 LAN 測試時相同，當 MH 進行交遞時，由於 MH 與 MSR 之間通訊中斷，就地重傳並不能改善效能。



圖表 7 Demo 時的網路環境示意圖

在 AT&T Wavelan 驅動程式測試結果中，在如圖 7 的測試環境下，使用有 ROAMING 能力的 WaveLan 驅動程式，搭配 Linux Mobile IP，從交大工三館六樓移到三樓，再回到六樓。MH 在離開 215 網域到進入 216 網域的這段期間因為在電梯裡，所以收不到任何 WP Beacon，會失去網路連線。在一走出電梯進到 216 網域後，卡的驅動程式發現 216 WP 的服務品質比原來 215WP 的品質好(215WP 的訊號已經收不到了)便自動切換到 216 網域使得底層實體網路的連線回復正常，至此 WP 基地台間的漫遊成功。

接著 MH 在 224.0.0.1 收到 216 網域 FA 送出的"You Are Here" Beacon，MH 開始與 HA(140.113.215.150)解除註冊，並向 FA (140. 113. 216. 269)進行註冊動作，隨後分別收到註冊成功訊息，至此跨網域的漫遊成功。所有工作在不到一秒鐘內完全結束。MH 可以開始使用原來的 IP 位址跨網域透過 216 網域的 WP 送出 ping request 給 ccsun23，也能收到從 ccsun23 送回的 ping echo。

當機器從三樓再次回到六樓後(回到

註冊網域)，我們的 WaveLan 驅動程式再次自動切換到 215 網域的 WP，MH、FA 和 HA 間也再次進行註冊和解除註冊的動作。

整個過程中除了在電梯中(沒有任何 WP 電波能涵蓋的區域)外，即使到了不同的網域，MH 還是能使用原 IP(整個過程中，我們開了一個 shell 和 BBS 連線)，保有原來的網路連線，於是基地台與跨網域間的漫遊都算是初步成功了。

在階層式繞路及註冊架構中，以 IETF Mobile-IP 為基礎，我們提出網路層的階層式行動性管理架構及通訊協定，以提供有效率的網路層交遞（handoff）及資料繞送流程。由模擬結果可顯示出，在合理的模擬模型及耗費參數前提下，HMIP 方法可以減少註冊耗費及交遞程序的時間延遲，而且 HMIP 對於網路壅塞的敏感度較小。另一方面，HMIP 對於某些傳輸特性的應用程式，可以提供更有效率的資料繞送流程。

新系統的環境評估及架設通常是研究的初步工作，在這個計劃中，我們完成的這個工作，並逐步改進系統的效能，相信這個行動計算環境可以提供我們往後更大的研究空間。現在我們只針對 TCP、IP 以及資料鏈結層做修改，為提供任何時刻、地點的網路連結服務，應用程式的配合或許能提供一個更完整、更有效率的行動計算環境。所以，這個計劃算是為我們未來提供許多的研究方向。

四、計畫成果自評

在計畫中，對於行動計算網路的研究，舉凡：資料連結層（data link layer）、網路層（network layer）、運輸層（transport layer）、行動計算環境的漫遊管理、實際行動計算網路架設、行動計算通訊協定的發展及評估等都有相當的進展。

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子計畫三　行動雙階開道系統之多頻道轉接研究

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研究題目：個人通訊服務系統之行動雙階開道：

：

參與人員：李龍盛盛sli@csie.nctu.edu.tw)，張明峰 副教授，陳榮傑 教授：

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中文摘要：：

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在個人通訊服務中有二項主要的技術，高階個人通訊服務含蓋較大的連續區域和支援使用者可高速移動。低階個人通訊服務含蓋較小的連續區域和支援使用者較低速的移動，在這份報報中，行動雙階開道盛TIGs)被提出並允許低階手機使用高階服務，使得低階手機使用者也可以在高速的情況下使用高階服務，MTIGs 和低階手機的漫遊管理已經發展出來，低階 HLR R料庫已被修改成可支援有效率的註冊和行蹤追蹤，電腦模擬可以用來計算 MTIGs 的效率，模擬的結果指出，MTIGs 的低階手機在塞車機率和強制結束機率比高階手機較高，這是因爲 MTIGs 結合一定數量的低階手機因此從低階手機發出一通電話較有可能被阻塞或強制中斷。：

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斷文摘要：：

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There :are :two :major :technologies :in :the :personal :communication :service :盛CS).: HighStier PCS sSstems cover large continous ares and support users moving at high: speed. LowStier PCS sSstems cover small Sontal areas and support users moving at low: speed. In this paper, mobil twoStier gatewaSs 盛TIGs) are proposed to enable lowStier: handsets to use highStier service so that lowStier users can also be served when theS: move at high speed. The roaming management protocols bor MTIGs and lowStier handsets: have been developed. The lowStier HLR database has been modibied to support ebbicient: registration and location tracbing. computer simulations were used to evaluate the: perbormance ob MTIGs. The simulation results indicate that lowStier handsets on MTIGs: ebperience slightlS higher blocbing probabilitS and borced termination probabilitS: than highStier handsets. This is because each MTIG aggregates a number ob lowStier: handsets and thus the calls brom the lowStier handsets are move libelS to be blocbed: or borced to terminate.：

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簡介：：

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The demand bor wireless telephonS has been steadilS growing worldwide. The range ob: personal communication service has also increased to provide not onlS voice service: but also data service. It re介uires an everSincreasing bunctionalitS to meet the range:

ob the service and the boreseen wide population ob users ob the personal communication : services 盛CS). The ultimate goal ob the PCS is to enable communication with an user : using a hanset at anS time, at anS place and in anS borm. :

:

PCS sSstems can be divided into highStier 盛ellular) sSstems and lowStier 盛ordless) : sSstems depending on the technologies used. The base stations 盛Bs) ob the highStier : 盛HT) PCS sSstems or cellular sSstems, such as 介MPS and GSM, use high radio transmitting : power with antennas mounted on tall towers to cover a large area and support user : to speed up to 250 bm/hr. On the other hand, the 介Bs ob the lowStier 盛LT) PCS sSstems : or cordless sSstems, such as DECT, P介S, and CT2, use low radio transmitting power : to cover a small area and support users moving at low speed 盛less than 50 bm/hr). : 介HT PCS is costSebbective bor users roaming at high speed because the coverage area : is large and continuous. 介LT PCS is costSebbective bor high densitS environments : such as metropolitan areas and urban residential areas where more communication : channels are re介uired. :

:

The integration ob multiStier PCS sSstems has been proposed recentlS. The motivation : to integrate HT and LT PCS sSstems is to provide the advantages ob both sSstems. : Depending on the networb and the radio technologies, Lin classibied multiStier PCS : sSstems into three groups as bollow: SRSN 盛imilar radio technologS, same networb : technologS), DRSN 盛ibberent radio technologS, same networb technologS) and DRDN : 盛ibberent radio technologS, dibberent networb technologS). Increasing capacitS, : improving circuit 介ualitS, and supporting high user speed are the major advantages : ob sSstem integration. Ebamples ob sSstem integration include 介MPSSP介S and GSMSP介S : developed in 介ellcore, and GSMSDECT in Europe. On the other hand, the buture PCS under : development will encompass in an uni介e standard the dibberent technologies ob : cordless and cellular mobile networbs. :

:

介twoStier gatewaS 盛TG) is a communication gatewaS between a LT handset 盛S) and : a HT PCS networb, so that LT HSs can use the HT service through a TG when the LT : service is unavailable. 介TG can be installed in a public vehicle where the LT PCS : is usuallS unavailable because the vehicel moves at high speed. 介s a result, the : gatewaS is mobile as the vehicle movesN the TGs will be reberred to as mobile twoStier : gatewaSs 盛TGs). Nnlibe the multiStier PCS where dualSmode HSs are re介uired to access : multiStier service, a LT HS can access both LT and HT sSstem services through the : MTGs in our proposed sSstem. 介PCS sSstem consists ob a group ob base stations 盛Bs) : interconnected bS a wireline networb. The service area ob a 介B is reberred to as a : cell. The 介Bs serve the calls to and brom the HSs in the cells via radio linbs. One :

or more cells are grouped into a registration area. The BSs of a registration area are connected to a mobile switching center (MSC) which is a central coordinating element providing the call processing for all the MSs within the service area.

The mobility manager employs a two-level hierarchical strategy, which maintains two databases to facilitate the roaming management: visitor location register (VLR) and home location register (HLR). One or more MSCs are connected to a VLR. For each MS entering its registration area, the VLR keeps a record containing information on its location and service data. In addition, each MS has a corresponding HLR. For each MS, the HLR maintains a pointer pointing to the VLR where the MS resides in. When a user subscribes the service of a PCS system, a record of user information is created in the HLR. When a MS moves into a new registration area, the location information of the MS will be updated. That is, when the user visits a location area other than the home location area, a temporary record for the PCS user is created in the VLR and used for handling of calls to or from user. When a call arrives for the MS, the HLR and the VLR are used to locate the MS.

進度：

MTTGs have been proposed to enable the LT users to user PCS in high-speed mobility. The MTTGs are functioned as gateways between the LT MSs and the HT PCs system. The MTTGs can be installed in public transportation vehicles where the LT PCS is usually unavailable due to high moving speed. In addition, the integrated system architechture and mobility management protocols for MTTG users have been presented in this paper. The MTTGs can be installed by PCS system providers. They are transparent to the PCS users.

Computer simulations were used to evaluate the system performance. The simulation results shows that the new call blocking probability and the forced termination probability of MTTG users are higher than those of HT mobile users. The call completion probability for MTTG users is lower than that of mobile users. In addition, the simulation results also show the presence of the MTTGs has only limited effect on the blocking probability of HT mobile users.

論文請參考：

Proceedings of the 5th Mobile Computing Workshop pp. 67-77, National Chiao-Tung University, Taiwan, March 27-25, 1999.

研究題目：在行動數據手機上減少電池能源的消耗：

：

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：

中文摘要：：

任何的行動數據手機都需要消耗電池能源，以維持正常運作，由於電池能源壽命有限，因此手機系統該如何有效的來使用這項珍貴的資源，是值得思考研究的，尤其第三代行動通訊服務蓬勃發展之後，許多多媒體資料的傳送都相當耗電；在本研究計畫中，提出了三種可行的機制，來儘可能減少手機的能源消耗，這些機制需要硬體上的支援；此外，在研究過程中，我們使用了理論模型和模擬結果，相互印證，以觀察三種省電機制的實際表現。

英文摘要：

All mobile data handsets need to consume battery power. Since battery power is life-limited and should be used efficiently, power consumption is an important issue in mobile data handsets design. This project addresses three mechanisms to reduce battery power consumption for a mobile data handset. A hardware support is needed to achieve the goal, and will be mentioned at the beginning of this paper. Some assumptions required in the modeling work are also given. Then three wake-up methods are described. Finally, analytical and simulation results are provided with some useful guidance on designing power-saving mobile data handsets systems.

簡介：

A mobile data handset system can be generally divided into three units that consume battery power. They are *data receiving*, *data processing*, and *user interface units* as illustrated in Figure 1. A data receiving unit is a fixed-size memory storage queue for packets received from wireless networks. A data processing unit is a CPU that processes the received data. A user interface unit is in charge of passing the processed data to mobile users. One approach to reduce power consumption is to design a mobile data handset that supplies power separately to the three units. With this design, the data processing and user interface units can be put in the sleep mode while the data receiving unit is waiting for data from the network. Those two units will not be woken up until the data receiving unit receives an incoming packet. A wake-up action is called a *switch-on*. The frequency of switch-on actions performed is defined as the *switch-on rate*. Once the data processing and user interface units are switched on, they work until the memory queue becomes empty. Then the units enter the sleep mode to conserve power. In sleep mode, only the data receiving unit is awake to receive packets. This handset architecture can be viewed as a single-server queueing system with finite capacity.

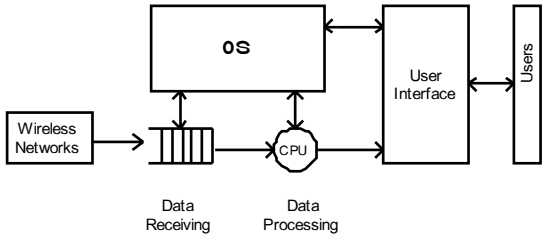


Figure 1. A mobile data handset system

Immediately waking up the data processing and user interface units upon receipt of a packet may cause too many switch-on actions. To avoid this problem, we let the data receiving unit to wait for more packets to arrive before waking up the other two units. To be more specific, a switch-on action is performed only when there has been a certain amount of packets in the memory queue. However, with the continuous arrival of packets, if we do not reserve enough space for the incoming packets, there could be some packets dropped. The probability of a dropped packet that may occur is defined as the *packet-dropping probability*. We consider three approaches for the switch-on mechanism. In the first approach, a *threshold* value is used to indicate whether it is time to switch on the system. As soon as the number of packets received reaches the threshold, those two units are woken up to start working. It is important to select the threshold value properly, since any threshold value can affect the switch-on rate and packet-dropping probability at the same time. For convenience, denote the switch-on rate by *Rs* and packet-dropping probability by *Pd*.

In our second mechanism, the concept of a timer is applied. Every time when the memory queue becomes empty, the server immediately goes for a vacation, and comes back as soon as the *vacation time period* expires. Sooner or later, the server must finish its vacation and come back to work, so eventually all packets will get served within a finite period of time. Here, how long a vacation should take is worth considering, and will be discussed in this paper.

In addition, a hybrid method, combining the strategies of the previous two mechanisms, is proposed as our third mechanism.

介果：

The state transition diagram for the threshold method:

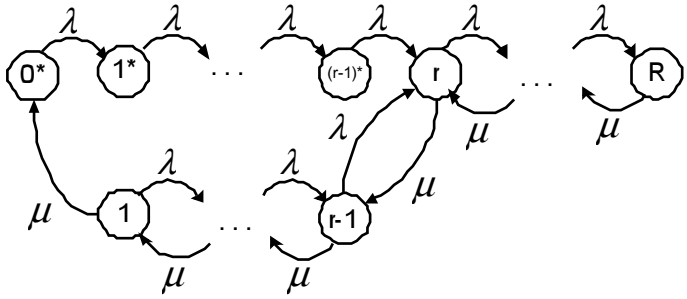


Figure 2. The threshold method

The state transition diagram for the vacation method:

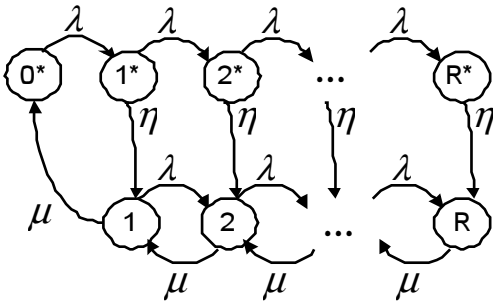


Figure 3. The vacation method

The state transition diagram for the hybrid method:

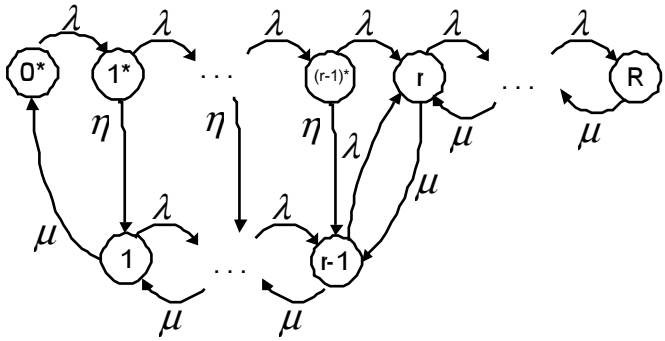
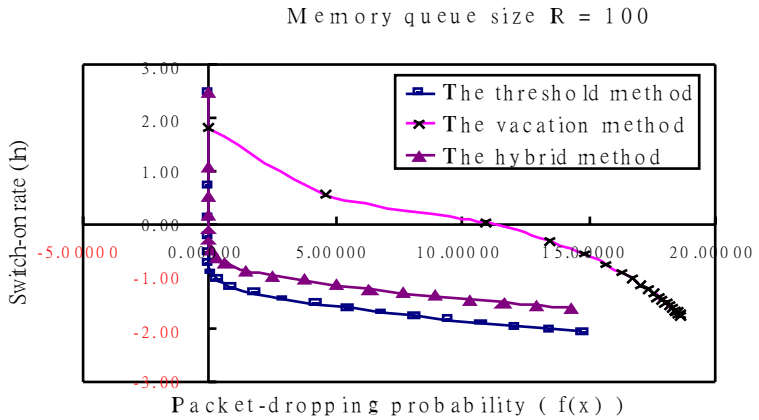


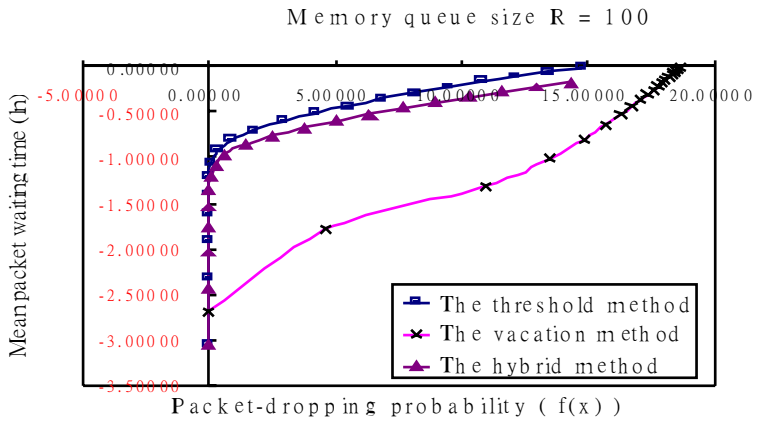
Figure 4. The hybrid method

How our three mechanisms perform compared with one another is shown in the following figures. When, = 0.76, Figure 5 (a) shows the different switch-on rates of the three methods with the

same packet-dropping probability. Clearly, the threshold method has the smallest switch-on rate, while the vacation method claims the highest. Figure 5 (b), however, tells that the vacation method has the lowest mean packet waiting time. Thus, there is no definite judgement to evaluate any method as good or bad. If the system designer cares more about the mean packet waiting time, the vacation method may be adopted regardless of its high switch-on rate. On the contrary, the threshold method is exercised if the switch-on rate is a bigger concern. A moderate alternative is using the hybrid method.



(a)



(b)

Figure 5. Comparison of three mechanisms

論文請參考：：

：

Proceedings of the 5th Mobile Computing Workshop pp. 46-54, National Chiao-Tung University, Taiwan, March 24-25, 1999.

子計畫四　行動網際網路之群播服務

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中文摘要：

在網際網路的日益盛行下，群播的需求不斷的增加；另外，人們對於電腦的可攜性要求也是愈來愈迫切。如何整合這兩套系統是當今重要的一項問題，在網際網路規約第四版中，有不少系統整合上的困難，也有不少人提出解決的方案，但每種方法都存在著些許問題。在新一代的網際網路規約下，由於更詳盡的規約設計，使得兩套系統可以更順利地整合。本篇就是針對新一代的網際網路規約所做的行動式系統與群播系統的整合。

與文摘要：

With the popularization of the Internet, we need multicast services more and more. On the other hand, people also desire the computer with high mobility. It is an important question to integrate multicast and mobile system. It has some problems to integrate these two systems in IPv4. Many solutions have been proposed to solve this, but there still have some problems with these solutions. In IPv6, with more elaborate design, it is easier to combine multicast and mobile system. This research is focused on the implementation of integrating the multicast and mobile system.

簡與：

Multicasting is a technical term that means that you can send a piece of data to multiple sites at the same time. It conserves the scarce bandwidth. Unfortunately, the majority of the routers on the Internet today do not know how to handle multicast packet. For the multicasting experiment some IETF fellow create the MBone. MBone contains islands and tunnels, and it can forward multicast packet from island to island through the tunnel. The main multicast routing protocol on MBone is DVMRP that employs the Reverse Path Multicasting (RPM) algorithm. The main reason of incoordination between Mobile-IP and DVMRP is that the mobile host retains its IP address when it stays on the foreign network where the network address is different from its home network address. When the mobile host sends out a multicast packet not in its home network, the DVMRP router cannot know the packet is originated from the foreign network via the packet's source address. It will assume the packet is originated from the source address's home network and make an unpredictable decision – the packet may been discarded even though the situation is not what we want.

In IPv6 environment, the Mobile-IPv6 is defined more thoughtful. In Mobile-IPv6, the mobile host must autoconfigure its new address by stateless or stateful mechanism when it moves to foreign networks. No matter what autoconfiguration mechanism is employed, the new IP address is composed of the new network's address as prefix and the other part as postfix. The mobile host will use this new IP address as its source address in its outgoing packets. This mechanism will solve the

problem we describe above, and we implement the integration of DVMRP and Mobile-IP in IPv6 environment in this research.

進度報告：

We have finished Mobile-IPv6 system based on linux environment. The linux kernel version that we developed is 2.1.50. The mobile host can detect movement via the router's advertisement and send binding message as registration. When the home agent receives the registration, it will intercept packets designated to the mobile host and relay these packets by tunnel. When the mobile host receives the tunnel's packet, it will send binding update message to the correspondent node. This triggers route optimization on transmission packets from correspondent node to the mobile host.

On the other hand, we have finished the base DVMRP router in IPv6 addressing format. This system is based on Windows 95 system. The DVMRP router can implement RPM checking, multicast packet forwarding, routing table maintenance, forwarding cache maintenance, pruning and grafting multicast tree. All the base functions defined in DVMRP version 3 [draft] have been implemented. Now, we devote to integrate and merge these two systems to work well.

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