I.COVER

Program for Promoting Academic Excellence of Universities（Phase II）

Final Report

子計畫三：後三代全 IP 無線網路技術

Beyond-3G All-IP Wireless Network Technologies

Serial No.：NSC-2752-E-009 -005- PAE

Overall Duration: Month 04 Year 2004 - Month 03 Year 2008

Report Duration: Month 04 Year 2004 - Month 03 Year 2008

National Chiao Tung University

2008.05.15

II. (FORM1)BASIC INFORMATION OF THE PROGRAM

Program Title: Beyond-3G All-IP Wireless Network Technologies（後三代全IP無線網路技術）					
Serial No.: NSC 96-2752-E-009 -005- PAE			Affiliation		National Chiao Tung University 國立交通大學
Principal Investigator	Name	Yi-Bing Lin 林一平	Program Coordinator	Name	Rong-Hong Jan 簡榮宏
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	Expenditures[1] (in NT$1,000)		Manpower[2]:Full time/Part time(Person-Months)	
	Projecte	Actual	Projected	Actual
FY 2004	7,432	7,237.879	12/192	15/361**
FY 2005	8,856	7,170.027	12/200	24/410**
FY 2006	8,875	7,298.387	24/196	24/432**
FY 2007	9,168	8,251.2	24/200	24/342**
Overall	34,331	29,957.49	72/788	87/1,557**

Serial No.	Project Title	Principal Investigator	Title	Affiliation
Main Project	Advanced Technologies and Applications for Next Generation Information Networks (II) 下一世代資訊通訊網路尖端技術與應用（二）	Wen-Tsuen Chen 陳文村	Chair Professor	Department of Computer Science, NTHU
		Wen-Hsiang Tsai 蔡文祥	Chair Professor	Department of Computer and Information Science, NCTU
Sub-Project 1	High Speed Networking Technologies 高速網路交換技術	Cheng-Shang Chang 張正尚	Professor	Institute of Communications Engineering, NTHU
Sub-Project 2	Optical Networking and QoS Technologies 光纖網路及服務品質保證技術	Maria C. Yuang 楊啓瑞	Professor	Department of Computer Science and Information Engineering, NCTU
Sub-Project 3	Beyond-3G All-IP Wireless Network Technologies 後三代全 IP 無線網路技術	Yi-Bing Lin 林一平	Chair Professor	Department of Computer Science and Information Engineering, NCTU
Sub-Project 4	Wireless Ad Hoc and Sensor Networking Technologies 無線隨意及感測網路技術	Wen-Tsuen Chen 陳文村	Chair Professor	Department of Computer Science, NTHU

Sub-Project 5	Network Security 網路安全	Wen-Hsiang Tsai 蔡文祥	Chair Professor	Department of Computer and Information Science,
Sub-Project 6	Techniques and Applications of Overlay Networks 疊蓋式網路之技術與應用	Chung-Ta King 金仲達	Professor	Department of Computer Science, NTHU

Notes: [1,2] Please explain large differences between projected and actual figures.

** We hired more part time students with lower salaries. Therefore, the actual student number is larger than the projected student number.

Program Director/Principle Investigator Signature: _____

III. (FORM 2) LIST OF WORKS, EXPENDITURES, MANPOWER, AND MATCHING SUPPORTS FROM THE PARTICIPATING INSTITUTES（REALITY）.

Serial No.: NSC -2752-E-009 -005- PAE	Program Title: Beyond-3G All-IP Wireless Network Technologies(後三代全 IP 無線網路技術)										
Research Item (Include sub projects)	Major tasks and objectives	Expenditures (in NT$1,000)					Manpower (person-month)					Matching Supports from the Participating Institutes (in English & Chinese)
		Salary	Seminar/ Conference-related expenses	Project- related expenses	Cost for Hardware & Software	Total	Principal Investigators	Consultants	Research/ Teaching Personnel	Supporting Staff	Total	
Sub-Project3:Beyond-3G All-IP Wireless Network Technologies	1. System design of B3G core networks	8,185.092	307.525	1,231.133	1,458.801	1,1182.551	72	0	567	43	682	1. ICL/ITRI NTD$1,000,000 2. JRC NTD$ 1,392,000 3. NTP NTD$ 8,024,564 4. NTP International Cooperation NTD$1,613,570 5. NTP B3G Platform Project NT$2,739,000 6. NTP Service IOT Project NT$8,373,000 7. NTP International Collaboration NT$1,613,57 8. ITRI/NCTU JRC Wireless Internet NT$1,138,500
	2. Broadband wireless access	5,399.787	216.069	679.267	1,199.692	7,494.815	53	0	415	36	504	1. III NTD$1,000,000 2. Intel Donation ~~NTD$1,000,000~~ 3. Broadband wireless access: Intel USD$90,000

												Applications and services in B3G networks: ITRI/NCTU JRC NTD$1,200,000
	3. Applications and services in B3G networks	4,543.075	215.533	657.386	1,144.560	6,560.554	67	0	419	8	494	1. JRC NTD$1,200,000 2. Intel NTD$60,000 3. Institute for Information Industry (III) $839,960 4. ITRI/NCTU JRC Wireless Internet NT$1,411,500
SUM		18,127.954	736.127	2,567.786	3,803.053	25,237.920	192	0	1,401	87	1680	

IV. (FORM 3) STATISTICS ON RESEARCH OUTCOME OF THIS PROGRAM

LISTING		TOTAL	DOMESTIC	INTERNATIONA	SIGNIFICANT[1]	CITATIONS[2]	TECHNOLOGY TRANSFER
PUBLISHED ARTICLES	JOURNALS	88	0	88	53		
	CONFERENCES	24	3	21			
	TECHNOLOGY REPORTS						
PATENTS	PENDING	12	5	7	-		
	GRANTED	9	7	2	-		
COPYRIGHTED INVENTIONS	ITEM						
WORKSHOPS/CONFERENCES [3]	ITEM	30	25	5			
	PARTICIPANTS						
TRAINING COURSES (WORKSHOPS/CONFERENCES)	HOURS						
	PARTICIPANTS						
PERSONAL ACHIEVEMENTS	HONORS/ AWARD [4]	40	19	21			
	EDITOR FOR JOURNALS	30	1	29			
TECHNOLOGY TRANSFERS	ITEM						
	LICENSING FEE						
	ROYALTY						
INDUSTRY STANDARDS[5]	ITEM						
TECHNOLOGICAL SERVICES[6]	ITEM				-	-	-
	SERVICE FEE				-	-	-

[1] Indicate the number of items that are significant. The criterion for "significant" is defined by the PIs of the program. For example, it may refer to Top journals (i.e., those with impact factors in the upper 15%) in the area of research, or conferences that are very selective in accepting submitted papers (i.e., at an acceptance rate no greater than 30%). Please specify the criteria in Appendix IV.

[2] Indicate the number of citations. The criterion for "citations" refers to citations by other research teams, i.e., exclude self-citations.

[3] Refers to the workshop and conferences hosted by the program.

[4] Includes Laureate of Nobel Prize, Member of Academia Sinica or equivalent, fellow of major international academic societies, etc.

[5] Refers to industry standards approved by national or international standardization parties that are proposed by PIs of the program.

[6] Refers to research outcomes used to provide technological services, including research and educational programs, to other ministries of the government or professional societies.

V. (FORM4) EXECUTIVE SUMMARY ON RESEARCH OUTCOMES OF THIS PROGRAM

1. General Description of the Program: Including Objectives of the Program

In Beyond-3G environments, mobile and wireless networks will be integrated together under an all-IP core network to support global roaming and services. Issues such as mobile security, QoS, and mobility management need to be investigated. For mobile ad hoc and sensor networks, critical issues include power saving, routing, sensing, MAC, and integration with other mobile networks. In terms of application, context-aware services and environmental monitoring applications need to be developed. In PAEU-I, we have made several major contributions. For example, Prof. Y.B. Lin proposed novel 3G core network protocols for mobility management, authentication, fault tolerance, and mobile database overflow control. Due to these contributions, he was awarded IEEE Fellow and ACM Fellow in 2003. The works of Prof. Y.C. Tseng on routing, MAC, and power-saving protocols for ad hoc and sensor networks have been well recognized internationally. Based on this established research energy, in PAEU-II, we have developed B3G all-IP core and access networks, including HSS, CSCF and OSA, and to invent advanced location determination and energy conservation technologies. Specific goals include:

- Issues on IP Multimedia Core Network Subsystem such as Fault tolerance of IMS, design and implementation of OSA (service network for IMS), IMS services (including prepaid, Voice over IP, and wireless data), all-IP mobility (including location management and packet re-routing), application-level security (including identity-based cryptosystem and end-to-end security mechanisms for SMS), IMS session management, IMS-related architectures (including WGSN push mechanism, ad-hoc andinfrastructure dual-mode mobile networks, and softswitch).

- Issues on Access Networks (i.e., Ad hoc, WLAN/WiMax, and Cellular networks) including , topics on load balance, security and authentication, multi-channel or multi-antenna access points, QoS support for VoIP and location-sensing routing, MAC, power-saving have been investigated. We have also investigated critical issues, such as efficient contention protocols, fast handoff, and resource scheduling. In addition, suitable analytical methodologies for these works also required. By investigating these topics, we expect to make significant contributions to these issues. Due to the fast advance of VoIP services, we will develop novel multi-channel MAC protocols for multi-hop ad hoc networks, and study how to integrate ad hoc networks with mobile VoIP services.

- Issues on B3G applications include seamless IP/PLMN integration, P2P technologies, and novel mobile data applications. The integration of IP networks and PLMN has to be done on both the network and the service layers. We have focused on the integration on the service layer, which requires novel designs and has more profound impacts on the user experience. Skype has demonstrated how P2P technologies can be used to provide a world-wide VoIP communication platform. P2P technologies can also be used in other mobile data applications, such as multimedia communications, and device-to-device communications and collaboration.

2. Breakthroughs and Major Achievements

Technology	State-of-the-Art	Breakthrough
IMS Core Network Technology	**This technology is mainly developed by international mobile equipment manufacturers, such as Nokia and Ericsson. Few universities can conduct research regarding this technology.**	● **Propose *One Pass Authentication* technology that reduces the IMS authentication traffic by 50%.** ● **Publish the book, Wireless and Mobile All-IP Networks, and receive Academic Publication Award of The Sun Yat-Sen Cultural Foundation, 2006.**
A Push-Based VoIP Service for an Internet-Enabled MANET	**VoIP services typically work in standalone MANET only, but not in Internet-enabled MANET.**	● **An architecture to support VoIP services in an Internet-enabled MANET.** ● **A push architecture to allow the VoIP gateway to stay off-line.**
Applications and Services in B3G Networks		● **Design and Analysis of Integrated GSM/GPRS prepaid service**

Network System Design of the B3G Core Network

Figure 2.1 depicts the B3G network architecture. For the User Equipment (UE) research, we have proposed an analysis tool SIPv6 Analyzer and a PoC client-side design and implementation. For the Radio Access Network (RAN) research, we have proposed a random number generation method to model excess life of mobile user residence time. For the core network research, we have studied failure restoration of mobility database, authentication vector management, connection failure detection. For IP Multimedia subsystem (IMS) research, we have studied I-CSCF caching, credit reservation modeling, credit allocation for prepaid service, SIP mobility, prepaid application server modeling, and ID-based cryptography.

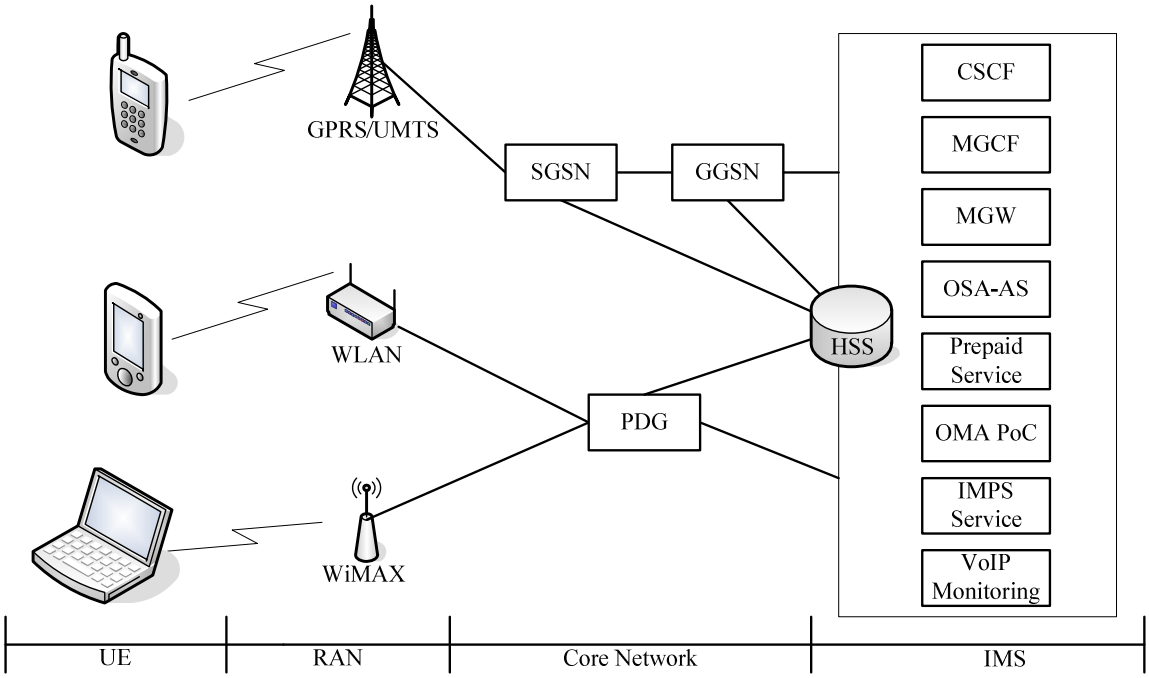

Figure 2.1 the B3G Network Architecture

Broadband Wireless Access Technologies

This part focuses on access technologies of broadband wireless networks. We have designed a multi-chain backoff (MCB) algorithm which provides high throughput and fair wireless access. We also developed a power-saving scheduling to extend the network lifetime and a hybrid routing method for multi-hop wireless LANs to improve the routing efficiency. The IEEE 802.11 standard defines multiple channels at the physical layer. However, most ad hoc networks assume that all nodes are operating under the same radio channel. To breakthrough the throughput limitation, we have proposed several multi-channel links layer protocols for multi-hop ad hoc networks. In

particular, a lightweight multi-channel MAC protocol characterized by location awareness capability has been proposed. It incurs no communication cost to conduct the channel assignment. Moreover, we have investigated optimization models and efficient algorithms to exploit the maximum channels reusability. In order to improve the network access efficiency and reduce roaming overhead, we have implemented a light-weight access protocol on a centralized WLAN server with thin access points. This centralized WLAN architecture reduces the handoff delay and cuts management overhead significantly. Finally, we have built a mobile ad hoc network across the NTHU and the NCTU campuses. The platform allows us to verify research ideas generated from the project. The ad hoc network is also connected to the core network we developed.

Applications and Services in B3G Networks

We have proposed an architecture to support VoIP services in an Internet-enabled mobile ad hoc network. To reduce power consumption, we have proposed a push mechanism to allow the VoIP gateway to stay off-line when there is no calling activity and to be “woken up” when necessary.

3. Categorized Summary of Research Outcomes. The criteria for top conferences and journals should be given and introduced briefly in the beginning of this section. In each research area, please give a brief summary on the research outcomes associated with the area. Note that the summaries should be consistent with the statistics given in Form3. Please list and number each research outcomes in sorted order in Appendix II, and list all the publications in top conferences and journals in Appendix III.

Network System Design of the B3G Core Network

Due to our fruitful results in both PPEAU-I and PPEAU-II, we were invited to guest editing an IEEE Wireless Communications special issue on Mobility and Resource Management published in 2004 [C.1]. By focusing on GPRS/UMTS research issues, we have developed a UMTS discontinuous reception mechanism for power saving [C.2]. We also developed a bandwidth-on-demand strategy for GPRS [C.4]. Based on the above studies, we developed a useful tool NCTUns 2.0 for wireless Internet simulation [C.6] (the major contributor is Prof. S.-Y. Wang in PPEAU-I). We investigated the UMTS short message mechanism and have invented a statistic approach for deriving the short message transmission delay distributions [C.7]. Based on the above study, we developed an efficient multicast mechanism for UMTS through

collaboration with ICL/ITRI, and received ROC Patent 205010 [patent1] (major work in PPEAU-I). In GPRS/UMTS mobility management, we have conducted signaling traffic analysis for multi-tier wireless mobile networks [C.5], and developed a per-user checkpointing for mobility database failure restoration [C.3]. To improve prepaid user experience and protect operator's revenue, we presented a real-time charging method for prepaid users with integrated voice and data services. An analytic model has been developed to evaluate the performance [C.44].

In Wireless VoIP, we have developed the VoIP services for GSM circuit switched data, GPPRS, and UMTS environments [C.8][C.9]. Through collaboration with ICL/ITRI. We received a patent for wireless VoIP [patent 2] (major work in PPEAU-I). We proposed an effective VoIP call routing mechanism in WLAN and cellular integration [C.35]. To integrate existing VoIP protocols, we developed an integrated call agent that is capable of establishing calls between SIP, H.323, MGCP/MEGACO users [C.45]. In addition, we developed a novel method enable one-stage dialing from the PSTN to a private telephone network and/or an IP telephony network through a VoIP gateway and/or a PBX ([C.126]). We have developed a novel, simple method for a dual-mode device to register with a location registrar the device's E.164 number and IP address ([C.128]).

By continuing PPEAU-I's work on WGSN, we have developed a mobile service platform using proxy technology [C.11], and a caching mechanism in I-CSCF of UMTS IP multimedia subsystem (IMS) [C.12]. Then we developed a GPRS-based WLAN authentication and auto-configuration for WGSN [C.13]. We further investigated the IMS authentication defined in 3GPP, and proposed an one-pass GPRS and IMS authentication procedure for WGSN. We developed the first connection failure detection mechanism of UMTS charging protocol [C.16], and the first checkpointing schemes for UMTS mobility database failure restoration [C.25]. We collaborated with ITRI to develop the first CORBA-based OSA service platform in Taiwan [C.18], devised the first credit allocation algorithm for UMTS services [C.19], and consistent wireless data access algorithms [C.36,C.37].We proposed a serving radio network controller relocation for UMTS all-IP network [C.20], investigated the impact of mobility on UMTS mobile telecommunications networks [C.21, C.23,C.24, C.26], and invented a novel random number generation for excess life of mobile user residence times [C.22,C.25]. We developed a fast identity-based cryptosystem mechanism for end-to-end mobile security [C.27] and applied this mechanism for SMS end-to-end security [C.28].

We designed and implemented a UMTS session management tool for he user equipment [C.29], and proposed new schemes for frame synchronization for UMTS HSDPA [C.30]. We also investigated IP connectivity for gateway GPRS support node [C.31].

In [C.58] we studied checkpointing and failure restoration of mobility database for *Universal Mobile Telecommunications System* (UMTS). By utilizing per-user checkpointing technique, individual *Home Subscriber Server* (HSS) records are saved into non-volatile backup storage form time to time. When a failure occurs, the backup record is restored back to the mobility database. We consider three per-user checkpoint schemes for the HSS. An analytic model is developed to investigate these schemes in terms of the probability that a HSS backup record is obsolete. This model is validated against simulation experiments. Our study provides guidelines for selecting an appropriate checkpoint scheme and parameters for various traffic conditions. In UMTS, the security function provides mutual authenticity and key agreement between the core network and the Mobile Station (MS). Specifically, the Serving GPRS Support Node (SGSN) in the core network obtains an array of Authentication Vectors (AVs) from the HSS/Authentication Center AuC), and consumes one AV for each mutual authentication. After the departure of the MS, the SGSN may keep the unused AVs for a time interval called the Reservation Timeout (RT) period. If the MS returns within the RT period, the SGSN uses the stored AVs for mutual authentication instead of obtaining new AVs from the HSS/AuC. Note that a long RT period results in fewer accesses to the HSS/AuC at the cost of extra AV storage in the SGSN. In [C.66], we proposed an analytic model to investigate the impact of the RT period on the system performance. Our study provides the guidelines for the mobile operators to select an appropriate RT period. The 3GPP defines *IP Multimedia Core Network Subsystem* (IMS) to support IP-based multimedia services. In IMS, any incoming call will first arrive at the Interrogating Call Session Control Function (I-CSCF). The I-CSCF queries the HSS to identify the serving CSCF (S-CSCF) of the called mobile user. The S-CSCF then sets up the call to the called mobile user. In [C.68], we investigated the performance of the IMS incoming call setup. We also proposed cache schemes with fault tolerance to speed up the incoming call setup process. Our study indicates that the I-CSCF cache can significantly reduce the incoming call setup delay, and checkpointing can effectively enhance the availability of I-CSCF.

In [C.88], we studied the optimum checkpointing interval of per-user checkpointing for mobility database failure restoration. The cost function that we consider includes the cost of checkpointing a user’s location record and the cost of

paging a user due to an invalid location record. Our results indicate that when user registration intervals are exponentially distributed, the user record should never be checkpointed if the expected checkpointing cost is more than the expected paging cost,. Otherwise, if paging costs more, the user record should always be checkpointed when a user registers.

IMS utilizes protocols such as IPv6, *Session Initiation Protocol* (SIP) and *Real-time Transport Protocol* (RTP) to deliver the multimedia content. In [C.59] we proposed an analysis tool called SIPv6 Analyzer to investigate the IMS-related protocols during IMS service deployment. The SIPv6 Analyzer not only dissects the protocol headers but also provides user-friendly functions such as message flow generation, and audio/video replay for IPv6, SIP and RTP. In IPv6-based IMS, a user equipment (UE) may not be allowed to roam or hand off from UMTS to a private-IPv4 GPRS network. In [C.65], we utilized SIP mobility and an automatic IPv6 tunneling mechanism, called Teredo, to support roaming/handoff of a UE between different networks. We have developed the first non-commercial Linux-based Teredo mechanism, and compared our solution with other Teredo implementations in the public domain. Our solution can reduce the tunneling overhead and transmission delay over two other implementations by 44%-74%. By tunneling IPv6 packets over IPv4 UDP, Teredo supports IPv4/IPv6 dual-stack nodes in private IPv4 networks behind Network Address Translation (NAT) to access IPv6 networks. However, the current Teredo protocol does not work with symmetric NAT. In [C.65] we proposed SymTeredo, an extension of Teredo with capability to traverse the symmetric NAT. Our extension preserves the Teredo architecture, and offers backward compatibility with the original Teredo protocol. The above results are utilized in an international collaboration with INT at France.

In [C.61] we proposed a client architecture for the Push to Talk over Cellular (PoC) service based on the Open Mobile Alliance (OMA) PoC specifications v1.0 release. We showed that most standard VoIP modules can be reused for the PoC client, and the VoIP software can be easily extended to support PoC service. A PoC client prototype has been implemented in the Industrial Technology Research Institute (ITRI) and National Chiao-Tung University (NCTU) Joint Research Center.

Through *Recharge Threshold-based Credit Reservation* (RTCR) mechanism, prepaid IMS services can be supported by the *Online Charging System* (OCS) in UMTS. In RTCR, when the remaining amount of prepaid credit is below a threshold, the OCS reminds the user to recharge the prepaid account. It is essential to choose an appropriate recharge threshold to

reduce the probability that the in-progress service sessions are forced-terminated. In [C.60] we developed an analytic model to investigate the performance of RTCR for OCS. Based on our study, the network operator can select the appropriate parameter values for various traffic conditions. In [C.62] we proposed a prepaid application server to handle both the prepaid calls and messaging services in IMS. When both voice and messaging are simultaneously offered, delivery of a message during a call may result in force-termination of that call due to credit depletion. To address this issue, we described a strategy to determine if a prepaid message can be sent out during a call session. We proposed an analytic model to investigate the performance of this strategy. Our study provides guidelines to select appropriate input parameters for the prepaid application server. In UMTS, a user may be engaged in multiple voice and/or data prepaid sessions at the same time. For such services, it is important to distribute appropriate amounts of prepaid credit units to simultaneously executed sessions of a user. [C.70] studied the credit allocation for the prepaid sessions. To simultaneously accommodate more prepaid sessions for a user, we proposed a credit reclaim mechanism called Prepaid Credit Reclaim (PCR). Analysis and simulation experiments are conducted to investigate the performance of our mechanism. Our study indicates that PCR can significantly improve the performance of the prepaid mechanism. In UMTS, the extension of GPRS tunneling protocol called GTP' is utilized to transfer the Charging Data Records (CDRs) from GPRS Support Nodes (GSNs) to Charging Gateways (CGs). To ensure that the mobile operator receives the charging information, availability for the GTP' transmission is essential. One important issue on GTP' availability is connection failure detection. It is desirable to select appropriate parameter values to avoid false failure detections (e.g., temporary network congestions) while to detect the true failures quickly. In [C.70], we proposed an analytic model to compute the false failure detection probability and the expected true failure detection time. Based on our study, the network operator can select the appropriate parameter values for various traffic conditions to reduce the probability of false failure detection and/or true failure detection time. The above results have been transferred to TL/CHT.

In a mobile telecommunications network, the period when an MS resides in a cell (the radio coverage of a base station) is called the cell residence time of that MS. The period between when a call arrives at the MS and when the MS moves out the cell is called the excess life of the cell residence time for that MS. In performance evaluation of a mobile telecommunications network, it is important to derive the excess life distribution from the cell residence times. This distribution determines if a connected call will be handed over to a new cell, and therefore significantly affects the call dropping probability of the network. In mobile telecommunications network simulation, generating the excess-life random numbers is not a trivial task, which has not been addressed in the literature. In [C.22], we showed how to

generate the random numbers from the excess life distribution, and developed the excess-life random number generation procedures for cell residence times with gamma, Pareto, lognormal and Weibull distributions. Our study indicated that the generated random numbers closely match the true excess-life distributions.

In the next generation mobile telecommunications, any third party that provides wireless data services (e.g., mobile banking) must have its own solution for end-to-end security. Existing mobile security mechanisms are based on public-key cryptosystem. The main concern in a public-key setting is the authenticity of the public key. This issue can be resolved by identity-based (ID-based) cryptography where the public key of a user can be derived from public information that uniquely identifies the user. In [C.28], we proposed an efficient ID-based encryption algorithm. We actually implemented the ID-based encryption schemes and compare the performance to show the advantage of our approach. Our solution outperforms a previously proposed algorithm by 20 -- 35%.

Broadband Wireless Access Technologies

In the access technologies on WLAN, the IEEE 802.11 standard adopts the binary exponential backoff (BEB) for collision avoidance. This approach may significantly degrade the network performance if contention window size is dramatically changed after each successful transmission degrades the network performance. In [C.54], we proposed a multi-chain backoff (MCB) algorithm which explores the possibility of using multiple backoff chains with different minimum contention windows and considering collision events on the wireless channel as hints to choose a proper chain. With the capability of switching to different backoff chains, our study shows that MCB offers higher throughput than the existing protocols, such as GDCF, IEEE 802.11, MILD, EIED, and LILD, yet still provides fair access to the wireless channel. In [C.96], we have also proposed a Fast Handoff Mechanism for IEEE 802.11 and IAPP networks, which can significantly reduce wireless handoff latency in IEEE 802.11 WLANs. In addition, a new power-saving method for WLAN is also developed [C.40]. On the other hand, with the increasing popularity of voice over WLAN (VoWLAN) services, there is a need to guarantee QoS for voice calls while supporting as many calls as possible. In [C.95], we propose a call admission control (CAC) and a resource adjustment (RA) mechanism to solve the handoff and resource redistribution issues over IEEE 802.11e wireless networks. The proposed scheme is designed to dynamically adjust the resource distribution among existing calls according to the network condition. Our study shows better utilization of bandwidth, decreased

blocking rate for new calls, and less dropping rate for handoff calls have been achieved by the proposed mechanisms. In [C.103], we have showed how to integrate SIP and 802.11e to conduct call admission control and resource reservation to support VoIP's QoS in IEEE 802.11e WLANs. We have also suggested some adjustments and MAC enhancements to 802.11e to facilitate VoIP traffics over WLANs. This work received the Best Paper Awards in NCS 2005 [C.216].

In terms of MANETs, we have further proposed a Multi-rate wireless Fair Queuing (MR-FQ) algorithm in [C.55], which allows a flow to transmit at different rates according to its channel condition and lagging degree. MR-FQ takes both time and service fairness into account. It not only guarantees fairness and bounded delays for packet flows but also increases the overall system throughput. In [C.64], we have proposed several cluster-based semi-asynchronous power-saving protocols for multi-hop MANETs. We showed how to cluster neighboring hosts such that synchronous power-saving protocols can be adopted within individual clusters, and asynchronous power-saving protocols can be adopted between clusters. In [C.27], we provides an analytic tool to evaluate the expected throughput of the route with spectral reuse, assuming that hosts move following the discrete-time, random-walk model by a given routing path. Because while many routing protocols have been proposed for MANETs based on different criteria, few have considered the impact of multi-rate communication capability that is supported by many current WLAN products. The derived result can also be added as another metric for route selection. We proposed a hybrid routing method that combines the advantages of Hierarchical Routing Tree (HRT) and Ad-hoc On-demand Distance Vector (AODV) routing for multi-hop wireless LANs [C.38]. A ring based information collection architecture were presented to improve the power efficiency for wireless ad hoc sensor networks [C.42]. In wireless ad hoc networks, constructing and maintaining a topology with lower nodes degrees is usually intended to mitigate excessive traffic load on wireless nodes. However, keeping lower nodes degrees often prevents nodes from choosing better routes that consume less energy. Therefore, a tradeoff is between the node degree and the energy efficiency. In [C.19], an adjustable structure, named the *r*-neighborhood graph, is proposed to control the topology. This structure has the flexibility to be adjusted between the two objectives To construct this structure, we have investigated a localized algorithm, named PLA, consuming less transmitting power during construction and execute efficiently in O(nlogn) time..

The wireless mesh network (WMN) attracts lots of interest as a new broadband Internet access technology. However, increasing throughput is still an open and

challenging research issue. One potential solution is to utilize multiple channels dynamically. However, most existing works do not consider the routing issue but use some popular single-path routing protocols, such as AODV and DSR. In [C.102], we propose a novel protocol named Joint Multi-channel and Multi-path control (JMM) to investigate the benefit of multi-path routing in multi-channel WMNs from the aspect of end-to-end throughput. By dividing the time into slots, JMM coordinates channel usage among slots and schedules traffic flows on dual paths. Our study shows that JMM efficiently decomposes contending traffics over different channels, different time, and different paths, and hence leads to significant throughput improvement (more than 240%). To the best of our knowledge, this is the first work discussing the joint design of multi-channel control and multi-path routing for WMNs. Single-channel medium access control (MAC) protocols are usually adopted for wireless communication among MSs. However, as the number of MSs increases, the performance of such protocols degrades quickly due to collision/contention. In [C.56], we developed a lightweight MAC protocol for a multi-channel MANET called GRID, which is characterized by location awareness capability. GRID incurs no communication cost to conduct the assignment. Our study indicates that GRID is effective under both the fixed-channel-bandwidth and the fixed-total-bandwidth wireless environments. In [C.48] and [C.56], we have proposed multi-channel MAC protocols for multi-hop ad hoc networks. We proposed a novel MAC protocol with on-demand channel assignment for multi-hop ad hoc networks [C.48]. We have developed an efficient MAC protocol for multi-channel mobile ad hoc networks based on location information [C.56]. Then an efficient reliable broadcasting protocol for wireless mobile ad hoc networks has been developed [C.57]. In [C.82], we consider the next-generation wireless mesh networks in which each node may be equipped with multiple radio interfaces, each capable of running in one of several modes, one of several channels, and each capable of supporting multiple modulations. The proposed methodology is based on linear programming with network flow principles and radio channel access/interference models. Given a network topology, traffic requirements, and gateway capacities, we show how to allocate network interface cards and their channels to fully utilize channel bandwidths. In addition, we consider a channel assignment problem for multi-channel multi-radio wireless mesh networks. In [C.99], we formally model the hybrid channel assignment scheme into an integer linear programming formulation. We provide the necessary as well as sufficient conditions of any feasible assignment. We also show that the approximability of the considered problem.

In [C.22], we study how to exploit spectral reuse in resource allocation in an IEEE 802.16 mesh network, which includes routing tree construction, bandwidth

allocation, time-slot assignment, and bandwidth guarantee of real-time flows to meet the need of wide-range broadband wireless access at low cost. The proposed spectral reuse framework covers bandwidth allocation at the application layer, routing tree construction and resource sharing at the MAC layer, and channel reuse at the physical layer. To the best of our knowledge, this is the first work which formally quantifies spectral reuse in IEEE 802.16 mesh networks and which exploits spectral efficiency under an integrated framework.

About the access technologies on cellar networks, we have developed an adaptive mechanism for soft handover in OVSF WCDMA systems in [C.47]. We are the first group to identify the importance of managing OVSF codes in WCDMA systems, which has significant impact on the utilization of the system. Several strategies, such as leftmost and crowded-first schemes, were proposed. [C.52] [C.53]. These works have been used and cited by several other researchers. As the General Packet Radio Service (GPRS) network begins to provide such as ”push-to-talk” (PTT) service, delay-sensitive packets should be given higher priority in transmission. In [C.21], we study two channel allocation schemes that implement priority queues for priority packets in the GPRS network: Bitmap Channel Allocation (BCA) and Uplink State Flag Channel Allocation (USFCA). Our study shows that the transmission delay of priority packets in the GPRS network can be better guaranteed using USFCA. We have also analyzed performance of multi-piconet Bluetooth networks. New analytical methodologies were developed, which can more accurately predict Bluetooth network performance [C.49]. In [C.15] and [C.70] we proposed original overflow control schemes for UMTS high speed downlink packet access. We are the first research team to identify and attack this problem. In order to handle the roaming problem in heterogeneous access technologies, we have proposed a mobility support for mobile host roaming between WLAN and GPRS networks via a handoff decision model to reduce the latency [C.39].

The access technologies can also help developing location systems. A two-phase localization algorithm was also developed for location sensing in wireless sensor networks [C.43]. One challenging issue in sensor networks is to determine where a given sensor node is physically located. This problem is especially crucial for very small sensor nodes. In [C.18], we present a GPS-less, outdoor, self-positioning method for wireless sensor networks. In the optimal transmitting power, the worst-case accuracy for all data points is within 28.87% of the separation-distance between two adjacent reference points (RPs) and the average accuracy is within 15.51%. We have implemented our positioning method on a sensor network test bed and the actual measurement show that the method can achieve average accuracy within 17.9% of the

separation-distance between two adjacent RPs in an outdoor environment. To alleviate Signal strength fluctuation problem in a fingerprint-based localization system, we propose a scrambling method to exploit temporal diversity and spatial dependency of collected signal samples in [C.84]. In wireless Internet applications, we proposed a web content adaptation model which is formulated as a linear multi-choice knapsack problem [C.41]. A dynamic programming method was designed for solving it.

Applications and Services in B3G Networks

Mobile Ad-hoc Network (MANET) is usually considered as a stand-alone network. In [C.14], we propose a two-tier MANET, in which the high-tier gateways are equipped with an additional cellular interface to connect to the Internet. This greatly improves the connectivity of MANET because cellular networks nowadays are almost globally available. To provide seamless roaming capability in private MANET, a modified Mobile IP is implemented in the gateways. We also propose a load-balancing routing protocol to relieve the bottleneck problem of the gateways. In addition, with slight modification, DHCP is adopted in the two-tier MANET to configure the addresses. Considering that connecting to the Internet using cellular interfaces incurs charges and power consumption, we propose a push mechanism to allow the VoIP gateway to stay off-line when there is no calling activities and to be “woken up” when necessary [C.30]. The push approach can save energy and call charges and prevent the MANET subsystem from losing incoming voice calls. In our architecture, we do not modify the SIP server or client architecture. In addition, with few cellular interfaces, the VoIP gateway can serve multiple users inside the MANET concurrently. In next stage, we will address the bandwidth management and call admission control issues for the VoIP gateway.

Prepaid personal communication service (PCS) user has outnumbered post-paid users. In [C.64], we studied the charging issues of an integrated GSM and GPRS prepaid service, where a single prepaid account provides a user both voice and data services. The call setup and charging procedures for GSM and GPRS are presented using the CAMEL network architecture. To reduce the probability of terminating both on-going voice and data calls, we suggest that no new call be admitted when the user credit is below a threshold. An analytic model has been developed to evaluate the performance of the approach. Computer simulations have also been used to verify the simulation results. The numeric results indicate that the forced termination probability can be signicantly reduced by choosing an appropriate threshold of the user credit.

To enable devices using different VoIP protocols to communicate, we have

designed a simple, flexible framework for this interworking function [C.23]. The framework is based on a half-call model where a call is controlled by two half-call finite state machines (FSMs), one representing the state of the caller and the other representing the state of the callee. The interworking function has been implemented such that the caller FSM of one VoIP protocol can interact with the callee FSM of any VoIP protocol. The development effort of the interworking function is minimized since only two half-call FSMs for each VoIP protocol are needed and they can be developed independently as long as the design conforms to the same interface specification. We have developed an integrated call agent (ICA) that contains the half-call FSMs of H.323, SIP and MGCP. Calls between devices using these VoIP protocols can be set up, maintained and terminated by the ICAs.

In [C.32], we proposed a UMTS and WLAN interworking solution called WLAN-based GPRS support node (WGSN), which allows a UMTS/WLAN dual mode MS to access heterogeneous wireless services. To reduce the power consumption of an MS, most WGSN applications are not activated at the MS, and MS-terminated services, such as incoming voice over IP (VoIP) calls, are not supported. To address this issue, a push mechanism called session initiation protocol (SIP)-based push center (SPC) was implemented in the WGSN node. For an incoming call to an MS, the SPC utilizes the UMTS short message service to activate the SIP User Agent of the MS. We studied the performance of the SPC. An analytic model was proposed to derive the expected number of lost calls during the activation period. The analytic results are validated against the simulation experiments. Our study quantitatively indicates how the SPC performance is affected by the activation time and the timeout period, and we also suggest how to select appropriate values of these two factors to optimize the SPC performance.

4. Program Management: the Mechanism for Promoting Collaboration and Integration among the Institutes Involved

5. A Summary of the Post-Program Plan（Including the Detailed Description of Budget and Plan Adjustment of the next year）

Technology	2000-2004	2005-2006	2007-2008
B3G Core Network	**OSA Platform and Applications**	**One-Pass Authentication**	● **SIP-IMS Applications**

Technology			● **Online Charging System**
Broadband Wireless Access Technologies	● **Two-tier heterogeneous mobile ad hoc network architecture.** ● **Multi-channel MAC Protocols.**	● **Power-saving protocols in MANET.** ● **Multi-channel, multi-radio wireless mesh network.**	● **QoS scheduling over WiMAX** ● **Power-save mechanism over WiMAX**

6. International Cooperation Activities (Optional)

- Conducting SIP VoIP Interoperability Test with Institut National des Télécommunications (INT), France
- Studying complex computer network with Russian Academy of Sciences, Russian

- Inviting porf. Jonathan Liu for short-term research, Florida University (客座來訪交通大學: 01/2006~07/2006)
- Organizing the "Rice-Xilinx WARP Workshop at NCTU", 2006/12 (2006 年無線通訊網路開放平台研討會,與美國 Rice University 共同籌辦).
- Collaborating with prof. Anish Arora, Ohio State University, 國科會國際合作計畫 “大型無線隨意感測網路上的覆蓋及省電協定設計及實測”

VI. APPENDIX I:MINUTES FROM PROGRAM DISCUSSION MEETINGS

Main Project：

- 2004/05/04 -- Program Integration Meeting

一、時間：93 年 05 月 04 日（二）12:00

二、地點：清大資電館 447 會議室

三、會議主席：陳副校長文村、蔡文祥副校長

四、與會人員：黃能富教授、馮開明教授、楊啓瑞教授、張明峰教授、曾煜棋教授、陳耀宗教授、曾憲雄教授、陳良弼教授、金仲達教授、(張正尚教授、林盈達教授、鄭聖慶博士、林一平教授、簡榮宏教授、許健平教授、袁賢銘教授、許雅三教授請假)

五、會議記錄：黃齡照

六、決議

(一)各子計畫目前的人事規劃爲 4~7 位教授。

(二)計畫績效評估方式，視國科會的規定後再議。

(三)行政管理

1. 每一季開會一次，安排半天的時間，請每個子計畫報告研究進度，並希望每一位主持人都能出席參加。時間訂於 3 月、6 月、9 月與 12 月的月底，下一次會議時間爲 9 月。
2. 子計畫與跨子計畫間的協調會議請自訂時間。
3. 計畫定期於期中舉辦成果發表會，期末爲國科會考評。(第一年成果發表會訂於期末)
4. 建構總計畫與各子計畫網頁資料。

- 2004/10/18 -- Program Integration Meeting

一、時間：93 年 10 月 18 日 (一) 中午 12 點整

二、地點：交大浩然圖書館八樓第一會議室

三、會議主席：蔡文祥 校長、陳文村 副校長

四、與會人員：蔡文祥校長、陳文村副校長、簡榮宏教授、金仲達教授、張正尚教授、李端興教授、黃能富教授、楊啓瑞教授、林盈達教授、陳智弘教授、李詩偉教授、鄭聖慶博士、林一平教授、張明峰教授、曾煜棋教授、曾憲

雄教授、陳耀宗教授、張玉山副教授、王家祥教授 (請假:許健平教授、袁賢銘教授、陳良弼教授、許雅三教授)

五、會議記錄：卓怡慧

六、決議

（一）行政管理

1. 下一次總計畫會議時間定於 12 月，兩校共同邀請學術界或法人單位擔任審查委員進行成果展示發表會及相關績效評估。
2. 往後兩校總計畫聯合會議，以每季舉行一次爲原則。報告內容除研究進度與成果外，建議加入計畫相關的學術活動(邀訪學者)與產學合作等項目的報告。
3. 後卓越計畫相關智慧財產權歸屬性(專利權、著作權等) ，請事先諮詢學校法務部門。
4. 請各子計畫注意經費運用進度；並請各子計畫助理隨時更新經費餘額，通知並提醒主持人經費運用進度。

- 2005/05/13 -- Program Integration Meeting

一、時間：94 年 05 月 13 日星期五 中午 12 點整

二、地點：交通大學電資大樓 203 會議室 蘭成廳

三、會議主席：蔡文祥 校長、陳文村 校長

四、與會人員：蔡文祥、陳文村、邱瀞德、李端興、馮明開、楊啓瑞(請假)、林盈達、田伯隆、李詩偉、林一平、張明峰、簡榮宏、曾煜棋、陳耀宗、張玉山、曾憲雄(林順傑代)、金仲達、吳宜鴻、蕭宏章

五、會議記錄：王慧敏

六、核閱：

七、決議：

（一） 各分項計畫製作可技轉項目的說明單，格式可參考企業的產品或技術簡介，並由金仲達教授與簡榮宏教授協調，訂定於 6 月底 ITRE 的時間舉辦說明會。

（二） 由於每季只舉辦一次兩校協調會議，請所有參與計劃的教授都來出席開會。

（三） 開會投影片請各分項提早一周繳交，格式請儘量統一，以便彙整。

- 2005/09/26 -- Program Integration Meeting

一、時間：94 年 09 月 26 日星期一 中午 12 點整

二、地點：清華大學資電館 447 會議室

三、會議主席：蔡文祥 校長、陳文村 校長

四、與會人員：張正尚教授、邱瀞德教授、許雅三教授、闕宏時、許育豪、吳自強博士後、陳奕錡、 王慧敏、羅志鵬(代替楊啓瑞)、陳靜雯、林一平教授、簡榮宏教授、曾煜棋教授、張明峰教授、施明婷、陳文村教授、黃啓富、王瓊瑩、陳耀宗教授、蔡文祥教授、曾憲雄教授、葉秉哲博士後、姚維民、林順傑、金仲達教授、林華君教授、廖文瑜

五、會議記錄：廖文瑜

六、討論議題：

（一） 增加國際合作的機會，如：舉辦或多參加國際研討會、收取國外的博士後研究員。

（二） 邀請專家學者來台短期訪問或演講時，可請他們做計劃的批評、評論，如：10 月郭宗傑教授來訪、11 月游本中教授來訪時。

（三） 請金仲達教授及簡榮宏教授，根據以往審查委員的意見，列表出該著重的項目，分配至各子計畫並加強其進度成果。

（四） 預定 11 月舉辦自評會議，邀請國外學者 2-3 位爲審查委員。

- 2005/12/16 -- Program Integration Meeting

一、時間：94 年 1 2 月 16 日（星期五）12:00

二、地點：交通大學電資大樓 203 會室蘭成廳

三、會議主席：陳文村校長、蔡文祥校長

四、出席人員：張正尚教授、黃能富教授、邱瀞德教授、吳仁銘教授、楊啓瑞教授、林盈達教授、陳智弘教授、田伯隆教授、林一平教授、張明峰教授、曾煜棋教授、簡榮宏教授、楊舜仁教授、陳志成教授、張志勇教授、金仲達教授、陳良弼教授、李政崑教授、王家祥教授、陳宜欣教授、及各子計畫相關研究助理人員等

五、會議記錄：何卉蓁

六、報告事項：總計畫及各分項計畫研究工作進度報告。

七、決議事項：

（一）研發智財成果：請各分項計畫彙整所完成研發技術成果資料及專利智財數據，舉凡技術移轉項目、專利智財、學術論文、技術報告等。作爲本年度國科會期中成果報告研發呈現，並冀達成本計畫預期目標。

（二）技術移轉、產學合作：本計畫仍將繼續秉持創新科技研發、以達追求學術卓越發展之目標，同時積極與產業界技術合作交流，運用本計畫研發成果進行技術移轉。

（三）擬訂於下次兩校計畫聯席會議時，再次檢討本計畫研發進度及產學合作之執行狀況。

- 2006/09/22 -- Program Integration Meeting

一、時間：95 年 09 月 22 日（五）14:00

二、地點：交通大學工程三館 345 會議室

三、會議主席：陳文村校長、蔡文祥校長

四、與會人員：金仲達教授、林盈達教授、張正尚教授、馮開明教授、楊啓瑞教授、張明峰教授、曾煜棋教授、曾憲雄教授、楊舜仁教授、簡榮宏教授、許健平教授、袁賢銘教授、陳宜欣教授、葉秉哲博後、詹振隆博後、吳志強博後、曲衍旭博士、林君怡助理、林玫靜助理、沈上翔助理、吳佳蓉助理、徐文靜助理、張巧涵助理、曹瑜珊助理

五、會議記錄：張巧涵

六、討論事項：

（一）審查意見中，哪些是我們要改進的？哪些不用或無法改進？

（二）如何增加內部技術對話與成功經驗分享？

（三）如何增加國際知名度？

（四）如何聚焦 challenging issues/impact/benchmark/state-of-the-art？

七、決議：

（一）成果展現(前卓+後卓)技轉、paper 等參數並編 brochure。

（二）三大主題內部增加交流，內部交流時安排經驗傳承。

（三）各主題分開請專家(3~5 位)作一天的 review 和 comment(12 月之前)。

（四）請準備格式讓各子計畫寫報告來符合評審的期望(明年 2 月之前，今年 12

月底初稿)。

（五）各子計畫的會議紀錄納入總計畫當檔案或附件。

（六）安排大約 4 月和 11 月各一次的經驗傳承研討會。

（七）下一次每三個月一次的報告分成三大主題。三大主題報告期前，三大主題先個別開會、 整合，並依第 4 點的格式報告。

（八）後卓越計畫註冊申請網站：iWIN.org.tw 或 iWIN.edu.tw

(iWIN.nthu.edu.tw 及 iWIN.nctu.edu.tw)

- 2006/11/22 -- Program Integration Meeting

一、時間：95 年 11 月 22 日（三）14:00

二、地點：交通大學工程三館 345 會議室

三、會議主席：金仲達教授、林盈達教授

四、與會人員：蔡文祥校長、林一平教授、楊舜仁教授、卓傳育博後、吳志強博後、闕宏時博士生、趙子萱博士生、許育豪博士生、梁睿琦博士生、何承遠博士生、楊凱超博士生、李皇辰博士生、巫芳璟博士、賴婉婷碩士、陳叡儀碩士生、鐘凱馨、吳至仁、陳建中、王宗志、 林君怡助理、林玫靜助理、沈上翔助理、吳佳蓉助理、張巧涵助理、蔡靜怡助理

五、會議記錄：張巧涵

六、報告事項：林一平教授經驗傳承會議

七、傳承會議內容大綱：

（一）寫作論文方面：

1.Writing style 很重要，其中要特別注意：

（1）名詞定義

（2）文法用字用詞

（3）logic

2.Response to reviews 的態度：

（1）constructive 意見要虛心接納

（2）遇到別人 reject 你的 paper 不用爭論。重要是要看看對方的意見，reject 不一定是負面的

3.如何讓你的 paper 被別人看，願意做 citation 的動作：

（1）先上網被看，吸取別人意見，修改論文

（2）把你的 paper 寄給該領域的專家，請他們看看

（二）給教授的建議：

1.做研究最好是系列性的，例如：一系列 papers

2.如果你的學生有出國的機會，幫他作名片

3.當 reviewer 時，寫的 review 不要太隨便

4.寫書是 promotion 效果最大的，尤其是技術性的教科書：

（1）寫國際教科書，要找好的出版商(好的出版商：Prentice Hall、Wiley、Academic Press)

（2）好的出版商就有好的 editor，可以幫你修改你的文法；另外好的出版商也有好的 channel

（3）第一本書找有名學者合作(國際合作/co-author)

（三）建議 for 博士生/ junior 教授：

1.博班學生帶名片、負責在 timely 給知名人士

2.conference 時可以見到很多人，要善用

3.很多人只看 SCI journals

4.投稿策略(類型. 先 try A 級)

5.多拿獎：

（1）recognition

（2）建階梯 for senior 教授，讓他們有依據往上爬

（3）拿獎可以證明你的成就，讓你有信心，相對的你對自己的要求也會變高

（四）學生的論文 Quality Control：

1.一段時間 focus on 一個學生(pipelined 而不是 parallel)，直到論文出去爲止，才再 focus on 第二個學生

2.要求學生自動看規格標準缺什麼

3.學生要把論文拿給老師看之前，要做最好的準備

（五）時間分配：

1.Email 而不是 conference，因爲 conference 很花時間

2.Reuse 過去 efforts(第二本書 3 個月完成)

3.熱忱、善用剩餘時間、reorganize 相關事情

4.晚上與週末繼續玩研究

- 2006/11/30 -- Program Integration Meeting

一、時間：95 年 11 月 30 日（四）10:00

二、地點：交通大學工程三館 412 會議室

三、會議主席：金仲達教授、林盈達教授

四、與會人員：卓傳育、許育豪、黃啓富、顏在賢、羅志鵬、蘇淑茵、林君怡、沈上翔、張巧涵

五、會議記錄：徐文靜

六、報告事項：

（一）針對 95 年 9 月 22 日總計畫會議中的決議事項，報告、投影片及網頁格式之討論。

（二）95/09/22 會議決議事項

1. 成果展現(前卓+後卓)技轉、paper 等參數並編 brochure。
2. 三大主題內部增加交流，內部交流時安排經驗傳承。
3. 各主題分開請專家(3~5 位)作一天的 review 和 comment(12 月之前)。
4. 請準備格式讓各子計畫寫報告來符合評審的期望(明年 2 月之前，今年 12 月底初稿)。
5. 各子計畫的會議紀錄納入總計畫當檔案或附件。
6. 安排大約 4 月和 11 月各一次的經驗傳承研討會。
7. 下一次每三個月一次的報告分成三大主題。三大主題報告期前，三大主題先個別開會、整合，並依第 4 點的格式報告。
8. 後卓越計畫註冊申請網站：iWIN.org.tw 或 iWIN.edu.tw (iWIN.nthu.edu.tw 及 iWIN.nctu.edu.tw)

七、決議事項：

(一)、國科會所規定之報告內容主要部份

I. BASIC INFORMATION OF THIS SUB-PROJECT

II. EXECUTIVE SUMMARY ON RESEARCH OUTCOMES OF THIS PROJECT

1.GENERAL DESCRIPTION OF THE PROJECT: INCLUDING OBJECTIVES OF THE PROJECT

2.BREAKTHROUGHS AND MAJOR ACHIEVEMENTS

3.CATEGORIZED SUMMARY OF RESEARCH OUTCOMES.

4.A SUMMARY OF THE POST-PROJECT PLAN

5. INTERNATIONAL COOPERATION ACTIVITIES

III.STATISTICS ON RESEARCH OUTCOMES OF THIS PROJECT

IV. LIST OF WORKS, EXPENDITURES, MANPOWER, AND MATCHING SUPPORTS FROM THE PARTICIPATING INSTITUTES

V. APPENDIX I

VI. APPENDIX II

(二)、針對後卓越計畫的報告、投影片及網頁內容，有以下決議:

1. II. EXECUTIVE SUMMARY ON RESEARCH OUTCOMES OF THIS PROJECT

2. BREAKTHROUGHS AND MAJOR ACHIEVEMENTS 應附下表

Subproject	Technology	State-of-the-art (technology researcher、affiliation)	Breakthroughs (verbal description on transfer、citation、comparable project)
	RDM	LDI W.Smith Berkeley	10G v.s 5G

3. II. EXECUTIVE SUMMARY ON RESEARCH OUTCOMES OF THIS PROJECT

4. A Summary of the Post-Project Plan 應附下表

	2000~2004	**2005~2006**	**2007~2008**
Tech 1.			
Tech 2.			
Tech 3.			

各子計畫的部份，針對 Breakthroughs 提出 2 個 technology(不超過 3 個)，從過去到現在及未來作一個時間表的呈現，說明其中的連貫及發展。

3.決議 1 與 2 所提的 technology 以 2 個爲原則，不超過 3 個。

4.投影片呈現內容與報告格式內容相同，包含 I~V 部分，其中 II 的第 2 節及第 4 節要先附上決議 1 及決議 2 的表格。

5.網頁:以公告性質爲主

(1).保留總計劃的部份，並將英文格式更改成與中文格式相同。

(2).將過時的資訊移除。(將首頁的會議紀錄、學術活動刪除)

(3).子計畫的網頁入口，應先由英文入口再轉換成中文。

(4).子計畫的網頁內容要包含 II、III、VI 的報告內容，且 VI 的部份要有 URL 連結可下載資料。

(5).將所有資料歸納於總計劃的主機之下，以便管理，再由計畫助理負責更新。

(6).網頁更新的部份於 2007/02/28 前，資料收集完成後，亦更新完成。

- 2007/01/08 -- Program Integration Meeting

一、 時間：96 年 01 月 08 日（星期一）14:00

二、 地點：清華大學電資館 447 會議室

三、 會議主席：陳文村校長、蔡文祥校長

四、 出席人員：張正尚教授、黃能富教授、邱瀞德教授、馮開明教授、楊啓瑞教授、林盈達教授、田伯隆教授、林一平教授、張明峰教授、曾煜棋教授、簡榮宏教授、楊舜仁教授、陳志成教授、張志勇教授、金仲達教授、陳耀宗教授、曾憲雄教授、袁賢銘教授、葉秉哲博士、金仲達教授、陳宜欣教授、及各子計畫相關研究助理人員等

五、 會議記錄：徐文靜

六、 報告事項：總計畫及各分項計畫研究工作進度報告。

七、 決議事項：

（一） 報告格式請統一，並附上 95/11/30 開會決議中應附之表格（請參照 95/11/30 會議紀錄）。

（二） 各分項計劃於一月 15 日之前繳交成果報告，以便總計畫彙整。

（三） 各計畫報告於一月底上傳至國科會。

- 2007/04/20 -- Program Integration Meeting

一、時間：96 年 04 月 20 日（五）14:00

二、地點：交通大學工程三館 427 會議室

三、會議主席：陳文村校長、蔡文祥校長

四、與會人員：金仲達教授、林盈達教授、張正尚教授、馮開明教授、楊啓瑞教授、張明峰教授、曾煜棋教授、曾憲雄教授、楊舜仁教授、簡榮宏教授、許健平教授、袁賢銘教授、陳宜欣教授、葉秉哲博後、詹振隆博後、曲衍旭博士、林君怡助理、林玫靜助理、何承遠助理、吳佳蓉助理、徐文靜助理、楊耀萱助理、楊佳文助理、蔡靜怡助理

五、會議記錄：楊耀萱

六、計畫進度成果報告

- 2007/10/12 -- Program Integration Meeting

一、時間：96 年 10 月 12 日（五）14:00

二、地點：清華大學資電館 4 樓 447 會議室

三、會議主席：陳文村校長、蔡文祥校長

四、與會人員：金仲達教授、陳耀宗教授、張正尚教授、馮開明教授、林華君教授、楊啓瑞教授、張明峰教授、曾煜棋教授、曾憲雄教授、黃能富教授、楊舜仁教授、簡榮宏教授、許健平教授、袁賢銘教授、葉秉哲博後、詹振隆博後、施汝霖博後、陳柏諭博班生、田柏隆博班生、曲衍旭博士、王竣聰、黃冠霖、林君怡助理、林玫靜助理、何承遠助理、徐文靜助理、楊耀萱助理、楊佳文助理、蔡靜怡助理

五、會議記錄：徐文靜

六、計畫進度成果報告

七、討論事項：

（一）.後卓越成果展時間及方式?

（二）持續合作之議題?

八、決議:

（一）預計於 1 月初發表成果展，將技轉項目及自評合於成果展中。

（二）建議各計畫討論後，於下一次會議討論清、交未來合作議題。

VII. APPENDIX II:

1. PUBLICATION LIST（CONFERENCES, JOURNALS, BOOKS, BOOK CHAPTERS, etc.）

Journal papers

[C.1] Y. Fang, P. Lin, and Y. -B. Lin, Mobility and Resource Management, IEEE Wireless Communications, 11(4): 4-5, 2004.

[C.2] S.-R. Yang, and Y.-B. Lin, Modeling UMTS Discontinuous Reception Mechanism. IEEE Transactions on Wireless Communications, 4(1), 2005.

[C.3] Y.-B. Lin, Per-user Checkpointing for Mobility Database Failure Restoration. IEEE Transactions on Mobile Computing, 4(2): 189-194, 2005.

[C.4] Y.-R. Haung, and Y.-B. Lin, A Bandwidth-on-demand Strategy for GPRS. IEEE Transactions on Wireless Communications, 4(4): 1394-1399, 2005.

[C.5] M. Fang, and Y.-B. Lin, Mobility Management and Signaling Traffic Analysis for Multi-tier Wireless Mobile Networks. IEEE Transactions on Vehicular Technology, 54(5): 1843-1853, 2005.

[C.6] S.-Y. Wang, and Y.-B. Lin, Wireless Internet Simulation Using NCTUns 2.0: An Innovative Network Simulator and Emulator. Wireless Communications and Mobile Computing, 5(8): 89-916, 2005.

[C.7] H.-N. Hung, Y.-B. Lin, M. -K. Lu, and, N. -F. Peng. A Statistic Approach for Deriving the Short Message Transmission Delay Distributions. IEEE Transactions on Wireless Communications., 3(6): 2345-2352, 2004.

[C.8] A.-C. Pang, and Y. -B. Lin, VoIP Services for Mobile Networks, Upgrade, the European Journal for the Informatics Professional, 5(1): 8-11, February, 2004. http://www.upgrade-cepis.org

[C.9] A.-C. Pang, and Y. -B. Lin, VoIP Services for Mobile Networks, Novatica, Redes I nalambricas: una nueva era en las Telecomunicaciones, 167, Jan. -Feb., 2004.

[C.10] Chen, M.F., Lin, Y.-B., Rao, R. C.-H., Wu, Q.C.A Mobile Service Platform Using Proxy Technology,Wireless Communications and Mobile Computing Journal, 6: 17-34, 2006.

[C.11] Lin, Y.-B., Tsai, M.-H.Caching in I-CSCF of UMTS IP Multimedia Subsystem.IEEE Transactions on Wireless Communications,5(1): 186-192, 2006.

[C.12] Y.-B. Lin, M.-H. Tsai, Caching in I-CSCF of UMTS IP Multimedia Subsystem. IEEE Transactions on Wireless Communications, 5(1): 186-192, 2006.

[C.13] Y.-B. Lin, M.-F. Chang, M.-T. Hsu,, and L.-Y. Wu, One-Pass GPRS and IMS Authentication Procedure for UMTS. IEEE Journal on Selected Areas in Communications, 23(6): 1233-1239, 2005.

[C.14] P. Lin, Y. -B. Lin, and Chlamtac, I. Module Count-Based Overflow Control Scheme for UMTS High Speed Downlink Packet Access. IEEE Transactions on Vehicular Technology, 53(2): 2004.

[C.15] P. Lin, Y. -B. Lin,, and Chlamtac, I. Overflow Control for UMTS High-Speed Downlink Packet Access. IEEE Trans. on Wireless Communications, 3(2): 524-533, 2004.

[C.16] H.-H. Chang, M.-F. Chang and C.-C. Tseng, “An Analysis of Location Record Checkpointing Interval for Mobility Database in PCS Networksm,” Accepted for publication, ACM Wireless Networks,

[C.17] S.-I. Sou, and Y.-B. Lin, Modeling of Mobility Database Failure Restoration using Checkpoint Schemes. IEEE Transactions on Wireless Commun (to appear).

[C.18] C.-M. Chou, S.-F. Hsu, H.-Y. Lee, Y.-C. Lin, Y.-B. Lin, and R.S. Yang. ICL OSA: A CORBA-based Open Service Access System. International Journal of Wireless and Mobile Computing (to appear).

[C.19] P. Lin, Y.-B. Lin, C.S. Yen, and J.-Y. Jeng, Credit Allocation for UMTS Prepaid Service, IEEE Transactions on Vehicular Technology (to appear).

[C.20] A.-C. Pang, Y.-B. Lin, H.-M. Tsai, and P. Agrawal, Serving Radio Network Controller Relocation for UMTS All-IP Network. IEEE Journal on Selected Areas in Communications, 22(4); 617-629, 2004.

[C.21] Y.-B. Lin, and A.-C. Pang, Impact of Mobility on Mobile Telecommunications Networks. Wireless Communications and Mobile Computing Journal (to appear).

[C.22] L.-W. Chen, Y.-C. Tseng, Y.-C. Wang, D.-W. Wang, and J.-J. Wu, "Exploiting Spectral Reuse in Routing, Resource Allocation, and Scheduling for IEEE 802.16 Mesh Networks", IEEE Trans. on Vehicular Technology, to appear. (SCI, EI)

[C.23] S.-R. Yang, and Y.-B. Lin, Performance Evaluation of Location Management in UMTS IEEE Transactions on Vehicular Technologies (to appear).

[C.24] Y. Xiao, M. Fang, and Y.-B. Lin, Hierarchical Implicit Deregistration with Forced Registrations in 3G Wireless Networks. IEEE Transactions on Vehicular Technologies (to appear).

[C.25] H.-N. Hung, P.-C. Lee, Y.-B. Lin, and N.-F. Peng, Modeling Channel Assignment of Small-Scale Cellular Networks. IEEE Transactions on Wireless Communications, 4(2): 646-652, 2005.

[C.26] Y.-C. Wong, T.-P. Wang, and Y.-B. Lin, Effects of Route Optimization on Out-of-Order Packet Delivery in Mobile IP Networks. Information Sciences, 169 (3-4): 263-278, 2005.

[C.27] L.-W. Chen, W. Chu, Y.-C. Tseng, and J.-J. Wu, "Route Throughput Analysis with Spectral Reuse for Multi-Rate Mobile Ad Hoc Networks", Journal of Information Science and Engineering, to appear. (SCIE, EI)

[C.28] J.-S. Hwu, S.-F. Hsu, Y.-B. Lin, and R.-J. Chen, End-to-end Security Mechanisms for SMS. International Journal of Security and Networks (to appear).

[C.29] C.-H. Gan, Y.-B. Lin, and S.-H. Chen, Design and Implementation of UMTS Session Management in the User Equipment. Wireless Communications and Mobile Computing Journal (to appear).

[C.30] P. Lin, Y.-B. Lin, I. Chlamtac, Modeling Frame Synchronization for UMTS High-Speed Downlink Packet Access. IEEE Transactions on Vehicular Technology (to appear).

[C.31] Y.-K. Chen, and Y.-B. Lin, IP Connectivity for Gateway GPRS Support Node. IEEE Wireless Communications, 12(1):37-46, 2005.

[C.32] V. W.-S. Feng, L.-Y. Wu., Y.-B. Lin, and W.E. Chen, WGSN: WLAN-based GPRS Environment Support Node with Push Mechanism. The Computer Journal, 47(4):405-417, 2004.

[C.33] Y. H. Chen, H.-N. Hung, Y.-B. Lin, and N.-F. Peng, Modeling of Ad-hoc and Infrastructure Dual Mode Mobile Networks. Intl. J. of Automation and Computing, 2(1), 2005.

[C.34] V. Feng, Y.-B. Lin, and S.-L. Chou, Design and Implementation of A Softswitch for Third Generation Mobile All-IP Network, Wireless Communications and Mobile Computing Journal (to appear).

[C.35] Y.-B. Lin, W.-E. Chen, and C.-H. Yen, Effective VoIP Call Routing in WLAN and Cellular Integration. IEEE Communications Letters, 9(10): 874-876, 2005.

[C.36] Y. Fang, and Y.-B. Lin, Strongly Consistent Access Algorithms for Wireless Data Networks, ACM Wireless Network, 11 (3): 243-254, 2005.

[C.37] Y. Fang, Y. Haas, B. Liang, and Y.-B. Lin, TTL Prediction Schemes and Effects of Inter-Update Time Distribution on Wireless Data Access. ACM Wireless Network, September, 2004.

[C.38] R.-H. Jan and Y.-L. Lin, "A hybrid routing method for multi-hop wireless area networks," IEICE Trans on Communication, vol. e87-b, no. 10, Oct., 2004, pp. 2939-2945.

[C.39] R.-H. Jan and W.-Y. Chiu, "An approach for seamless handoff among mobile WLAN/GPRS integrated networks," *Computer Communications*, vol. 29, no1, 2005.

[C.40] H.-P. Lin, S.-C. Huang and R.-H. Jan, "A Power-Saving Scheduling for Infrastructure-Mode 802.11 Wireless LANs," *Computer Communications*, vol. 29, no. 17 , 2006, pp. 3483-3492.

[C.41] R.-H. Jan, C.-P. Lin, and M.-S. Chern, "An optimization model for Web content adaptation," *Computer Networks*, vol. 50, no. 7, 2006, pp. 953-965.

[C.42] S.-C. Huang, R.-H. Jan, and W. Yang, "RICA - A Ring-based Information Collection Architecture in Wireless Sensor Networks," *International Journal of Sensor Networks*, vol. 1, no. 3/4, 2006, pp.190-199.

[C.43] Y.-H. Gau, H.-C. Chu, and R.-H. Jan, "A Weighted Multilateration Positioning Method for Wireless Sensor Networks" *International Journal of Pervasive Computing and Communications*, (to appear), 2006.

[C.44] W.-Z. Yang, F.-S. Lu, M.-F. Chang, “Performance Modeling of an Integrated Mobile Prepaid Services," IEEE Trans. on Vehicular Technology, vol. 56, no. 3, pp. 899-906, 2007.

[C.45] H.-H. Chang, M.-T. Hsu and M.-F. Chang, “An Integrated Call Agent of the Converged VoIP Network,” Journal of Information Science and Engineering, vol. 23, no. 5 pp. 787-799, 2007.

[C.46] M.-F. Chang, L.-Y. Wu, and Y.-B. Lin, “Performance Evaluation of a Push Mechanism for WLAN and Mobile Network Integration”, IEEE Trans. on Vehicular Technology, Vol. 55, no. 1, pp. 380-383, 2006.

[C.47] K.-J. Lin and Y.-C. Tseng, "Adaptive Selection Combining for Soft Handover in OVSF W-CDMA Systems", IEEE Communications Letters, Vol. 8, No. 11, Nov. 2004, pp. 656-658. (SCI, EI)

[C.48] S.-L. Wu, C.-Y. Lin, Y.-C. Tseng, and J.-P. Sheu, "A Novel MAC Protocol with On-Demand Channel Assignment for Multi-Hop Mobile Ad Hoc Networks", Int'l J. of Electrical Engineering, Vol. 11, No. 4, Nov. 2004, pp. 361-374. (EI)

[C.49] T.-Y. Lin, Y.-K. Liu, and Y.-C. Tseng, “An Improved Packet Collision Analysis for Multi-Bluetooth Piconets Considering Frequency-Hopping Guard Time Effect”, IEEE J. on Selected Areas in Communications, Vol. 22, No. 10, Dec. 2004, pp. 2087-2094. (SCI, EI)

[C.50] L.-C. Wang, S.-Y. Huang, and Y.-C. Tseng, "Interference Analysis and Resource Allocation for TDD-CDMA Systems to Support Asymmetric Services by Using Directional Antennas," IEEE Trans. on Vehicular Technology, Vol. 54, No. 3, May 2005, pp. 1056-1069. (SCI, EI)

[C.51] Y.-C. Wang, S.-R. Ye, and Y.-C. Tseng, “A Fair Scheduling Algorithm with Traffic Classification in Wireless Networks”, Computer Communications, Vol. 28, 2005, pp. 1225-1239. (SCIE, EI)

[C.52] C.-M. Chao, Y.-C. Tseng, and L.-C. Wang, "Reducing Internal and External Fragmentations of OVSF Codes in WCDMA Systems with Multiple Codes", IEEE Trans. on Wireless Communications, Vol. 4, No. 4, July 2005, pp. 1516-1526. (SCIE)

[C.53] C.-M. Chao, Y.-C. Tseng, and L.-C. Wang, "Dynamic Bandwidth Allocation for Multimedia Traffic with Rate Guarantee and Fair Access in WCDMA Systems", IEEE Trans. on Mobile Computing, Vol. 4, No. 5, Sep./Oct. 2005, pp. 420-429. (SCI)

[C.54] S.-R. Ye and Y.-C. Tseng, “A Multi-Chain Backoff Mechanism for IEEE 802.11 WLANs”, IEEE Trans. on Vehicular Technology (to appear). (SCI, EI)

[C.55] Y.-C. Wang, Y.-C. Tseng, and W.-T. Chen, “MR-FQ: A Fair Scheduling Algorithm for Wireless Networks with Variable Transmission Rates”, Simulation: Transactions of The Society for Modeling and Simulation International (to appear). (SCI)

[C.56] Y.-C. Tseng, S.-L. Wu, C.-M. Chao, and J.-P. Sheu, "An Efficient MAC Protocol for Multi-Channel Mobile Ad Hoc Networks Based on Location Information”, Int’l Journal Communication Systems (to appear). (SCI)

[C.57] C.-S. Hsu, Y.-C. Tseng, and J.-P. Sheu, "An Efficient Reliable Broadcasting Protocol for Wireless Mobile Ad Hoc Networks", Ad Hoc Networks (to appear).

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[C.59] W.-E. Chen, Y.-H. Sung, and Y.-B. Lin. SIPv6 Analyzer: An Analysis Tool for 3GPP IMS Services. Accepted and to appear in *Wireless Communications and Mobile Computing Journal*.

[C.60] S.-I. Sou, H.-N. Hung, Y.-B. Lin, N.-F. Peng, and J.-Y. Jeng. Modeling Credit Reservation Procedure for UMTS Online Charging System. Accept and to appear in *IEEE Transactions on Wireless Communications.*

[C.61] L.-Y. Wu, M.-H. Tsai, Y.-B. Lin, R.-S.Yang. A Client-Side Design and Implementation for Push to Talk over Cellular Service. Accepted and appear in *Wireless Communications and Mobile Computing.*

[C.62] S.-I. Sou, Y.-B. Lin, Q. Wu, and J.-Y. Jeng. Modeling Prepaid Application Server of VoIP and Messaging Services for UMTS. Accepted and to appear in *IEEE Trans. on Veh. Technol.*

[C.63] S.-M. Huang, Q.-C. Wu , Y.-B. Lin, and C.-H. Yeh. SIP Mobility for IP Multimedia Core Network Subsystem. *Wireless Communications and Mobile Computing,* 6, 1-15, 2006.

[C.64] H.-N. Hung, P.-J. Lee, and Y.-B. Lin. Random Number Generation for Excess Life of Mobile User Residence Time. *IEEE Trans. on Veh. Technology,* 55(3), 1045-1050. 2006.

[C.65] S.-M. Huang, Q.-C. Wu, and Y.-B. Lin.Enhancing Teredo IPv6 Tunneling to Traverse the Symmetric NAT. *IEEE Communications Letters,* 10(5), 408-410, 2006.

[C.66] L.-Y. Wu, and Y.-B. Lin, Authentication Vector Management for UMTS. Accepted and to appear in *IEEE Trans. on Wireless Commun.*

[C.67] P. Lin, Y.-B. Lin, C.-H. Gan, and J.-Y, Jeng. Credit Allocation for UMTS Prepaid Service. *IEEE Trans. on Veh. Technol,* 55(1),306-317, 2006. (TL/CHT)

[C.68] Y.-B.Lin, M.-H. Tsai. Caching in I-CSCF of UMTS IP Multimedia Subsystem. *IEEE Transactions on Wireless Communications,* 5(1), 186-192, 2006.

[C.69] J.-S. Hwu, R.-J. Chen, and Y.-B., Lin. An Efficient Identity-based Cryptosystem for End-to-end Mobile Security. *IEEE Transactions on Wireless Communications,* 5(9),2586-2593, 2006.

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[C.85] T.-Y. Lin, W.-H. Tam, K.-L. Fan, and Y.-C. Tseng, "Resource Planning and Packet Forwarding in Multi-radio, Multi-mode, Multi-channel, Multi-rate (M^4) Wireless Mesh Networks", Computer Communications, to appear. (SCIE, EI)

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[C.90] Y.-C. Wang, S.-R. Ye, and Y.-C. Tseng, “A Fair Scheduling Algorithm with Traffic Classification in Wireless Networks”, Int'l Symp. on Performance Evaluation of Computer and Telecommunication Systems (SPECTS) 2004.

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[C.94] S.-R. Ye and Y.-C. Tseng, “A Multi-Chain Backoff Mechanism for IEEE 802.11 WLANs”, Workshop on Wireless, Ad Hoc, and Sensor Networks, 2005, Taiwan.

[C.95] P.-Y. Wu, Y.-C. Tseng, and H. Lee, “Design of QoS and Admission Control for VoIP Traffics over IEEE 802.11e WLANs”, National Computer Symposium, 2005, Taiwan. (recipient of the Best Paper Awards in NCS 2005)

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[C.108] S.-P. Kuo, Y.-C. Tseng, and C.-C. Shen, "Increasing Search Space for Pattern-Matching Localization Algorithms by Signal Scrambling ", IEEE Asia-Pacific Wireless Communications Symposium, 2007.

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Book Chapters

[C.110] Y. -C. Wang and Y. -C. Tseng, " Packet Fair Queuing Algorithms for Wireless Networks" (a book chapter in " Design and Analysis of Wireless Networks" , Nova Science Pub., edited by Y. Pan and Y. Xiao, 2004, ISBN: 1-59454-186-8)

[C.111] Y. -C. Tseng and S. -R. Ye, " Wireless LAN MAC Protocols Using Busy Tones and Jamming Signals" (a book chapter in " Wireless LANs and Bluetooth" , Nova Science Pub., edited by Y. Xiao and Y. Pan, expected 2005).

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[C.114] W.-H. Yang and Y.-C. Tseng, “Mobile WiMax Networks and Their Integration with WiFi Networks” (a book chapter in WiMax/MobileFi: Advanced Research and Technology, CRC Press, edited by Y. Xiao).

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[C.119] Y.-C. Tseng and T. Ren, “Methods and Systems for Dynamic Load Balance in WLAN”, No. 229521, Taiwan (2005.03-2024.1). (曾煜棋,阮騰輝, “動態網路負載平衡方法以及系統”) (granted)

[C.120] 曾煜棋,阮騰輝, “動態網路負載平衡方法以及系統”, USA (pending)

[C.121] Yi-Bing Lin, Mobility Management Method and System for Wireless Data Networks.(with ICL/ITRI), R.O.C. patent temporarily approved, U.S. pending, Germany pending.

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[C.124] M,-F, Chang, Y.-B. Lin and C.-F. Liang, “Method and Apparatus for a PSTN User Calling back a User on a Private Telephone Network,” USA and ROC (pending)

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[C.134] Y.-C. Tseng, P.-Y. Wu, and H.-W. Lee. Method for Establishing a Voice over IP Call in a WLAN. Europe (pending, owned by Zyxel Communications).

[C.135] Y.-C. Tseng, J.-J. Chen, and H.-W. Lee. HANDOFF METHOD OF MOBILE DEVICE UTILIZING DYNAMIC TUNNEL. USA (pending, owned by Zyxel Communications).

[C.136] S.-F. Kuo, R.-H. Jan, and S.-H. Huang. A predictive handoff scheme for wireless LANs. ROC Patent I263439, 2006.

[C.137] 陳柏諭等, “使用無線感測網路提供群組導引服務之方法及系統”, Taiwan (pending).

[C.138] 潘孟鉉等, “適用於信標模式無線網路快速資料傳輸機制”, Taiwan (pending), submitted in 2007.

[C.139] 洪簡廷州, 潘孟鉉, 蔡佳宏, 曾煜棋, “動態緊急指示裝置、方法及系統”, Taiwan (pending, owned by NTHU), 2007.

3. INVENTION LIST

4. LIST OFWORKSHOPS/CONFERENCES HOSTED BY THE PROGRAM

[C.140] Y. -C. Tseng, Vice Chair, Int' l Conf. on Distributed Computing Systems (ICDCS), 2004, Japan. (Participants : 200)

[C.141] Chair: Yi-Bing Lin Co-chair: Whai-En Chen, 2004 Training Course , 14 hours, (Participants : 100)

[C.142] Chair: Yi-Bing Lin Co-chair: Whai-En Chen, 2005 Training Course, 21 hours, (Participants : 100)

[C.143] Y.-B. Lin and Y.-C. Tseng, General Chairs: Mobile Computing Workshop, 2005, Taiwan. (Participants : 120)

[C.144] Y. -C. Tseng (Demo/Exhibition Chair) and R.H. Jan (Special Session Chair): Int’l Conf. on Information Technology: Research and Education (ITRE), 2005. (Participants :100)

[C.145] Dharma P. Agrawal, From Cell Phones to Ad hoc/Sensor Networks, NCTU, 2005/3/14 (Participants : 82)

[C.146] Anish Arora, Project ExScal: Extreme Scaling of Wireless Sensor Networks, NCTU, 2005/3/21 (Participants : 77)

[C.147] Y.-C. Tseng, Training Course Wireless ad hoc and sensor networks: technologies and applications, 2005/07/25~2005/07/27(Participants : 84)

[C.148] Next generation wireless networks:Security and Qos quarantee, NCTU, 2005/10/25 (Participants : 63)

[C.149] Program Chair, Int'l Workshop on Wireless Security and Privacy (WiSPr), 2006, Columbus, USA (to be held in conjunction with ICPP 2006).

[C.150] Y.-B. Lin , R.H. Jan , General Chair: Mobile Computing Workshop, 2006, Taiwan. (to be held in 03/2006).

[C.151] Chair: Yi-Bing Lin Co-chair: Whai-En Chen, 2006 Training Course ,14 hours, (Participants : 55)

[C.152] Chair: Yi-Bing Lin Co-chair: Whai-En Chen, Y.-B. Lin , Smartbits Training , 4 hours , (Participants : 55)

[C.153] Chair: Yi-Bing Lin Co-chair: Whai-En Chen, RADVISION Training, 7 hours, (Participants : 55)

[C.154] Y.-B. Lin. Specific Contribution and Keynote Speech on Telecomm. Development towards 4G in Taiwan, 2006 US-Taiwan Telecommunication Technology Conference, Jun.1, 2006.

[C.155] Y.-C. Tseng, Vice Chair, IEEE Int'l Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, 2006, Taiwan.

[C.156] Y.-C. Tseng, Co-Chair, Int'l Computer Symp. (Workshop on Computer Networks and Wireless Communications), 2006, Taipei.

[C.157] Y.-C. Tseng, General Co-Chair, IEEE Asia Pacific Wireless Communications Symp. (APWCS), 2006, Korea.

[C.158] Y.-C. Tseng, Organizing the "Rice-Xilinx WARP Workshop at NCTU", 2006/12/19-20, National Chiao Tung University, Taiwan.

[C.159] Y.-C. Tseng, Int'l Liaison Co-Chair, Int'l Conf. on Parallel Processing, 2007, Xi'An, China.

[C.160] Y.-C. Tseng, Vice Chair, IFIP Int'l Conf. on Embedded and Ubiquitous Computing (EUC), 2007, Taipei.

[C.161] Y.-C. Tseng, General Chair, IEEE Asia Pacific Wireless Communications Symp. (APWCS), 2007, Taiwan.

[C.162] Y.-C. Tseng, Co-Chair, IEEE Int'l Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, 2008, Taiwan.

[C.163] Y.-C. Tseng, Program Chair: Distributed Wireless Sensor Networks Workshop, Chung-Yuan University, Taiwan, 2006.7.6-7.

[C.164] Keynote Speech: "Wireless Sensor Network Research in Taiwan", IEEE VTS Asia Pacific

Wireless Communications Symposium (APWCS), 08/24/2006, Daejeon, Korea.

[C.165] Panel Discussion: “Sensor Networks: Is it for real or just for research?”, in IEEE Int’l Conf. on Sensor Networks, Ubiquitous, and Trustworthy Computing (SUTC), 2006.

[C.166] Keynote Speech: "Location Sensing Techniques and Applications", Workshop on Wireless Ad Hoc and Sensor Network (WASN), 2007/09, Tamkang University. (WASN2007-keynote-TKU-short.ppt)

[C.167] Keynote Speech: "Wireless Sensor Network Techniques and Applications", Information Education and Technological Applications Conference (IETAC), 2007/11.

[C.168] Talk: "Wireless Sensor Network: Techniques and Applications", 大同大學, 2007/11.

[C.169] Invited Talk: "如何做研究", 大學教師學術生涯規劃研習營, NCTU, 2007/12.

5. LIST OF PERSONAL ACHIEVEMENTS OF THE PIS

Yi-Bing Lin

[C.170] K.T. Lee Breakthrough Award, IICM, 2004.

[C.171] Fellow, American Association for the Advancement of Science (AAAS), 2004. Citation:Honored for distinguished contributions to the design and modeling of mobile telecommunications networks and for leadership in personal communications services education.

[C.172] Recognition of Excellence, Ministry of Economic Affairs, ROC.2004. Citation: In recognition of his significant achievement in setting directions for the wireless communication industry of Taiwan.

[C.173] IEE Fellow, 2004

[C.174] Member of Editorial Board, IEEE Transactions on Wireless Communications

[C.175] Member of Editorial Board, IEEE Transactions on Vehicular Technology

[C.176] Member of Editorial Board, ACM/KAP Wireless Networks

[C.177] Editor, IEEE Personal Communications Magazine

[C.178] Senior Technical Editor, IEEE Network

[C.179] Advisory Board, Intl. Journal of Ad Hoc and Ubiquitous Computing

[C.180] Guest Editor IEEE JSAC special issue on Mobile Computing and Networking, 2004

[C.181] Guest Editor IEEE Wireless Communications special issue on Mobility and Radio Resource Management, 2004

[C.182] Guest Editor ACM/Springer Mobile Networks and Applications Special Issue on Broadnets

[C.183] 教育部通訊專題製作競賽 大專組 冠軍 (陳懷恩博士帶領), 2004

[C.184] NICI IPv6 軟體程式競賽 冠軍 (陳懷恩博士帶領), 2004

[C.185] Japan IPv6 Appli-Contest 實作組 冠軍 (陳懷恩博士帶領), 2004

[C.186] NCHC 國網盃軟體設計競賽 團體精神獎 (吳坤熹博士帶領), 2004

[C.187] 教育部通訊專題製作競賽 大專組 冠軍 (陳懷恩博士帶領), 2005

[C.188] Quanta's Outstanding Invention Award, 2005

[C.189] Guest Editor IEEE Wireless Communications special issue on Voice over Wireless Local Area Network, 2005

[C.190] W.Y. Pan Distinguished Research Award, 2005.

[C.191] Teco Award, 2005

[C.192] ISI Highly Cited Scholar (Author Publication Number: A0096-206-L); One of the ten highly cited authors in Taiwan, and among 250 most cited Computer Science researchers worldwide (see http://hcr3.isiknowledge.com).

[C.193] Academic Publication Award of The Sun Yat-Sen Cultural Foundation, 2006.

[C.194] Academic Award of the Ministry of Education, 2006.

[C.195] Best Impact Award, IEEE Taipei Section, 20**06.**

Y.-C. Tseng

[C.196] Y.-C. Tseng, Outstanding Research Award (National Science Council, 國科會傑出研究獎, 2003~2005)

[C.197] Editorial Board, Tamsui Oxford Journal of Mathematical Sciences, 2002-present.

[C.198] Editorial Board Member, 臺南大學南大學報, 2005.8-2006.7.

[C.199] Associate Editor, The Computer Journal, Oxford University Press (2001~present).

[C.200] Editorial Board, Journal of Information Science and Engineering, 08/2002~07/2005.

[C.201] Editorial Board, Int'l Journal of Ad Hoc and Ubiquitous Computing, 2004-present.

[C.202] Editorial Board, Wireless Communications and Mobile Computing, Wiley, 2004-present.

[C.203] Editorial Board, Int'l Journal of Pervasive Computing and Communications, Troubador Pub., 2004-present.

[C.204] Guest Editor, Journal of Information Science and Engineering, Special Issue on "Mobile Computing", May 2004.

[C.205] Associate Editor, Telecommunication Systems, Springer Science Pub. (2005~present).

[C.206] Editorial Board Member, Int'l Journal of Sensor Networks (IJSNet), 2005-present.

[C.207] Associate Editor, IEEE Trans. on Vehicular Technology (2005~present).

[C.208] Editorial Board, Journal of Interconnection Networks (2007~2009).

[C.209] Distinguished Alumnus Award, 2005, The Ohio State University.

[C.210] Elite Information Technology Award, Annual Computer Show Org., Republic of China, 2004. (九十三年資訊月「傑出資訊人才獎」)

[C.211] Outstanding EE Professor Award, The Chinese Institute of Electrical Engineering, 2005 (中國電機工程學會, 傑出電機工程教授獎).

[C.212] Acer Dragon Paper Award, 2005, by Acer Foundation (第十九屆宏碁龍騰知識經濟論文優等獎, 2005).

[C.213] Excellent Paper Award, The 10th Mobile Computing Workshop, 2004 (J.-R. Jiang, Y.-C.

Tseng, and B.-R. Linn, “A Mechanism for Quick Bluetooth Device Discovery”).

[C.214] Annual Best Paper Award, 1st place, Chinese Institute of EE Society, “Event-Driven Messaging Services over Integrated Cellular and Wireless Sensor Networks: Prototyping Experiences of a Visitor System”, with Y. K. Liu, 2004. (九十三年中國電機工程學會，青年論文獎第一名，“整合行動電話網路及無線感測網路之事件驅動訊息系統”，劉衍谷同學)

[C.215] Annual Best Paper Award, 3rd place, Chinese Institute of EE Society, “Decentralized Energy-Conserving and Coverage-Preserving Protocols for Wireless Sensor Networks”, with L.-C. Lo, 2005. (九十四年中國電機工程學會，青年論文獎第三名，“無線感測網路中省電並維持覆蓋程度之分散式協定”，羅立竹同學)

[C.216] Best Paper Award, National Computer Symposium, 2005 (P.-Y. Wu, Y.-C. Tseng, and H. Lee, “Design of QoS and Admission Control for VoIP Traffics over IEEE 802.11e WLANs”)

[C.217] National Communication Contest, 1st place, Ministry of Education, Taiwan, "An Ad Hoc Network-Based Home VoIP System", with L. Li, P. H. Lee, J. Z. Chen, and Q. Wu, 2004. (教育部九十二學年度大專校院通訊科技專題製作競賽，研究所組，優勝獎，吳坤熹，李淩，李沛鴻，陳建志同學)

[C.218] National Communication Contest, 2nd place, Taiwan, 2005, “Indoor Security and Emergency Navigation Services by Wireless Sensor Networks”, awarded by Ministry of Education, with Y. Y. Tsai, C. H. Tsai, M. S. Pan, and C. F. Huang. (教育部九十三年「通訊競賽」研究所組優等獎，蔡岳洋，蔡佳宏，潘孟鉉，黃啓富，題目: 以無線感測器網路實作室內安全監控以及緊急逃生導引系統)

[C.219] Demonstration in Keynote Speech, Intel Development Forum, Fall 2005, Taiwan: The iMouse System (intelligent mobile surveillance system by wireless sensor networks).

[C.220] 國立交通大學 「第 14 屆思源創意競賽」金竹獎，指導教授, 2005 (獲獎學生:游敦皓，吳秉禎，林慧榛，呂依璇，題目:墓仔埔也敢去－異質位置感知導覽系統及其應用平台，Heterogeneous Location-Aware Guide System and Service Platform).

[C.221] 國立交通大學 「第 14 屆思源創意競賽」銀竹獎，指導教授, 2005 (獲獎學生:范日中，顏宗信，林素貞，題目: 哺(ㄅㄨ)哺(ㄅㄨ)加上小蜘蛛—無線攝影車與室內無線感測網路之應用, The Application of Wireless Controlling Car and Sensor Network).

[C.222] 中華民國電腦學會優良論文獎佳作，“IEEE 802.11e 無線網路中 VoIP 傳輸品質保證與允入”，吳佩曄，曾煜棋，李弘威 (2005).

[C.223] 獲教育部評定優良教科書，“無線區域及個人網路--隨意及感測網路之技術與應用”，曾煜棋，潘孟鉉，林致宇 (2006).

[C.224] 中華民國資訊學會碩博士最佳論文獎佳作，"藉由無線感測器網路建立一室內 3D 環境下的緊急導引系統"，蔡佳宏，曾煜棋 (2006).

[C.225] 智慧化居住空間情境模擬創作競賽，第三名，"以無線感測網路爲基礎之智慧型室內燈光調節系統"，葉倫武、潘孟鉉、林育萱、廖家良、曾煜棋 (2007)

[C.226] Associate Editor, Telecommunication Systems, Springer Science Pub. (2005~present).

[C.227] Guest Editor, Int'l Journal of Pervasive Computing and Communications, Special Issue on "Key Technologies and Applications of Wireless Sensor and Body-area Networks".

[C.228] Editorial Board Member, Int'l Journal of Sensor Networks (IJSNet), 2005-present. Website: http://www.inderscience.com/ijsnet

[C.229] Associate Editor, IEEE Trans. on Vehicular Technology (2005~present).

[C.230] Guest Editor, Signal Processing (Elsevier pub.), Special Issue on Information Processing and Data Management in Wireless Sensor Networks, expected 2006.

[C.231] Editorial Board, Int'l Journal of Vehicular Technology (2006~present).

[C.232] Associate Editor, IEEE Trans. on Mobile Computing (2006~present).

[C.233] 獲教育部評定優良教科書, "無線區域及個人網路--隨意及感測網路之技術與應用", 曾煜棋, 潘孟鉉, 林致宇 (2006).

Rong-Hong Jan

[C.234] Guest Editor, International Journal of Ad Hoc and Ubiquitous Computing (IJAHUC) ,Special Issue on "Pervasive Computing through Networked Sensing Devices", 2005.

[C.235] TPC member: The Eighth IASTED International Conference on Wireless and Optical Communications, 2008, Quebec City, Quebec, Canada, May 26-28, 2008

[C.236] TPC member:International Wireless Communications and Mobile Computing Conference (IWCMC2006), Sheraton Wall Centre, Vancouver, Canada, July 3-6, 2006

[C.237] TPC member:The 2006 IFIP International Conference on Embedded and Ubiquitous Computing (EUC'2006), Seoul, Korea, August 1-4, 2006

[C.238] TPC member:The sixth IASTED International Conference on Wireless and Optical Communications, Banff, Canada, 2006

[C.239] Best Paper Award in *he 2nd Workshop on Wireless, Ad Hoc, and Sensor Networks(WASN)*, National Central University, Taiwan.

[C.240] Best Paper Award in the *10th Mobile Computing Workshop*, Taichung, Taiwan, 2004 Mar., pp. 259-266.

6. LIST OF TECHNOLOGY TRANSFERS

7. LIST OF TECHNOLOGY SERVICES

Journal

IEEE Transactions on Wireless Communications

IEEE Journal on Selected Areas in Communications

IEEE Transactions on Vehicular Technology

IEEE Communications Letters
ACM Mobile Network and Applications
ACM Wireless Network
IEEE Communications Letters
IEEE Trans. on Mobile Computing
Ad Hoc Networks, Elsevier
ACM Mobile Networks and Applications

Conference

IEEE Int'l Conf. on Communications (ICC)
IEEE Vehicular Technology Conference
IEEE INFOCOM
ACM MOBICOM

VIII. APPENDIX III: LIST OF PUBLICATIONS IN "TOP" JOURNALS AND CONFERENCES

[C.241] Y.-B. Lin, Per-user Checkpointing for Mobility Database Failure Restoration. IEEE Transactions on Mobile Computing, 4(2): 189-194, 2005.

[C.242] H.-N. Hung, Y.-B. Lin, M. -K. Lu, and, N. -F. Peng. A Statistic Approach for Deriving the Short Message Transmission Delay Distributions. IEEE Transactions on Wireless Communications.,3(6): 2345-2352, 2004.

[C.243] Y.-B. Lin, M.-F. Chang, M.-T. Hsu,, and L.-Y. Wu, One-Pass GPRS and IMS Authentication Procedure for UMTS. IEEE Journal on Selected Areas in Communications, 23(6): 1233-1239, 2005.

[C.244] P. Lin, Y. -B. Lin, and Chlamtac, I. Module Count-Based Overflow Control Scheme for UMTS High Speed Downlink Packet Access. IEEE Transactions on Vehicular Technology,53(2): 2004.

[C.245] P. Lin, Y. -B. Lin,, and Chlamtac, I. Overflow Control for UMTS High-Speed Downlink Packet Access. IEEE Trans. on Wireless Communications,3(2): 524-533, 2004.

[C.246] L.-W. Chen, Y.-C. Tseng, Y.-C. Wang, D.-W. Wang, and J.-J. Wu, "Exploiting Spectral Reuse in Routing, Resource Allocation, and Scheduling for IEEE 802.16 Mesh Networks", IEEE Trans. on Vehicular Technology, to appear. (SCI, EI)

[C.247] S.-I. Sou, and Y.-B. Lin, Broadcast Approach for UMTS Mobility Database Recovery. Accepted and to appear in *IEEE Transactions on Mobile Computing.*

[C.248] Y.-B. Lin, M.-H. Tsai. Caching in I-CSCF of UMTS IP Multimedia Subsystem. *IEEE Transactions on Wireless Communications*, 5(1), 186-192, 2006.

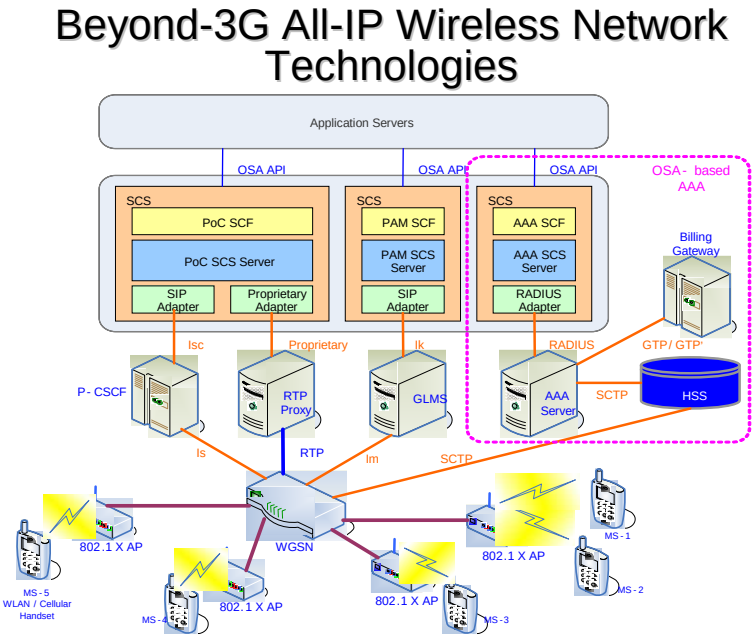
[C.249] S.-R. Ye and Y.-C. Tseng. A Multi-Chain Backoff Mechanism for IEEE 802.11 WLANs. Appear in *IEEE Trans. on Vehicular Technology*. (SCI, EI)

[C.250] A.-A.-K. Jeng, and R.-H. Jan. The r-neighborhood graph: an adjustable structure for topology control in wireless ad hoc networks. Accepted and to appear in *IEEE Transactions on Parallel and Distributed Systems*, 2006.

[C.251] M.-F. Chang, L.-Y. Wu, and Y.-B. Lin. Performance Evaluation of a Push Mechanism for WLAN and Mobile Network Integration. *IEEE Trans. on Vehicular Technology*, 55, 380-383. 2006.

IX. APPENDIX IV: SLIDES ON SCIENCE AND TECHNOLOGY BREAKTHROUGHS

(TWO SLIDES FOR EACH BREAKTHROUGH)



The first advanced OSA platform in the University

- One-pass WGSN and WCSCF Authentication
- Location Sensing: GPS-Less low-cost Positioning
- Thin AP Architecture for WLAN
- Power Saving for WLAN
- Load Balance:802.11 Access Points and Clients
- Seamless Handoff Technologies for WLANs

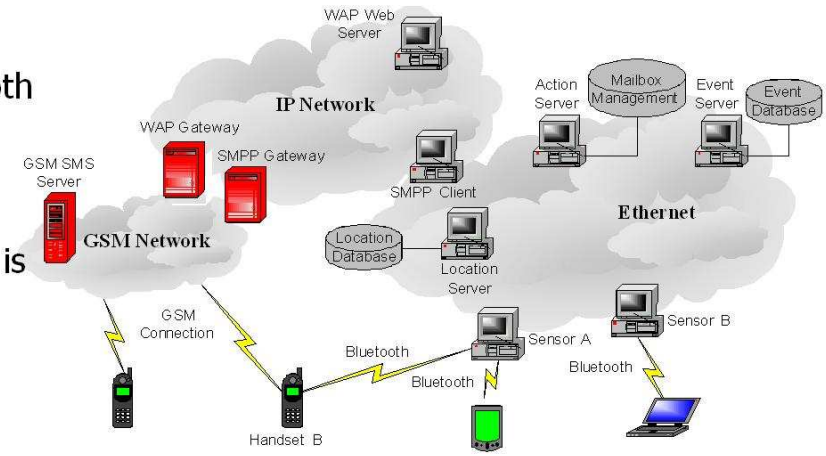
Published 33 first-class journal papers

Received awards from major contests

Received AAAS Fellow and IEE Fellow

Event-Driven Messaging Services over Integrated Cellular and Bluetooth Networks

- an event-driven messaging service over an integrated cellular-and-Bluetooth network.
- A new analytical methodology for multi-piconet Bluetooth networks is presented.
- This work has been published in IEEE JSAC.



A Multi-Chain Backoff Mechanism for IEEE 802.11 WLANs

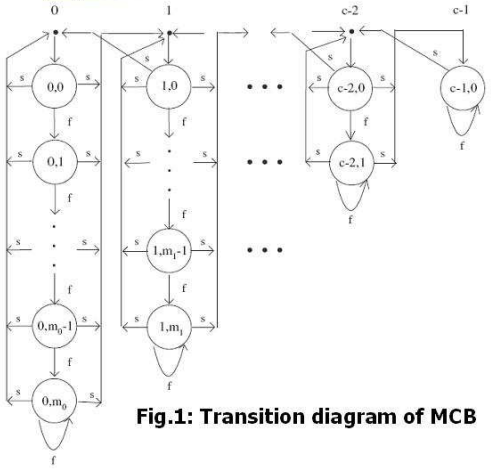


Fig.1: Transition diagram of MCB

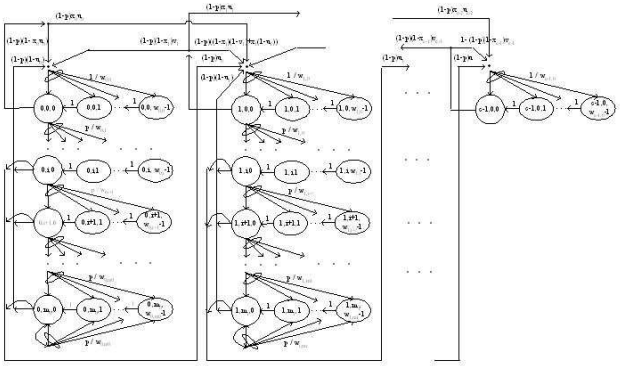
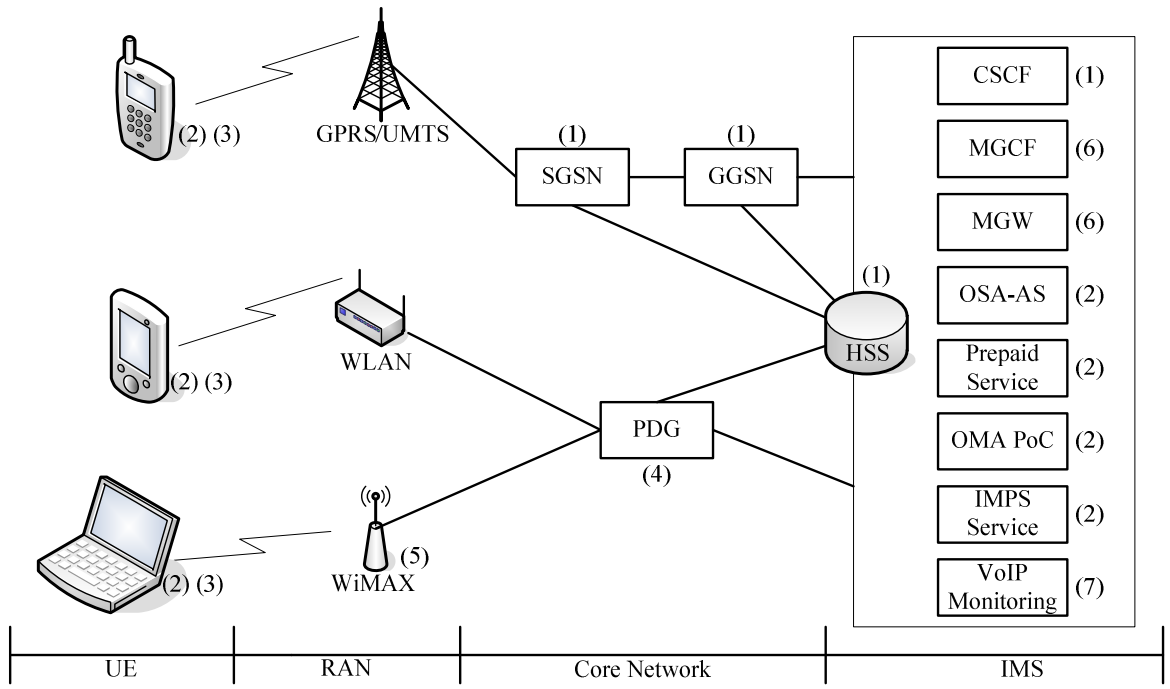


Fig.2: Analysis of saturation throughput

- A new IEEE 802.11 access control MAC protocol called Multi-Chain Backoff has been proposed.
- This work has been published in IEEE TVT.

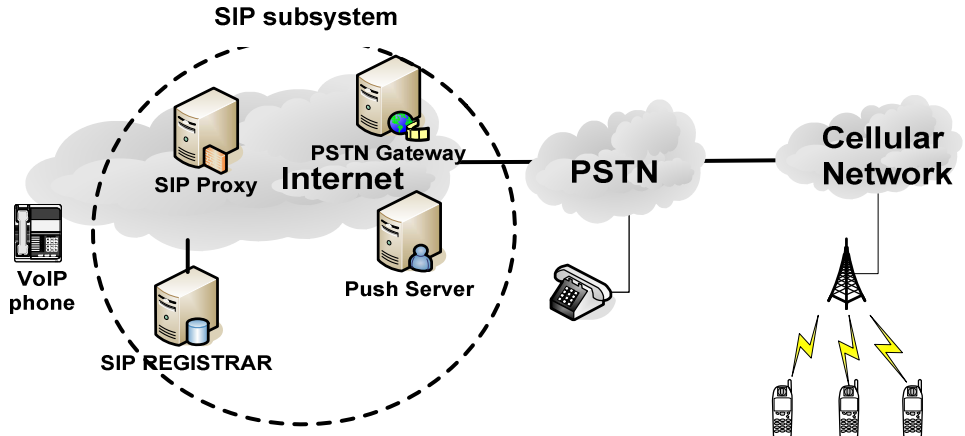
B3G Core Network Technology



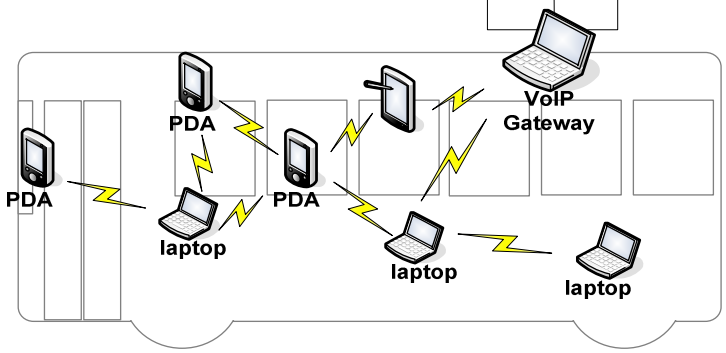
B3G Core Network Technology

(1) One Pass Authentication
(2) SIP-IMS Applications
(3) IMS P2P Multimedia Communication
(4) WiMAX/WLAN/UMTS Roaming and Mobility Management
(5) WiMAX Radio Resource Management
(6) IMS Voice Quality Test
(7) IMS VoIP Monitoring

A Push-Based VoIP Services for an Internet Enabled MANET

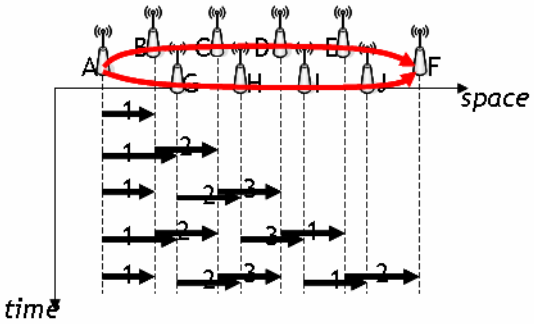


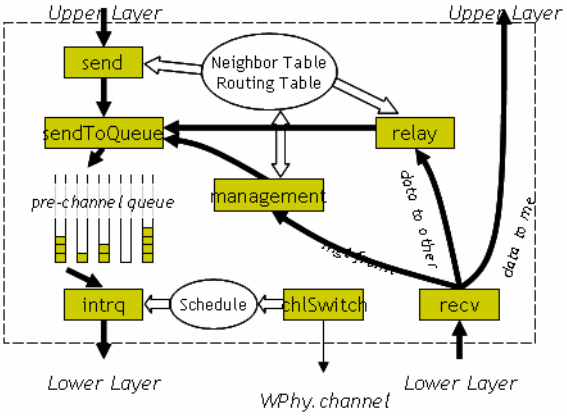
- An architecture to support VoIP Services over MANET
- A push mechanism to allow VoIP gateway stay offline
- Support multi-types of wireless interfaces



Joint Multi-Channel Link Layer and Multi-Path Routing Design for Wireless Mesh Networks

- Combine { Multi-path routing; Dynamic channel switching link layer; Multi-channel single-radio }
- More suitable for wireless mesh networks
  - Higher end-to-end throughput
  - Fault tolerance
  - Load balance





X. APPENDIX V: FINAL SELF-ASSESSMENT

PROGRAM TITLE: Sub-project 3 : Beyond-3G All-IP Wireless Network Technologies

	ASSESSMENT SUBJECT	SCORE (1~5, LOW TO HIGH)
PROGRAM'S CONTENTS & PERFORMANCE	Importance & Innovation of the Program's Major Tasks	5
	Clarity and Presentation of the Report	5
	Viability of the Program's Approaches & Methodologies	5
	Principal Investigator's Competence for Leading the Program	5
	Interface & Integration between Overall & Sub-Project(s)	4
	Interface & Integration among All Sub-Projects	5
	Manpower & Expenditures	4
PROGRAM'S RESULTS	Contribution in Enhancing the Institute's International Academic Standing	5
	Impact on Advancing Teaching or on Technology Development	5
Total Score		43

REVIEWER'S COMMENTS & SUGGESTION:

- 期刊論文和專利有相當豐碩的成果
- 在 IMS Core Network 提出 one pass auth. technology
- 整合 VoIP, prepaid 及 WiMAX 等. 皆有不錯的成果
- P30/31 雛型系統績效成果豐富
- 可多將成果移轉給 Service Operators 業者.
- 可與 ITRI MTWAL 實驗環境結合和運用成果.

Program Reviewer's Signature: 簡智傑

X. APPENDIX V: FINAL SELF-ASSESSMENT

PROGRAM TITLE: Sub-project 3 : Beyond-3G All-IP Wireless Network Technologies

	ASSESSMENT SUBJECT	SCORE (1~5, LOW TO HIGH)
PROGRAM'S CONTENTS & PERFORMANCE	Importance & Innovation of the Program's Major Tasks	5
	Clarity and Presentation of the Report	5
	Viability of the Program's Approaches & Methodologies	4.5
	Principal Investigator's Competence for Leading the Program	5
	Interface & Integration between Overall & Sub-Project(s)	5
	Interface & Integration among All Sub-Projects	5
	Manpower & Expenditures	5
PROGRAM'S RESULTS	Contribution in Enhancing the Institute's International Academic Standing	5
	Impact on Advancing Teaching or on Technology Development	4.5
Total Score		44

REVIEWER'S COMMENTS & SUGGESTION:

This sub-field is very well-organized with excellent research outcome. It not only ~~pro~~ provides comprehensive study on almost all aspects of wireless networking technologies, but seems to reach out on the optical domain as well. There are 8 journal papers and many patent applications with quite a few granted, a really great accomplishment.

A great job!

Program Reviewer's Signature: _____

X. APPENDIX V: FINAL SELF-ASSESSMENT

PROGRAM TITLE: Sub-project 3 : Beyond-3G All-IP Wireless Network Technologies

	ASSESSMENT SUBJECT	SCORE (1~5, LOW TO HIGH)
PROGRAM'S CONTENTS & PERFORMANCE	Importance & Innovation of the Program's Major Tasks	4.5
	Clarity and Presentation of the Report	5
	Viability of the Program's Approaches & Methodologies	4.5
	Principal Investigator's Competence for Leading the Program	5
	Interface & Integration between Overall & Sub-Project(s)	4
	Interface & Integration among All Sub-Projects	4
	Manpower & Expenditures	5
PROGRAM'S RESULTS	Contribution in Enhancing the Institute's International Academic Standing	4
	Impact on Advancing Teaching or on Technology Development	5
Total Score		

REVIEWER'S COMMENTS & SUGGESTION:

1、學術論文量與質均佳.

2、學生之PI得獎甚多.

3. subproject 間可再加強整合

4. 有大規模的 trial, 實為可喜

Program Reviewer's Signature: ____________