Program for Promoting Academic Excellence of Universities (Phase II)

Annual Report

下一世代資訊通訊網路尖端技術與應用（二）

Advanced Technologies and Applications for Next Generation Information Networks (II)

NSC-93-2752-E-001-004-PAE

Overall Duration: April 2004 - March 2008
Annual Duration: April 2004 - March 2005

National Tsing Hua University
National Chiao Tung University
2004.02.28

II. (FORM1) BASIC INFORMATION OF THE PROGRAM

Program Title: **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)					
Serial No.: NSC-93-2752-E-001-004-PAE			Affiliation		National Tsing Hua University National Chiao Tung University
Principal Investigator	Name	Wen-Tsuen Chen 陳文村	Program Coordinator	Name	Chung-Ta King 金仲達
	Tel:	(03)573-1064		Tel:	(03)574-2804
	Fax:	(03)573-4554		Fax:	(03)572-3694
	E-mail	wtchen@cs.nthu.edu.tw		E-mail	king@cs.nthu.edu.tw

	Expenditures[1] (in NT$1,000)		Manpower[2]	
	Anticipation	Reality	Anticipation	Reality
FY93	46,433,447	*39,632,913	2,257	2,238
FY94	49,696,156	-	2,357	-
FY95	49,744,426	-	2,333	-
FY96	51,278,263	-	2,369	-
Overall	197,152,292	*39,632,913	9,316	2,238

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 楊啟瑞	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, NCTU
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 make a note if there is a big difference between anticipation and reality.

*The number accumulated till the end of January 2005.

Principal Investigator's Signature: _____

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

Serial No.: 93-2752-E-007-001-PAE	Program Title: 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）

Research Item (Include sub projects)	Major tasks and objectives	Expenditures (in NT$1,000)					Manpower (person-month)					Matching Supports from the 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	
Main Project	Coordination and project management	2,094.166	0.000	607.652	280.000	2,981.818	24	-	-	36	60	-
Sub-Project 1 ： High Speed Networking Technologies	1. High Speed Networking Technologies 2. High-Speed security switch and content inspection technologies	3,482.068	700.000	638.880	2,679.652	7,500.600	108	-	264	12	384	3,600(in NT$1000)
Sub-Project 2：Optical Networking and QoS Technologies	1. Design/Exploration of Optical Coarse Packet Switching (OCPS) technology; 2. Design/Construction of a WDM OCPS-based experimental network, OPSINET-II, and its 10G optical switch; 3. Optimization of routing and wavelength assignment for OPSINET-II; 4. Network and application QoS;	4,158.186	440.000	1,311.466	2,168.545	8,078.197	60	12	168	12	252	2,930(in NT$1000)
Sub-Project 3：Beyond-3G All-IP Wireless Network Technologies	1. System design of B3G core networks 2. Broadband wireless access 3. Applications and services in B3G networks	3,980.000	300.000	800.000	1,752.000	6,832.000	48	-	212	8	268	1,580(in NT$1000)
Sub-Project 4：Wireless Ad Hoc and Sensor Networking Technologies	1. Ad Hot Network 2. Sensor Network 3. Applications and Sensors of Ad Hot and Sensor Network	3,246.172	600.000	1,142.000	1,217.142	6,205.314	96	12	360		468	3,500(in NT$1000)
Sub-Project 5：Network Security	1. Active Information Hiding Techniques 2. Security Knowledge Warehousing Technology	2,893.000	450.000	800.000	410.000	4,553.000	72	-	238	27	337	-

	3. Advanced Research on Pluggable Secure Framework for Middleware 4. High Performance P2P Security Techniques											
Sub-Project 6：Techniques and Applications of Overlay Networks	1. Overlay network technique Streaming data management techniques 2. Streaming data management techniques	4,590.736	846.000	600.639	208.000	6,245.375	96	-	285	16	397	-
SUM		24,444.328	3,336.000	5,900.637	8,715.339	42,396.304	504	24	1,527	111	2,166	4,510

IV. (Form 3) Statistics on Research Outcome of this Program

The summarized statistics of all sub-projects

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	86	7	79	48	**	
	Conference	89	14	75	30		
	Technology Reports	10	10				
Patents	Pending	24	14	10	3		
	Granted	6	4	2	2		
Copyrighted Inventions	Item	1					
Workshop/Conference[3]	Item	22	20	2			
	Participants	2299	1949	350			
Training Course (Workshop/Conference)	Hour	42	42				
	Participants	485	485				
Personal Achievements	Honor/ Awards[4]	25	22	3			
	Keynotes Given by PIs)	22	19	3			
	Journal Editors	24	6	18			
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item	2	2				
Technological Services[6]	Item	1	1		-	-	-
	Service Fee				-	-	-

** Most listed papers were just accepted, and it is not reasonable to give the citations.

Sub- project 1：High Speed Networking Technologies

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	6	2	4	5	**	
	Conference	7	2	5	3		
	Technology Reports						
Patents	Pending						
	Granted						
Copyrighted Inventions	Item						
Workshop/Conference[3]	Item	5	5				
	Participants	270	270				
Training Course （Workshop/Conference）	Hour						
	Participants						
Personal Achievements	Honor/ Awards[4]	4	3	1			
	Keynotes Given by PIs)	3	3				
	Journal Editors	1		1			
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item						
Technological Services[6]	Item				-	-	-
	Service Fee				-	-	-

Sub-project 2：Optical Networking and QoS Technologies

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	7		7	5		
	Conference	7		7	6		
	Technology Reports						
Patents	Pending	8	4	4	-		
	Granted	1	0	1	-		
Copyrighted Inventions	Item						
Workshop/Conference[3]	Item	6	6				
	Participants	490	490				
Training Course (Workshop/Conference)	Hour						
	Participants						
Personal Achievements	Honor/ Awards[4]	2	2				
	Keynotes Given by PIs)	4	2	2			
	Journal Editors						
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item						
Technological Services[6]	Item				-	-	-
	Service Fee				-	-	-

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

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	24		24	16	**	
	Conference	1		1	0		
	Technology Reports	0		0			
Patents	Pending	2	2		2		
	Granted	2	2		2		
Copyrighted Inventions	Item						
Workshop/Conference[3]	Item	2	1	1			
	Participants	300	*	300			
Training Course (Workshop/Conference)	Hour	30	30				
	Participants	100	100				
Personal Achievements	Honor/ Awards[4]	2	1	1			
	Keynotes Given by PIs)						
	Journal Editors	6		6			
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item	2	2				
Technological Services[6]	Item				-	-	-
	Service Fee				-	-	-

***To be held on Mar.31, 2005.**

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	27	4	23	15		
	Conference	36	5	31	11		
	Technology Reports						
Patents	Pending	7	5	2	-		
	Granted	1	0	1	-		
Copyrighted Inventions	Item	0		0			
Workshop/Conference[3]	Item	3	3				
	Participants	800	800				
Training Course (Workshop/Conference)	Hour						
	Participants						
Personal Achievements	Honor/ Awards[4]	11	11	0			
	Keynotes Given by PIs)						
	Journal Editors	12	4	8			
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item						
Technological Services[6]	Item				-	-	-
	Service Fee				-	-	-

Sub- project 5：Network Security

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	13	0	13	3		
	Conference	15	4	11			
	Technology Reports	10	10				
Patents	Pending						
	Granted	1	1				
Copyrighted Inventions	Item	1					
Workshop/Conference[3]	Item	2	2				
	Participants	59	59				
Training Course （Workshop/Conference）	Hour	2	2				
	Participants	185	185				
Personal Achievements	Honor/ Awards[4]	4	4				
	Keynotes Given by PIs)	14	14				
	Journal Editors	3	1	2			
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item						
Technological Services[6]	Item	1	1			-	-
	Service Fee					-	-

Sub-project 6: Techniques and Applications of Overlay Networks

Listing		Total	Domestic	International	Significant[1]	Cited[2]	Technology Transfer
Published Articles	Journal	9	1	8	4	**	
	Conference	23	3	20	10		
	Technology Reports	0	0	0	0		
Patents	Pending	7	3	4	1		
	Granted	1	1	0	0		
Copyrighted Inventions	Item	0	0	0	0		
Workshop/Conference[3]	Item	4	3	1	0		
	Participants	380	330	50	0		
Training Course (Workshop/Conference)	Hour	10	10				
	Participants	200	200				
Personal Achievements	Honor/ Awards[4]	2	1	1			
	Keynotes Given by PIs)	1	0	1			
	Journal Editors	2	1	1			
Technology Transfer	Item						
	Licensing Fee						
	Royalty						
Industry Standards[5]	Item						
Technological Services[6]	Item				-	-	-
	Service Fee				-	-	-

[1] The criterion of "significant" is defined by the PIs of the program. For example, it may refer to Top journals (those with impact factors in the upper 15%) in the area of research, or conference that are very selective in accepting submitted papers, say at an acceptance rate no greater than 30%. Please specify the criteria in Form4, "Executive Summary on Research Outcome", and list all the "TOP" journals or conferences in Appendix III.
[2] The criteria of "citations" refer to the publications that are cited by other research teams, i.e., exclude self-citations.
[3] Refers to the workshop and conferences hosted by the program.
[4] Includes Laureates of Nobel Prize, Member of Academia Sinica or equivalent, fellow of major international academic societies, etc.
[5] Industry standards approved by national or international standardization parties that are proposed by PIs of the program
[6] Using research outcome of the program to provide technological services, including research and educational programs, to other ministries of the government or professional societies

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

(Please state the followings concisely and clearly)

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

The ever-growing demand for Internet bandwidth and recent advances in optical and wireless technologies bring about fundamental changes in the design and implementation of the next generation broadband Internet. Moreover, as broadband Internet is expected to support a multitude of data and real-time and high-mobility traffic, it needs diverse Quality-of-Service (QoS) guarantees and value-added services. This project aims at the exploration of advanced technologies and applications for high speed, high bandwidth, wired/wireless, secured, and integrated networks. In the PPAEU-I project, sponsored by the Ministry of Education we have gathered distinguished researchers from National Tsing Hua University (NTHU) and National Chiao Tung University (NCTU) and made significant achievements along the aforementioned directions. This PPAEU-II project is built on top of the PPAEU-I achievements. It consists of six sub-projects aiming at three major themes: electronic-switching and optical-switching backbone networks, wireless core and access networks, and network security/overlay networks. The six sub-projects are further detailed below.

Sub- project 1：High Speed Networking Technologies

The fundamental problem of backbone networks is that the speed of electrons is much slower than the speed of light. The challenge is then to build switches that scale with the transmission speed of fiber optics. There are two possible approaches for this problem: the electronic approach and the optical approach. The electronic approach is to use parallel electronic devices to acquire the needed speedup for fiber optics. On the other hand, the optical approach is to explore the possibility of building intelligent logic control directly with optical devices. For both approaches, we have been making significant impacts in this research field. In PPAEU-I, the innovative switch architecture proposed by Prof. C. S. Chang and his colleagues is adapted by a research team at the Stanford University to design a 100 terabits/sec optical router. Prof. N. F. Huang and his colleagues have developed a 16 Gbps Gigabit Ethernet Service Switch (GESS). The next step is to design Scaleable high availability and load balancing security switch for wired/wireless Ipv4/Ipv6 networks. Some novel and fast layer-7 content inspection algorithms for multiple gigabit networks are also designed and implemented. These new approaches can be easily implemented in the FPGA system to provide hardware solution and furnish much better performance on the speed of string matching (content inspection) than those of famous published articles. By continuing our research in this field, we can maintain our position as leaders in the international competition in terms of academic excellence.

Sub-project 2：Optical Networking and QoS Technologies

The major goal of this subproject is to explore and realize the key optical networking and Internet QoS technologies. In the area of optical networking, we continue exploring the Optical Coarse

Packet Switching (OCPS) paradigm. The OCPS paradigm supports per-burst rather than per-packet switching by advocating the enforcement of traffic control and traffic engineering to achieve wavelength-based statistical multiplexing gain and QoS. Major research works include: QoS burstification control, traffic scheduling/shaping and admission control, architectural design and performance analysis of all-optical core switches with fiber delay lines and full/partial wavelength sharing, preventive contention control and reactive wavelength contention resolution, and optical tunnel management and resource optimization. Significantly, we design and construct the 10G WDM OCPS-based IP-over-WDM experimental network, called OPSINET-II, including its 10G/wavelength optical core switch, to realize the above technologies. In the area of Internet QoS, we focus on network and application QoS to achieve fairness and differentiation from the perspectives of layer four and above. The track on network QoS aims to provide fairness by embedding congestion control mechanisms at the source and destination hosts, i.e. at the end-to-end level; at the ingress and egress routers, i.e. at the edge sides; or inside the core routers, i.e. at the core network. Based on the underlying fair network QoS, the track on application QoS targets to provide differentiated QoS at the application layer, by putting (1) consumer-side gateways (for SOHOs and enterprises who are mostly information consumers), (2) ISP-side gateways (at the edge of an ISP), and (3) provider-side gateways (for ICPs who are mostly information providers).

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

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. 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 the objective of Sub-project 3 is to build B3G all-IP core and access networks, including HSS, CSCF and OSA, and to invent advanced location determination and energy conservation technologies.

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

Sub-project 4 focuses on the areas of wireless ad hoc and sensor networking. We have developed key technologies for mobile ad hoc networks, such as routing, load balancing, topology control, power-saving protocols, QoS, integration with cellular networks, and P2P computing and communications. Key issues for sensor networks that have been addressed included sensor coverage and connectivity, location tracking, object tracking algorithms, security, and communication protocols. We then integrated these on a network platform that includes WLAN/GPRS/Bluetooth. In particular, we demonstrate how a Bluetooth sensor network can be used in an office environment to facilitate daily business.

Sub-projects 3 and 4 together address critical research issues in access networks, B3G core networks, and ad hoc and sensor networks. Team members in these two sub-projects have collaborated closely. The NCTU team focuses more on core networks and radio access networks, while the NTHU team focuses more on the mobile ad hoc and sensor networks. We will build a common integrated platform consisting of Wireless GPRS Support Node (WGSN), an all-IP core network, and ad hoc and sensor networks. On top of these, context- and location-based services are being developed by the NCTU team, and VoIP applications are being developed by both NTHU and NCTU teams.

Sub-project 5：Network Security

This sub-project intends to investigate key issues related to network security, which could be viewed in various aspects. Since now-a-days most software systems are exposing to the Internet, these systems may be attacked by hostile users or affected by various virus, worms or Trojan programs. To protect software systems in the private sectors, we need mechanisms that act as guard of the private software systems. These mechanisms can be viewed in four levels: network level, system level, application level and content level. At the network level, we try to block out the incoming data packets which may be harmful. Since the P2P traffic occupies almost 90% of the Internet traffic flow, and a large portion of these flows may be harmful, thus we try to investigate efficient techniques which can accommodate the P2P traffic. However, it is very difficult to detect and to block out harmful traffic completely, so there may be some of them still break into the private network domain and thus into the proprietary computer systems, therefore we need a system level security, which is to protect the computer software system from being affected even the harmful data intrude into the system. To enable the easy deployment of system software, we would like to develop a plug and play secured middleware framework. Further, to deal with the harmful data, we need to build a knowledge warehouse that keeps all possible information regarding the security knowledge. By comparing with the information in the warehouse, we should be able to judge whether the received data is safe or not. If unfortunately the system has been broken through and the private information has been accessed, we still can prevent the important information from been read, that is, the information can not be displayed meaningfully to human beings so that the intruder is unable to understand the content of the stolen information. These tasks are categorized into four research topics which will be studied in this subproject.

Sub-project 6: Techniques and Applications of Overlay Networks

The objective of this subproject is to develop key technologies for using overlay networks to support large-scale, open, and autonomous streaming data processing. Potential applications include data grids for long-term ecological research, security surveillance, and virtual music channel. These applications often involve a large variety of streaming data coming from distinct data warehouses, pervasively deployed sensors, mobile objects, etc. that are individually managed with very diverse

characteristics and dynamic behavior. Techniques of overlay networks can be applied at various layers, e.g. resource aggregation, streaming data collection and delivery, data storage and processing, and metadata inquiry and retrieval. In this sub-project, we develop key overlay technologies to support continuous data streams, including overlay formation and structuring, streaming data placement, content delivery, and environment adaptation. On top of the overlays, we build up the basic components for managing continuous data streams, including querying and mining continuous data streams and developing important streaming applications.

2. Breakthrough and Major Achievements

Sub- project 1：High Speed Networking Technologies

- A 30Gbps Time Division Multiplexing (TDM) Switch with 8B/10B CODEC IP for Ultra High Speed Switch Fabric Applications

More than three-fifth of the funding for this subproject is directed to the design and implementation of a 30Gbps Time Division Multiplexing (TDM) Switch with 8B/10B CODEC. Faculty members for this include Prof. Cheng-Shang Chang (張正尚), Prof. Yarsun Hsu (許雅三), Prof. Duan-Shin Lee (李端興), Prof. Ching-Te Chiu (邱瀞德). Prof. Jenming Wu (吳仁銘), Prof. Kai-Ming Feng (馮開明), and Prof. Shuo-Hung (Shawn) Hsu (徐碩鴻). It also involves 15 graduate students. The whole design group consists of several design teams: analog team, digital team, IO cell team, CODEC team, testing team, FPGA team and theoretical team. The symmetric TDM switch is a very simple and scalable switch architecture (proposed by Prof. C. S. Chang and D. S. Lee) that can be used for recursive construction of switches with much higher speed. Prof. C. T. Chiu and Prof. J. M. Wu coordinated the weekly project meetings, solving all the technical problems encountered in the chip design (with the help from Prof. Y. S. Hsu, Prof. K. M. Feng and Prof. S. H. Hsu). In the first phase of this design project, a single TDM switch chip is designed to have 8 inputs/outputs. The current chip design consists of 50 pins with the chip size 1531.45um x1535.05um.

The gate count is 44553 and the power assumption is roughly 222mW. It is designed to run at the internal speed of 210Mhz with the overall capacity of 33Gbps. Our chip was ranked on the top of the list by CIC among all the submissions in the same phase and it has been taped out by CIC for UMC 0.18 fabrication. It is expected that the first batch of chips will be back to the lab by April 2005 for testing. If successful, the next design step is to recursively construct the 8x8 chips into a single 64x64 chip with a much higher speed (>260Gbps).

- Complexity of queues

Queues are infinite dimensional switches in time. As queues can be easily implemented by electronic memory, people are not concerned about how queues are built in electronic switches. However, in the domain of optical switching, it is very difficult (and expensive) to build optical memory. Building queues with minimum complexity becomes an important research topic. In a

recent research paper in IEEE Transaction on Information Theory (Dec. 2004), Prof. C. S. Chang, Prof. D. S. Lee, and Mr. C. K. Tu (a former M.S. students of ours) developed mathematical theory for recursive construction of First In First Out (FIFO) optical multiplexers by the combination of crossbar Switches and fiber Delay Lines (SDL). It is shown that by cascading multi-stage SDL units, 2-to-1 FIFO multiplexers with buffer B can be constructed by using only 1+log2(B+1) 2x2 switches. Moreover, self-routing paths through the 2x2 switches can be determined upon packet arrivals by keeping track of the virtual waiting time of the multiplexer. This work results in a regular journal paper in IEEE Transactions on Information Theory, 2004. Our recent work further shows that a single input/single output FIFO queue can also be constructed recursively by a three-stage expansion as in the classical Clos networks.

- High Speed Scalable Security Switch

Current layer 2 switches are cheap but without the supporting of security functions, and it is not practical to redesign a Layer-7 security switch due to cost consideration. Professor Nen-Fu Huang proposed a flexible architecture for network security switch so that the traffic between switching ports is inspected and protected in a cost effective way. In this architecture, a gigabit security engine with layer-7 packet inspection capability is designed to accompany with traditional managed L2 switches. The architecture is scalable to provide high-speed network environment with load balancing and high availability (HA) features. The proposed architecture is also suitable for the wired or wireless networks (such as infrastructured ad hoc networks). For the security engine, efficient packet content inspection algorithms are proposed to provide very fast multiple-string matching. A prototyping for this system has been implemented to demonstrate the concept of scalable security switch. The research result has been submitted for publication.

Sub-project 2：Optical Networking and QoS Technologies

- Optical Networking

In the area of optical networking, we have finished the network/system design and subsystem construction of the OPSINET-II. The major subtasks achieved are delineated in our first figure in the appendix. OPSINET-II supports 10 Gb/s per each wavelength, and facilitates with three newly-designed key sub-systems: (i) optical 10G core switch with FDL-based buffers, partial wavelength sharing, and FPGA-based header processing and header/payload synchronization, as depicted in the second figure; (ii) multi-level ASK-based header/payload multiplexing and label swapping; and (iii) routing and wavelength assignment optimizer for OPSINET-II with multi-granularity switching capabilities.

The major achievements and breakthroughs are five-folds. First, as shown in our second figure in the appendix, the switch employs the partial wavelength sharing technique in combination of FDL-based optical buffers implemented by AWGs, resulting in high optical switch scalability and superlatively low packet loss probability, compared to prevailing existing optical switches. Second, the optical switch exploits two different sets of wavelength converters (WCs) at the front and back ends, most significantly, based on two different WC techniques, respectively. Consequently, such design allows low-priority packets to be preempted by newly arriving high-priority packets. Third, the switch supports dynamic QoS differentiation via threshold-based wavelength allocation with

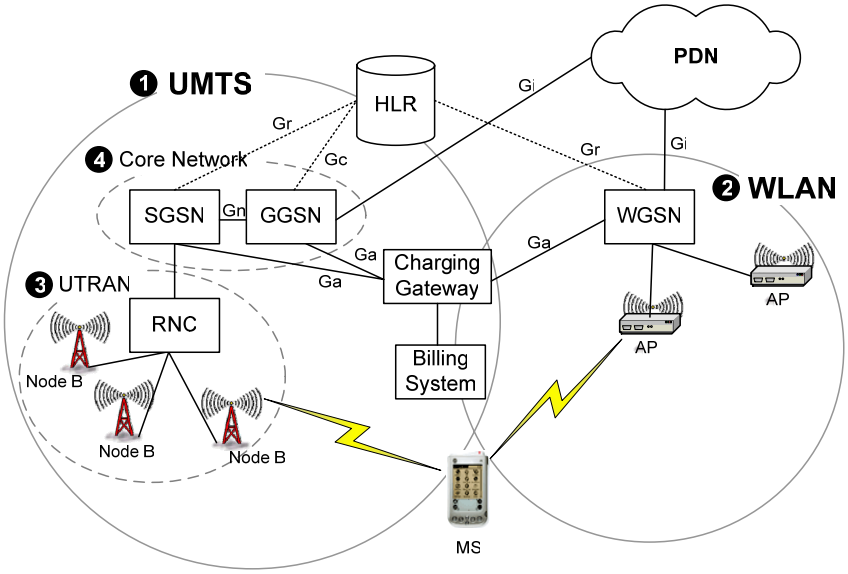
packet preemption. Such effective and superior QoS differentiation has never been proposed and implemented in any of the existing core optical switches of 10G and above. Forth, by taking advantage of the nature of OCPS, we adopt a new modulation scheme which superimposes a low-speed ASK label on top of a high-speed DC-balanced line-coded ASK payload. An old ASK label is erased by modulating the combined payload and label signal with the inverse of the received ASK label. This new approach does not require sophisticated optical components and is easy to implement. We've justified the superiority via extensive feasibility and scalability analyses through simulations and hardware experiments. Finally, we have designed a Lagrangean-based RWA optimizer to facilitate Routing and Wavelength Assignment (RWA) in OPSINET environment including switches with different switching-granularity capabilities. RWA in an arbitrary mesh WDM network has been shown as an NP-complete problem. In this work, we propose an efficient approximation approach, called Lagrangean Relaxation with Heuristics (LRH), aimed to resolve RWA in OPSINET. The task is first formulated as a combinatorial optimization problem in which the bottleneck link utilization is to be minimized. The LRH approach performs constraint relaxation and derives a lower-bound solution index according to a set of Lagrangean multipliers generated through subgradient-based iterations. In parallel, using the generated Lagrangean multipliers, the LRH approach employs a new heuristic algorithm to arrive at a near-optimal upper-bound solution. Numerical results demonstrate that the LRH-based RWA optimizer achieves efficient and precise RWA computation for newly arriving connections, while incurring a minimum of time and space complexity.

- QoS Technologies

In the area of Internet QoS, the major achievements and breakthroughs are four-folds. First, we have designed a TCP-aware Load Balancer, which provides on-the-fly TCP path selection subject to load balancing of access links. Second, we have proposed the Co-DRR, an Integrated uplink and downlink scheduler for bandwidth management over wireless LANs. Co-DRR is an IEEE 802.11-compatible host-based fair scheduling algorithm based on the deficit round robin (DRR) and distributed-DRR (DDRR) schemes, to cooperate the uplink and downlink quantum calculations to simultaneously control uplink and downlink bandwidth. Third, we offer bandwidth management by shaping TCP traffic at edge gateways. This study evaluates possible TCP-aware approaches through self-developed implementations in Linux, testbed emulation, and live WAN measurement. Finally, in the area of application QoS, we propose Request Scheduling for differentiated QoS at website and access gateways.

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

Our studies (OSA and all-IP network related protocols) have been well recognized by the international research society. Because of these contributions, Yi-Bing Lin was awarded Fellow of AAAS (American Association for the Advancement of Science) in 2004. Lin is Taiwan's first AAAS Fellow in the IT and communications area. Lin was also invited to serve as co-guest editor for IEEE Wireless Communications special issue on Mobility and Radio Resource Management appeared in 2004. The relationship of research topics addressed in this subproject are illustrated in the following figure.

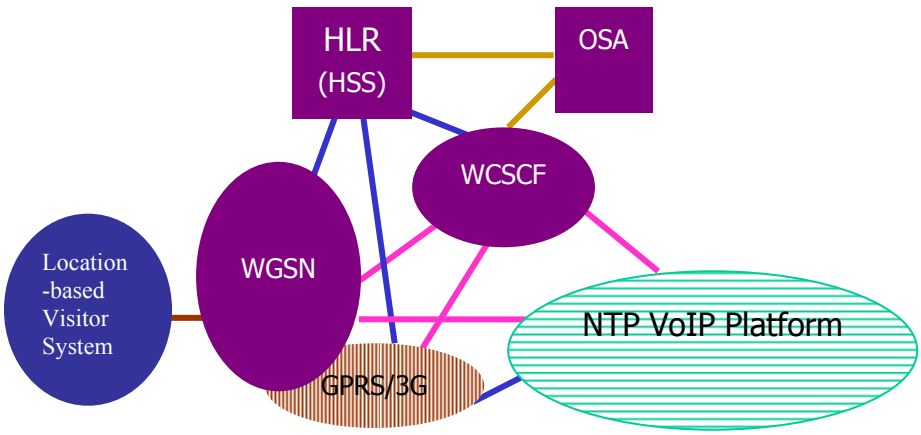


- 3G Core Network protocol

In PPAEU-I, we proposed novel 3G core network protocols for mobility management, authentication, fault tolerance, and mobile database overflow control. Based on this established research energy, in PPAEU-II we are building B3G all-IP networks, including HSS, CSCF, and OSA. With collaboration with CCL/ITRI, we have completed HSS and CSCF prototypes. These prototypes will be further polished and then commercialized by CCL/ITRI.

- Authentication for IMS

Another major contribution is the invention of the one-pass authentication for IP Multimedia Subsystem(IMS). In 3GPP, all-IP networks duplicate authentication procedures in both the mobile network level and the application level. We have proved that in our all-IP environment, the two-level authentication can be consolidated to significantly cut the network signaling overhead. This work was published in IEEE JSAC and is in the patent application process. We have completed the WGSN prototype with SS7-based signaling and SIP ALG with push mechanisms. SIP-based VoIP platform has been built on top of WGSN. The WGSN and 3G all IP architecture is illustrated in the following figure.



- Novel VoIP Call Routing

We have developed a novel method for handling telephone calls from the PSTN to a private telephone network and/or an IP telephony network through a VoIP gateway and/or a PBX (Private Branch Exchange). The design is applicable to VoIP trunking/access gateway, PBX, MGCP call agent, and MEGACO media gateway controller. The method is in the patent application process.

- Broadband Wireless Access Networks

In the access network part, we have addressed the important OVSF code assignment problem in 3G networks. We are the first group in the world to identify the importance of managing OVSF codes in WCDMA systems. We proved that this issue has significant impact on system performance. The work has been cited by several other researchers. We have built a cross-NTHU-and-NCTU mobile ad hoc network to connect the two campuses. The ad hoc network is also connected to our core network. The platform allows us to verify research ideas generated from the project. To improve the network access efficiency and reduce roaming overhead, we have developed a centralized WLAN server with thin access points and implemented a light-weight access protocol. This centralized WLAN architecture reduces the handoff delay and cuts management overhead significantly.

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

- Wireless Ad Hot Network

The main theme of sub-project 4 is to develop ad hoc and sensor networks, which are integrated under a common core network. In the area of ad hoc networks, we have developed a two-tier heterogeneous mobile ad hoc network architecture, on which several novel load balancing protocols are developed. We have proposed and implemented a QoS MAC protocol for multi-channel wireless network architecture. We have proposed a two-tier authentication mechanism. The first tier, based on a hash function and the MAC concept, provides fast message verification and group identification. The second tier, based on secret sharing technology, provides secure user identification. This two-tier authentication mechanism can prevent internal and external attacks, including black holes, impersonation, routing table overflows and energy consummation attacks. Some of the results have been published in ACM MONET and IEEE VTC conference.

- Wireless Sensor Network

In the area of sensor networks, a Bluetooth-based sensor network called Visitor System has been proposed and prototyped. We integrated sensor networks with instant messages and developed interesting applications. The result is published in IEEE JSAC. Based on these prototypes, we have identified sensor coverage problem and Bluetooth device discovery problem and made major contributions to these problems. We have further pushed to the application level and developed a Distributed Guiding Navigation Protocol (DGNP) and an Entrance Guarding System. A mobile sensor platform which was used to replace the broken devices or to monitor the uncovered area was developed. We have designed a mobile sensor platform that can be used for moving to failure

regions to achieve the goal of full sensing coverage. To assist location-aware applications, we have developed an efficient and effective location scheme based on radio propagation modeling for indoor wireless local area networks. Some of the results are published in IEEE JSAC and ACM MONET.

- Core Network

In the area of core networks, we have established an integrated heterogeneous network testbed consisting of 3GPP, 3GPP2 and WLAN. The testbed is capable of running IPv4 and IPv6. Mobility management and authentication protocols have been developed. In addition to analysis and simulation, the proposed protocols have been implemented. A revolutionary SIP-based VPN has been proposed and implemented. A dynamic HA assignment scheme to improve IPsec-based VPN has also been developed and implemented. Results have been filed as patents and published in IEEE Wireless Communications as well as in a book.

Sub- project 5：Network Security

- Active MPEG data hiding

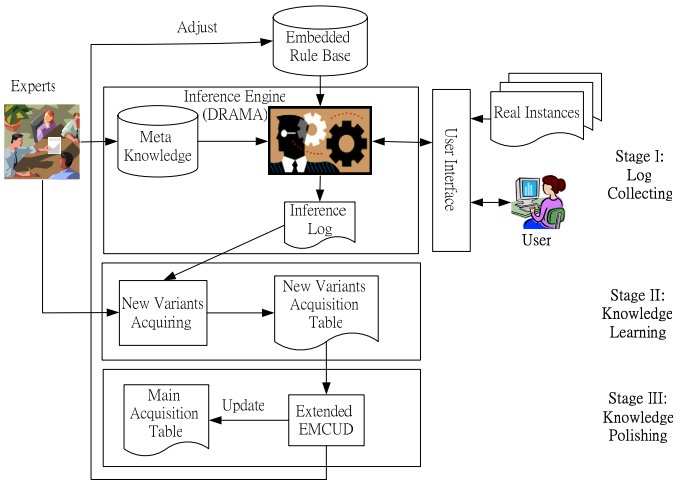
We have developed active MPEG data hiding techniques with the help of active agents for covert communication applications. This active information hiding technique allows large amounts of secret data to be conveyed unnoticeably with publicly available Internet access devices. We have also developed a novel active watermarking technique in flash files (SWF) for copyright protection purpose. When the SWF is downloaded from the server, a visible watermark will appear to warn the user. The protection scheme is resilient against removal attacks, and the user must provide a proper key to remove the watermark and play the file correctly.

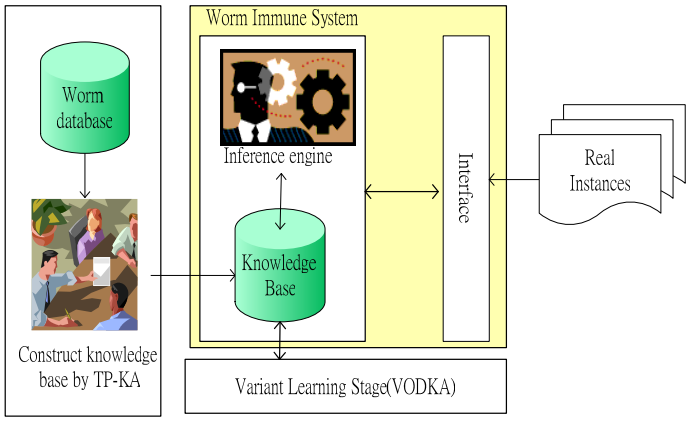
Using active information hiding techniques, we are able to hide information in Microsoft Word documents for covert communication purposes, which is not possible using passive data hiding techniques. By utilizing the revision tracking features of Microsoft Word, our proposed method actively transforms sentences in the document into different versions and thereby embeds secret data for covert communication purposes. The secret information is retrieved by actively transforming and analyzing the transformed sentences in the stego-document by the receiving agent.

- Variant Objects Discovering Knowledge Acquisition (VODKA)

Although much well-known domain knowledge can be acquired from experts and technical reports, many unknown or variant security problems derived from old ones are still emerging to threaten the cyber world. Hence, we have developed a new knowledge acquisition methodology, *Variant Objects Discovering Knowledge Acquisition* (*VODKA*) including three stages (Log Collecting Stage, Knowledge Learning Stage, and Knowledge Polishing Stage), to iteratively discover the variants derived from original objects through observing the inference behaviors of those embedded rules with marginally acceptable certainty factor. Then the newly generated rules of variants confirmed by domain experts will be integrated into the knowledge base.

Our major achievements include proposing the ontology of computer worm domain and constructing the corresponding knowledge base. Also, we have proposed VODKA for monitoring the inference behaviors and learning the candidates of knowledge. The VODKA can be used to polish the existing knowledge base, especially in computer worm domain. The worm immune prototype system embedded with VODKA using DRAMA engine is also implemented.





- PJFM security architectur

Regarding the middleware, we have designed a modern security architecture base on PJFM. This architecture is based on PFJM, which has remarkable performance and persistence features. We add pluggable interface layer, pluggable modules layer, CODEX (Content-based Filter) layer and other mechanisms, which were lacked in recent commercial products, to PFJM platform. These mechanisms make PFJM more secure.

- High Performance P2P Security Gateway

We have designed a “P2P Security Gateway” on the uplink of the border router. Due to the characteristic of today’s P2P software, it produces packets with varying IP addresses and TCP ports; our gateway not only deals with L3/L4 information, but also examines the “Packet Payload”, which is very time consuming. We try to build a database for patterns or signatures of P2P packets, and the gateway will be instructed to filter out "all" or "some" packets passing through it. By

applying the pattern matching to these packets, the packet filter knows which of these packets should be blocked. With the distributed architecture, the main functionality of the packet filter can be reduced from L7 to L3/L4, so that high performance operation can be reached. The filtering rules will be derived based on the results of traffic analysis.

Sub-project 6: Techniques and Applications of Overlay Networks

In this sub-project, we use one application scenario to guide our research. The scenario is a virtual music channel application, in which multiple music channels are delivered to multiple listeners and one or more virtual channels are generated by mining music features and listeners' preference patterns. New techniques are needed to analyze and mine information in the data streams. The overlay techniques also need to be pushed into a new level, in which overlays not only interconnect and aggregate distributed nodes and resources, but also provide metadata indexing, query processing, data mining and matching. In addition, they have to support content storage, caching, buffering, and delivery. Major achievements so far are listed below.

- Design and development of a generic overlay infrastructure

We have developed a generic overlay infrastructure called VC2A to support data streaming operations, as exemplified in the virtual music channel application. VC2A extends the expressiveness of DHT and includes a novel P2P resource management mechanism. A key component in VC2A is a mobile agent system called Mobilet. Mobilet is the first system to integrate a mobile agent system with a P2P network in Taiwan. The integrated system enables the peers in a P2P network to share resources, manage the system, and deploy services. On top of VC2A, we developed a streaming system called "layered chaining", which is based on MPEG-4 FGS and the chaining scheme. For determining the optimal manner to utilize the proxy buffer, we further employ the concept of optimal chaining, which is an improved chaining scheme to efficiently utilize the client buffer. The idea is to treat all clients' bridge buffers as a global shared buffer. If the inter-arrival time between two consecutive clients is larger than the accumulated size of backward and forward buffer, the incoming client may "borrow" buffer from other clients to cover the playback gap.

VC2A includes a scalable component infrastructure for assisting autonomous computing. The major components includes: Java DynamicSocket middleware for supporting Java RMI over heterogeneous wireless networks, a reliable roaming mechanism, the ability to support customized roaming and scheduling optimization, specification for software component using ontology, software APIs for extensible buildings of Runtime Optimizers, and Integration of CMS (Component management systems) and CCA. VC2A prototype is now under development and future experiments will be conducted on Taiwan UniGrid, which was developed with partial support from this sub-project.

- Streaming data management

Managing data has been widely studied in the literature, but most of them focus on static data

instead of continuous data streams. The main challenges include a prompt response to the request, a compact summary of the unbounded data, and a mechanism that adapts to the limited resources. Hence, in this subproject, we emphasize on data stream management, focusing especially on issues of mining and querying data streams. We have designed an efficient approach of mining frequent itemsets from data streams with a time-sensitive sliding window. Our approach consists of a storage structure that keeps the potentially frequent itemsets and a discounting table that provides the approximate counts of the data items to be expired. The data stream is divided into blocks, which are poured into the mining process one-by-one.

We have also developed a novel framework to support sequential queries, e.g. to find the approximate answers of each query from multi-valued data streams. To use the commonality between queries, the query manager decomposes queries into n-grams and groups similar ones into clusters. Then, the pruning mechanism computes the lower-bound distance between the incoming data n-gram and the summarization of each cluster. Once a data n-gram becomes a partial answer of certain queries, the merging mechanism will decide whether to keep it for waiting the subsequent partial answers. The filtering engine will report the matched result if the merging mechanism collects all the partial answers of a query. A query algorithm that can find top-k objects across multiple nodes in the streaming environment is also developed. Our approach is to install certain arithmetic constraints at each node. Once the constraints are violated, the node will send corresponding data to the monitoring node. Experiment results show the transmission time and spaces of our techniques remain lower than those of other techniques.

3. Categorized Summary of Research Outcomes

(The criteria for top conference 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 outcome in sorted order in Appendix II, and list all the top conference and journals in Appendix III.)

Since most ACM and IEEE transactions and journals have a very rigorous review process and are influential in the research community, we include them in the top journal listing. Other journals are listed if their SCI impact factor is comparable to that of ACM/IEEE journals. For conferences, the primary factor in considering their quality is the acceptance rate. A conference must have an acceptance rate no more than 30% to be included in our top conference listing. A listing of the top conferences and journals is given in Appendix III.

In the following, we summarize the research outcomes in each research area of this project.

Sub- project 1：High Speed Networking Technologies

- *Load balanced Birkhoff-von Neumann switches*

Motivated by the recent interest in load-balanced switches, Prof. C. S. Chang and Prof. D. S. Lee worked with Dr. Issac Keslassy (a former Ph.D. student of Stanford University and now with Technion, Israel) and Prof. Nick McKeown (Stanford University) worked on optimal load balancing in fixed interconnecting networks. It is shown that given a fixed transmitting and receiving capacity at each node, a biased mesh achieves the optimal universal throughput. This work results in an IEEE INFOCOM 2005 paper.

To solve the out-of-sequence problem in the load balanced Birkhoff-von Neumann switches, Prof. C. S. Chang, Prof. D. S. Lee and Miss Y. J. Shih proposed a mailbox switch architecture that uses the symmetric TDM switch fabrics. The key idea of the mailbox switch is that there is a feedback path via the symmetric TDM switch fabrics and it can be used for communicating the virtual waiting times of the mailbox boxes (virtual output queues). By so doing, packets depart in the order of their arrivals. This work results in an IEEE INFOCOM 2005 paper.

To find out the throughput of framed based load balanced Birkhoff-von Neumann switches, Prof. C. S. Chang, Prof. D. S. Lee and Mr. C. L Yu derived a generalized Pollaczek-Khinchin formula. The Pollaczek-Khinchin formula is one of the most elegant (and important) formulas in queuing theory and it can be used for computing the mean value of an M/G/1 queue. Our generalization allows a batch of F departures after each service completion. As such, it can be applied for much supplicated queuing systems, including switches with line grouping and framing. This work results in an IEEE INFOCOM 2005 paper.

- *Mathematical modeling for HTTP*

Through a joint study program between National Tsing Hua University and IBM Watson Research center, Prof. C. S. Chang worked with Dr. Zhen Liu at IBM Watson Research center on mathematical modeling for HTTP. It is known how bandwidth is shared by TCP-like connections. By associating each TCP-like connection with a utility function, the bandwidth sharing problem of TCP-like connections can be modeled as a distributed optimization problem for utility functions. One of the main contributions of this work is to provide a theory for bandwidth sharing of a large number of HTTP-like connections. It is shown that there is a utility function at the HTTP level for an HTTP-like connection and such a utility function can be derived from the utility function at the TCP level. The bandwidth is then shared by HTTP-like connections through utility functions at the HTTP level. This work results in a regular journal paper in IEEE/ACM Transactions on Networking, 2004.

- *Multicasting with coding*

It is known that network coding can be used to achieve the maximum network flow for multicasting in a network with reliable transmissions. For a network with unreliable transmissions, incremental forward error correction can also be used to increase the throughput of the system. In the work by Mr. I. C. Lee, Prof. C. S. Chang and Mr. C. M. Lien, it is shown via the large deviation principles that there exist strong laws of large numbers for the asymptotic throughput of multicasting in unreliable tree-type networks. This work results in a regular journal paper in IEEE Transactions on

Information Theory, 2005.

- *Network Intrusion Detection and Prevention Systems (IDS/IPS)*

IDS/IPS are more and more important for the network security. The matching of packet strings against collected signatures dominates signature-based NIDS performance. In the work by Professor Nen-Fu Huang, a fast string matching algorithm over the Network Processor platform that conducts matching sets of patterns in parallel. Is proposed. This work results in a regular journal paper in *ACM Transactions on Embedded Computer Systems*, August 2004..

- *Scalable security switch for wired/wireless Ipv4/Ipv6 networks*

Professor Nen-Fu Huang proposed a flexible architecture for network security switch so that the traffic between switching ports is inspected and protected in a cost effective way. In this architecture, a gigabit security engine with layer-7 packet inspection capability is designed to accompany with traditional managed L2 switches. A prototyping for this system has been established to demonstrate the concept of security switch. The research result is also submitted for publication.

Sub-project 2：Optical Networking and QoS Technologies

1. We have proposed a novel QoS Scheduler/Shaper for Optical Coarse Packet Switching IP-over-WDM Networks [B1,B9]. The work has been published in the in the Optical Communications and Networking (OCN) Series of the *IEEE Journal on Selected Areas in Communications*. According to the chief editor's information, the journal has a very low acceptance rate, ranging from 15% to 20% among different subtopics. The experimentation part of the work is also invited as a 30-minute invited talk presented/published in *IEEE/SPIE APOC*, the largest optical communication and network conference in Asia.

2. In the design/construction of OPSINET-II, and its 10G optical switch, the paper for the switch architecture and technology is currently being written. The components, such as the wavelength converter [B3] and optical filters [B4] have been published in Rated-A optical devices and system journal, *IEEE Photonic Technology Letter*.

3. In the optimization of routing and wavelength assignment for OPSINET-II, we have proposed an efficient approximation approach, called Lagrangean Relaxation with Heuristics (LRH) optimizer [B2, B8], aimed to resolve RWA in OPSINET. RWA in an arbitrary mesh WDM network has been shown as a hard NP-complete problem. Numerical results demonstrate that the LRH-based RWA optimizer achieves efficient and precise RWA computation for newly arriving connections, while incurring a minimum of time and space complexity, compared to existing famous approaches. The work has been published in the in the Optical Communications and Networking (OCN) Series of the *IEEE Journal on Selected Areas in Communications*, with an average of 18% acceptance rate. In addition, a simple version of the work is also published in rate-A conference, *IEEE Globecom'04*.

4. In the areas of network/application QoS, we have published our survey and measurement-based comparison of bandwidth *management techniques* [B6] in *IEEE Commun. Surveys and Tutorials*, which is a top journal with the highest readability. We have also published three pieces of work, namely on-the-fly TCP Path Selection Algorithm in access link load balancing [B11], tunnel minimization and relay for managing VPNs [B12], and the shaping of TCP traffic at edge gateways [B13] in rate-A conference, *IEEE Globecom'04*.

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

- 3G Core Network Protocol

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 CCL/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].

- Novel VoIP Call Routing

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 CCL/ITRI. We received a patent for wireless VoIP [patent 2] (major work in PPEAU-I). To support SIP-based VoIP service in UMTS IPv6 networks, IPv4 and IPv6 interworking is required. Through collaboration with NICI and NTP, we developed NCTU SLT, a socket-layer translator for IPv4-IPv6 translation [C.10].

- Authentication for IMS

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 [C.14].

- Broadband Wireless Access

In [C.15] and [C.16] 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 [C.17], we have developed an adaptive mechanism for soft handover in OVSF WCDMA systems. We are the first group in the world 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, are proposed. We have published the results in [C.18] and [C.19]. These works have been used and cited by several other researchers. In terms of access networks, we have analyzed performance of multi-piconet Bluetooth networks. New analytical methodologies were developed, which can more accurately predict Bluetooth network performance. In addition, new enhancements to IEEE 802.11 access control MAC protocol have been proposed. A new multi-chain scheme was proposed to reduce packet collision probability. These pioneer works have been published in prestigious journals such as IEEE JSAC and IEEE TVT [C.21, C.22, C.23].

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

- We have developed a two-tier heterogeneous mobile ad hoc network architecture. In particular, several load balancing protocols are developed. A Bluetooth-based sensor network has been proposed and prototyped. We show how to analyze Bluetooth performance when there are multiple piconets coexisting. Device discovery delay in a Bluetooth-based sensor network is analyzed too. A prototype called Visitor System has been developed, based on which the above ideas were verified. From these experiences, we have also shown coverage and connectivity determination algorithms for sensor networks.
- We are designing an efficient wireless peer-to-peer network architecture, which contains three major parts: wireless backbone networks, application design, and peer-to-peer data storage and searching scheme. We have proposed a QoS MAC protocol for multi-channel wireless network and a distributed application for guiding navigation protocol in wireless sensor networks. The guiding navigation protocol calculates the paths distributed based on local sensing information and can be extended to multi-exit environment.
- An AVL-tree-based structured peer-to-peer architecture was proposed and evaluated. The proposed scheme shows comparable performance as popular DHT-based peer-to-peer architectures do. We also designed an interest-based grouping scheme on clustered peer-to-peer networks, which employed the locality of user behaviors to improve the search performance on loosely structured pee-to-peer networks.
- We have established an integrated heterogeneous network testbed consisting of 3GPP, 3GPP2 and WLAN. The testbed is capable of running IPv4 and IPv6. Mobility management and authentication protocols have been developed. In addition to analysis and simulation, the proposed protocols have been implemented.
- In order to roam between IPv4 and IPv6 networks, we have developed NAT-PT between heterogeneous networks.
- For security, a revolutionary SIP-based VPN has been proposed and implemented. A dynamic HA assignment scheme to improve IPsec-based VPN has also been developed and implemented.
- We have proposed a two-tier authentication mechanism for MANETs. The first tier, based on a hash function and the MAC concept, provides fast message verification and group identification.

The second tier, based on secret sharing technology, provides secure user identification. This two-tier authentication mechanism has been presented in IEEE 2004 Vehicular Technology Conference.

- We have developed a location scheme based on the signal-to-noise ratio (SNR) for indoor wireless local area networks (LANs), where the mobile terminal position is determined according to the measured SNRs for multiple base stations. With the antenna pattern-measurement method for measuring the SNRs, more accurate location estimation can be achieved. Our experimental results show that 86 percent of the location errors of a mobile terminal are less than two meters. We have also developed a radio propagation model for locating a mobile terminal in indoor wireless LANs. The proposed radio propagation modeling approach reduces the number of training data points with no significant degradation in the location accuracy, as compared to the conventional empirical method. These results are published in the 2005 IEEE Consumer Communications & Networking Conference (CCNC) and the 2005 IEEE Vehicular Technology Conference - Spring (VTC 2005-Spring)

Sub- project 5：Network Security

Research on information hiding techniques has yield many useful new methods for hiding data in different types of media for different information security applications. The research outcomes are of great academic importance, and we have 13 journal and 15 conference papers, not including the submitted ones, published under the program. Two patents are pending. Major research outcomes are as follows:

- A novel approach to secret image sharing, this is based on a (k, n)-threshold scheme with the additional capabilities of steganography and authentication;
- Proposed a combined approach to integrity protection and verification of palette images using fragile watermarks and digital signatures;
- Proposed a new adaptive method for data hiding in palette images with security protection by color ordering and mapping, as well as parameter randomization;
- A block-based authentication technique. We proposed a novel block-based authentication technique for binary images by block pixel rearrangements;
- Proposed a data hiding method in image mosaics by visible boundary regions and its copyright protection application against print-and-scan attacks.
- VODKA method: This is to polish knowledge base and developed a worm immune prototype system using DRAMA engine.
- Accomplished “mGrid: Mobile Grid SDK”: The integration of the previous years’ project result PFJM into the core architecture of the mGrid platform. The fast message passing and high-reliability of the PFJM proves to be a valuable asset to the overall steadiness of the mGrid Platform.
- A high performance P2P Gateway architecture: which use the off-line parallel mechanism to perform the pattern matching for filtering purpose. The proposed architecture can execute the P2P traffic screening in a much faster speed.

The journal named Expert Systems with Applications is one of the most important publications in AI domain, especially in expert system research. We have also obtained Honor Award from

MobileHero 2004, Ministry of Economic Affairs, R.O.C, 2004.

Sub-project 6: Techniques and Applications of Overlay Networks

- P2P overlay networks: In a P2P system heterogeneity and dynamics are the norm. Our research works concentrate on the key issues in heterogeneity and dynamics. We propose an architecture called Tornado to handle the heterogeneity, in which a peer can host a number of loads according to its capability. The loads can be migrated on-the-fly on node overloading. A novel mechanism, called Typhoon, is proposed to handle the migration of loads. The mechanism not only reduces the maintenance overheads to handle the migration, but also improve the efficiency of routing. These works are published in JPDC and IPDPS. We have also developed effective schemes for handling similarity searches n DHT-based P2P systems. We propose a design that can locate objects with k designated key values using a single lookup operation.
- Chaining scheme for streaming data delivery: On the basis of the emerging peer-to-peer structure and the characteristic of user's behaviors, a scalable video delivery scheme, named P2PVD, is proposed for large scale video-on-demand application. This work has been presented in International Conference on Multimedia and Expo 2004. To more efficiently deliver streaming data, we consider chaining for reducing the required buffer space. We propose an optimal chaining scheme that utilizes not only the backward and forward buffers, but also all the available client buffers in a collaborative network. This result inherently makes the optimal chaining scheme scalable to the streaming services. This work has been accepted to IEEE Transactions on Multimedia.
- Software component management and adaptation: In this research work, we argue that additional annotation specifications for components are needed to advance system adaptation in distributed systems. We first introduce annotation specifications for components. This information can be retrieved by Java introspection and represented in DAML+OIL language. Based on the specifications, we then present a Component Management Service (CMS) model and architecture to address the specification and composition issues of components on heterogeneous distributed architectures. With this framework, we can dynamically adapt RMI over different networks, such as Bluetooth, GPRS, and WLAN, with optimization-related strategies. We employ Java Dynamic Proxy and exception handling techniques to help perform roaming and resource scheduling among heterogeneous wireless environments. These results have been published in ICC, IPDPS, and Concurrency and Computation: Practice and Experience.
- Streaming data management: Using data mining concepts and novel representations of music data, effective music classification and retrieval methods were proposed. These works result in two regular papers in International Conference on Database Systems for Advanced Applications, 2004. To handle the complexity of polyphonic music, a lower bounding mechanism for query processing is proposed to achieve efficient music content-based retrieval. This work results in a journal paper to appear in ACM Multimedia Systems Journal. Through the integration of music classification and data mining, a personalized service of music recommendation is designed. This work results in a journal paper to appear in Journal of Intelligent Information Systems. A novel algorithm for sequential pattern mining is also proposed and its efficiency is proved to be the best in this field. This work results in a regular paper in IEEE Data Engineering Conference, 2004,

and is further enhanced and submitted for journal publication.

4. Program Management
(the Mechanism to Promote Collaboration and Integration among the Schools Involved)

Based on our experiences in conducting the PPAEU-I project, we found the following mechanisms to be effective in promoting the collaboration and integration among the sub-projects and team members.

- Project meetings: Project meeting is by far the most effective way of promoting the collaboration within and between sub-projects. Most sub-projects have regular project meeting at least once a month; some even run every two weeks. Through these events, project members are able to understand what others are doing and thinking. New insights may be uncovered from people of different perspectives. In addition, possible obstacles are identified and necessary interface are defined. Although the project members are from different schools, such as NCU, NCTU, and NTHU, we have been collaborating with each other for many years. Good communication channels have been well established.
- Common platform and testbed: Common platform is also an effective means for integrating the research works. For example, in sub-projects 3 and 4, we have established an integrated platform that can be used by both sub-projects across schools. On this platform, we can test our ideas and make sure that our implementations are compatible. Specifically, the platform has the following components: (i) SIP call servers developed by NCTU, (ii) handover mechanisms developed by both NTHU and NCTU, (iii) security and AAA mechanisms developed by both NTHU and NCTU, and (iv) ad hoc networks developed by NCTU. Currently, we are able to make SIP calls through ad hoc networks and cellular networks to the Internet, and vice versa. We are also discussing our new testbed plan, in which NCU will also actively involve.
- Project reviews and consulting: We take every possible opportunity to invite established researchers to visit us and review our projects. These scholars not only provide us with valuable advices on future trends and research directions, but also help us to establish collaborations with international research community. The reviews also press the team members to cooperate and integrate their works. Among the visited scholars include Prof. Ben Wah of UIUC, Prof. Jay Kuo of USC, Prof. Phillips Sheu of UCI, Prof. Bob Lee and Prof. Peter Yum of Hong Kong Chinese University, and Prof. L.M. Ni of Hong Kong Science and Technology University.
- Site visits: As part of external collaborations, we often form teams for site visits. During the visits, the team members not only establish ties with those institutes, the team members have more time to discuss within themselves. A number of visits are in planning, including III and Microsoft Research Asia.

5. A Summary of the Post-Program Plan
(including the Description of Adjusting Budget and Plans of FY94)

The post-program plan for each sub-project is given as follows. (The description of adjusting budget is given in Appendix V.

Sub- project 1：High Speed Networking Technologies

As reported earlier, we have one major achievement and one breakthrough: (i) A 30Gbps Time Division Multiplexing (TDM) Switch with 8B/10B CODEC IP for Ultra High Speed Switch Fabric Applications, and (ii) Complexity of queues. We shall carry out our research along these lines. For the symmetric TDM switch, we have learned a lot of valuable experiences in both the process of IC design and team work. As commented by Prof. Shuo-Yen Robert Li (Chinese University, Hong Kong), we have a strong team in digital circuit design and a strong team in the theoretical support of the switch. It is not easy to put up such a team and this is something that they cannot do in Hong Kong. In the next year, we expect that we should be able to reach a higher speed by moving into more advanced fabrication processes, such as 0.13 or lower. We will also work on the improvement of the analog circuit for the switch. Analog circuit design requires experienced and talented engineers. This will be one of the main challenges as we are lack of experienced engineers in this area. As indicated in our original proposal, we shall also work on linecards that are able to interface with the symmetric TDM switches and other industrial standards, such as SONET or Gigabit Ethernet. This part also needs a lot of analog circuit design. Moreover, it requires to design a control chip that handles high speed memories in the linecards.

Complexity of queues is of both theoretical and practical interest. Its main application is to build optical buffers with minimum complexity. For this, we shall work with people in Sub-project 2 as they have been conducting research in this area for a long period of time. In fact, we recently received a funding from the University System of Taiwan (UST) that supports cooperation between National Tsing Hua University and National Chiao Tung University. This funding is mainly for purchasing equipment. As such, we have to adjust our original budget allocation for personnel salary and equipment. If possible, we will try to build optical multiplexers and FIFO queues based on our theory. The theory for the complexity of queues itself is very fascinating. It is related to juggling, something that Prof. Claude Shannon worked on during his entire life. Our research on this topic might be able to open a new area of research that is parallel to the classical switching theory.

Sub-project 2：Optical Networking and QoS Technologies

- **The 2nd year:** (1) We will finish the construction of the edge router and control system of OPSINET-II and give formal demonstrations. The basic system includes QoS burstification, traffic shaping, and traffic scheduling, and FPGA implementation of the control part. (2) We will accomplish the design and performance modeling and analysis of the refined optical switch architecture, in addition to call admission control at edges. Results will be used in OPSINET-II construction of the third year, and displayed in paper submission, reports, and patents. (3) We will also engage the research on traffic grooming and resource optimization. Results will be

presented in paper submission, reports, and patents. (4) We will finish the design and analysis of 9-in-1 gateway and give formal demonstrations.

- **The 3rd year:** (1) We will finish the construction of the 10G optical label switch router of OPSINET-II and give formal demonstrations. The work includes FPGA control, ASK-based label swapping system, partial/full wavelength sharing, and multistage optical FDL buffers (2) we will accomplish the design and performance modeling and analysis of the QoS traffic control exerted at both edges and label switch routers. Results will be used in OPSINET-II construction of the last year, and displayed in paper submission, reports, and patents. (3) We will also engage the research on traffic engineering. Results will be used in the GMPLS simulator/emulator to be designed and implemented in the last year. (4) We will finish the design and analysis of 10-in-1 gateway and give formal demonstrations.
- **The 4th year:** In the last year, we will combine all previous results and demonstrate integrated accomplishments. We will finish the entire construction of 10G OPSINET-II and give formal demonstrations. The OPSINET-II experimental network includes edge routers, optical label switches, and full-grown traffic control and GMPLS-based traffic engineering. In the area of network/application QoS, we will give formal mathematical analysis of TCP-friendly congestion control and request scheduling. In addition, we will perform field trials of the 10-in-1 implementation in the real Internet environment to supplement our lab test results.

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

- **The 2nd year: W**e will enhance WGSN prototype with SCTP-based signaling and integrate OSA into WGSN; we will interwork OSA with WGSN/VoIP platform; we will also develop a location-based event-driven messaging system (including SMS and MMS). Mapping and navigation engines will be developed.
- **The 3rd year: W**e will integrate WGSN and VoIP platform through the advanced CSCF; we will complete development of advanced CSCF prototype to be integrated into the WGSN VoIP platform; we will develop SIP/VoIP services over our mesh network platform.
- **The 4th year: W**e will transfer the enhanced WGSN prototype to the domestic industry; we will complete WGSN VoIP platform tailored for university education. A novel location-based web access control mechanism will be developed. We will develop SIP/VoLP services over our multi-antenna network platform and integrate it with our QoS Mechanisms.

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

- **The 2nd year:** (1) Extend our mesh network with more nodes; (2) Conduct more extensive experiments on our mesh network platform; (3) Develop communication and coverage protocols for sensor networks; (4) Extend our mesh network to multi-antenna mesh networks; (5) Develop roaming protocols for 3GPP and 3GPP2 networks.
- **The 3rd year:** (1) Develop navigation protocols for our sensor network platform; (2) Design gateway architecture for our multi-antenna mesh network; (3) Design SIP mobility management for VPN.
- **The 4th year:** (1) Integrate our mesh and sensor networks into our core all-IP network testbed; (2) Extensive deployment and test of our multi-antenna mesh network.

Sub- project 5：Network Security

In the second year, we will investigate the topic of active steganography, we will continuously analyze the worm patterns and signatures to enrich our knowledge warehouse. New incremental mining algorithms will also be proposed to discover the useful worm signatures and patterns to identify the possible attackers. We will propose a new Repertory-grid based knowledge acquisition methodology to acquire useful meta-knowledge and design a concept hierarchy to build a ontology of network security. In order to evaluate our proposed method, a prototype of our proposed security knowledge warehouse will also be designed and implemented too**.** We will also design a multi-dimensional schema of a security knowledge warehouse for on-line analysis and decision making, we will also concentrate on the API support of secured middleware including pluggable authentication, authorization, encryption, and configurable framework. We will also collect all possible P2P traffic patterns, study their characteristics and investigate a fast pattern matching mechanism based on IPv4/IPv6 for P2P gateway. Further, the information in the knowledge warehouse can be used for P2P traffic analysis, this would increase the accuracy of judgment in pattern matching process.

In the third year, our study will be on the new topic of active authentication. Besides, we will propose a new repertory-grid based knowledge acquisition methodology to acquire useful meta-knowledge, such as system specific rules, DDOS signatures, and filter policies from experts and apply feature selection technology to select useful attributes from various knowledge sources. We will also proceed with middleware and application development, including content based filter, application based security, inter-multicast domain security. We will investigate semantic engine, which is a parallel and high performance traffic analysis mechanism.

In the last year of this project, we will evaluate the performance of our methods proposed in the previous three years from the viewpoints of hidden data imperceptibility, cover media distortion, data hiding capability, error probability, and security protection capability. PFJM framework will have flexible pluggable interface to provide an interface to any developers within the project and JMS API to invoke the security check. PFJM has its own monitoring mechanisms. It is possible to integrate PFJM with more sophisticated mechanisms like intrusion detection or intelligent flow control. We will continuously refine and enhance the feature selection, feature extraction, knowledge fusion/integration from the viewpoints of heterogeneous knowledge source and unbalanced knowledge source integration. We are going to fine tune the performance of the middleware framework, as well as to do system integration and perform field test.

Sub-project 6: Techniques and Applications of Overlay Networks

As we investigate more research issues of the overlay network from different aspects, we become more and more aware of specific features and requirements of managing P2P overlay networks. It is interesting that the various research communities (such as database community and network community) are also getting more and more excited about research issues correlated to the overlay network. Based on the research results of this year, we plan to investigate the correlations between various aspects of managing the overlay network in the future.

In the next year, we will investigate the query mechanism on P2P architectures for the data streams. Distributed query processing within an overlay network is far more challenging as compared to that of the traditional distributed database systems, since the topology of the network is semi-structured or even unstructured. Designing efficient query flooding mechanisms will become an additional new challenge for the data stream management. Moreover, given that resources are heterogeneous in nature, exploitation and taking advantage of heterogeneity will becomes another key challenge. Hence, we intend to integrate metadata servers, which can locate resources in the heterogeneous environment, into the overlay network. Furthermore, we intend to deploy all resource distribution techniques, including content distribution techniques and component management techniques, in the overlay network. The deployment can further help us to evaluate and enhance developed ideas.

In the third year, we will work on the following research: (1) methods for processing complex queries on data streams; (2) real-time algorithms for semantic object identification on multimedia streams; (3) a monitoring and management system for overlays; (4) a working development framework; (5) overlays for data grid using our infrastructure. In the fourth year, we will work on the followings: (1) mechanisms for high-level concept derivation and maintenance on multimedia streams; (2) mechanisms for approximate matching on multimedia streams; (3) integration of QoS control in our infrastructure; (4) deployment and field test of our infrastructure in data grid.

VI. (FORM 5) ASSESSMENT (DONE BY PROGRAM REVIEWERS DURING INTERNAL PROGRAM REVIEW, 1/27/2005)

PROGRAM TITLE: Advanced Technologies and Applications for Next Generation Information Networks (II)

	ASSESSMENT SUBJECT	SCORES (1~5, LOW TO HIGH)
PROGRAM'S CONTENTS & PERFORMANCE	Importance & Innovation of the Program Major Task	**5**
	Program Report Redaction	**4, typos and grammars**
	Viability of the Program Approaches & Methodologies	**5**
	Principal Investigator's Competence for Leading the Program	**5**
	Interface & Integration between Overall & Sub-Project(s)	***, some projects are quite independently**
	Interface & Integration among All Sub-Projects	***, neutral**
	Manpower & Expenditures	***, not qualify to comment**
PROGRAM'S RESULTS	Contribution in Enhancing the International Academic Standing	**5**
	Impact on Advancing Teaching or on Technology Development	**5, definite**
	OVERALL	**5**

REVIEWER'S COMMENTARY & SUGGESTION:

A. Preamble

This project has a good balance between research and development and is rightly suited for undertaking by universities. The half-day intensive review and the following discussions have shown very strong team spirit between the two groups of academics from NTHU and NCTU.

B. Technical Merit

I asked many questions during the program review meeting; all were answered satisfactorily. A couple of the sub-projects I am more familiar with I rate them as performing exceedingly well. The publication output is enviable. The whole project is in good progress.

C. Budget Management

It is difficult to assess the suitability of budget and expenditure. The team size is large, but many R&D works are performed by graduate students whose capabilities take time to develop. These students also need to take courses and write research papers for degree requirements. It is hoped that many of them can continue working on this projects after graduation. The total budget, however, is very small compared to industrial development work of the same scale.

D. Recommendations

1. *Recruit Talents Worldwide.* In particular, postdoctoral fellows from India and mainland China could be considered. They can adapt to the local environment quite easily and they are quite economical to hire.
2. *Tight Integration with Applications*. Information technology is application driven. Therefore, a continuous market research is recommended to guide the direction of the project so that the technologies developed can have a higher impact on the economy.
3. *Innovation Driven*. This project has captured all the important areas in networking. Much emphasis is put on the infrastructure technology. Universities should be endowed with the mission of up-stream or forward-look research. I therefore would recommend setting aside 10% of the overall budget for this purpose. The aim is to come up with new and exciting ideas, in other words, to be a leader in some areas.
4. *Full Time Management*. I understand all professors involved are working extremely hard. But for project of this type, 4 years of duration is a bit long. The time used for teaching and writing research papers is compromising the progress. I therefore recommend that key leaders of the sub-projects be given time-off to lead projects full-time. They need time to monitor the world-wide trend and to foster synergy between sub-projects in addition to managing the tasks being in-charged.

Program Reviewer's Signature: Tak-Shing Yum

Principal Investigator's Feedback: (Available)

1. We already hired several postdoctoral fellows in this project. We will look for possibility of hiring foreign applicants.

2. Tight integration is always our goal. In the coming three year, tigher integration will be seen, as has been outlined in our original proposal.

3. Innovation is always a high priority goal in this project. This has been reflected in our results of patents, papers, and prototypes. However, because budget is allocated with specific purposes, setting aside 10% of budget solely for this purpose may not be possible.

4. Doing full time management of this project is unlikely under our current system. However, the universities already allow us to buy out some teaching hours for executing research projects.

	Assessment Subject	Scores (1~5, Low to High)
Program's Contents & Performance	Importance & Innovation of the Program Major Task	**5**
	Program Report Redaction	**5**
	Viability of the Program 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	**4**
	Manpower & Expenditures	**4**
Program's Results	Contribution in Enhancing the International Academic Standing	**5**
	Impact on Advancing Teaching or on Technology Development	**4**
	Overall	**5**

REVIEWER'S COMMENTARY & SUGGESTION:

I am pleased to serve on the advisory committee to evaluate the progress of this project. The performance of Project II has certainly moved to another level of excellence than that of Project I. In particular, many innovative ideas were proposed, which is the major difference between Project I and Project II. The project team, under the excellent and visionary leadership of two PIs, has reached the goal of world class. In sub-project 1, the 30Gbps TDM switch design is very interesting with great commercial value. I am quite impressed by the wireless security switch prototype and its scalable architecture. It has both academic and industry values. Sub-project 2 is also world class. I believe it is one of the very few in the academic world that is able to make such an optical interconnect. Sub-project 3 has a number of very interesting technologies for B3G networks. This sub-project has a very impressive publication record in leading journals and conferences. Sub-project 4 is attacking some very important network issues. I was quite impressed by their demo prototype system. They also have excellent publications. Sub-project 5 is attacking a critical issue and has achieved very good research results. However, the quality of publication can be further improved. In sub-project 6, they have good publications. They should consider having an overlay prototype for some interesting applications, such as MAZE of Peking University. Collecting real workload will further help their research in this direction.

From the report, every sub-project has regular meetings. I also notice that all sub-projects met twice a year (in 2004). They may consider having quarterly meetings to share ideas and to create some healthy competition.

The impact on advanced teaching is not clear to me.

I would also suggest emphasizing the quality of publication venues. They should consider publication only in top journals and prestigious conferences to get truly respected international visibility.

Overall, I am truly impressed by the performance of this project and look forward to seeing more innovative results from such an excellent project team.

Program Reviewer's Signature: Lionel Ni

PRINCIPAL INVESTIGATOR'S FEEDBACK: (AVAILABLE)

Sub-project 5 is working in the direction of improving their publication quality. Since this is the first year of the project, we should be able to achieve this goal, in terms of both publication quantity and quality. We have also set aside some budget to encourage participants to attend quality conferences.

In subproject 6, we have already developed two prototype systems, one based on the structured P2P and the other on unstructured P2P. Initial results have been reported in [F.8] and [F.14]. However, the systems are very primitive, lacking many features. We are currently working on a production system that can be released for general use. This is an important task of the next year. Overlay applications have also been planed for some time. Currently, we are working on two applications, one being virtual music channels and the other being streaming data grid services. We expect to have prototype running in the next year.

VII. APPENDIX I CHRONICLE OF PROGRAM INTEGRATION MEETING

Main Project：
93/05/04 -- Program Integration Meeting
93/10/18 -- Program Integration Meeting

Sub- project 1：High Speed Networking Technologies
Regular Weekly Meetings (TUE. And THU.)
Tue 1-3PM CSEE431
Thu 1-3PM CSEE447

Sub-project 2：Optical Networking and QoS Technologies
Regular meeting (Every Tuesday)

Sub-project3: Beyond-3G All-IP Wireless Network Technologies
93/06/11-- Regular meeting
93/07/07-- Regular meeting
93/07/21-- Regular meeting
93/08/06-- Regular meeting
93/09/02-- Regular meeting
93/10/04-- Regular meeting
93/12/02-- Regular meeting
93/12/14-- Regular meeting
94/01/20-- Regular meeting

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies
93/05/26-- Regular meeting
93/06/23-- Regular meeting
93/07/27-- Regular meeting
93/08/06-- Regular meeting
93/09/01-- Regular meeting
93/10/04-- Regular meeting
93/11/03-- Regular meeting
94/01/14-- Regular meeting

Sub-project 5: Network Security
93/04/21-- Regular meeting
93/06/02-- Regular meeting
93/06/30-- Regular meeting
93/10/15-- Regular meeting
93/12/14-- Regular meeting

Sub-project 6: Techniques and Applications of Overlay Networks
93/05/17（一）12:00 CSEE 447
93/06/07（一）12:00 CSEE 431
93/07/21（三）12:00 CSEE 533

93/09/16（四）12:00 CSEE 533
93/11/03（三）12:00 CSEE 550
93/12/17（一）12:00 CSEE 431
94/01/03（一）12:00 CSEE 447
94/01/17（一）12:00 CSEE 431

VIII. APPENDIX II

1. PUBLICATION LIST

(CONFERENCE, JOURNAL, BOOK, BOOK CHAPTER, etc.)

Sub- project 1：High Speed Networking Technologies

Journal Papers:

[A.1] C.-J. Chen and D.-S. Lee, "Optimal OVSF Code Assignment and Reassignment in WCDMA Systems", accepted by *Journal of Institute of Electrical Engineers*.

[A.2] D.-S. Lee and C.-C. Lin, "Window Adaptive TCP for EGPRS Networks", *Journal of Information Science and Engineering*, Vol. 20, No. 5, pp. 805 - 820, September 2004

[A.3] D.-S. Lee and C.-C. Chen, "QoS and Call Admission Control of Multimedia Traffic in a PCS Network", accepted by *International Journal of Communication Systems*

[A.4] Cheng-Shang Chang, Duan-Shin Lee and Chao-Kai Tu, "Recursive construction of optical multiplexers with switched delay lines," *IEEE Transactions on Information Theory,* Vol. 50, pp. 3221-3233, 2004.

[A.5] Cheng-Shang Chang and Zhen Liu, "A bandwidth sharing theory for a large number of HTTP-like connections," *IEEE/ACM Transactions on Networking,* Vol. 12, pp. 952-962, 2004.

[A.6] R.T. Liu, Nen-Fu Huang, C.H. Chen, C.N. Kao, "A Fast String Matching Algorithm for Network Processor-based Intrusion Detection Systems", *ACM Transactions on Embedded Computer Systems,* Vol. 3, No. 3, August 2004, pp. 614 – 633.

Conference Papers:

[A.7] I-Chung Lee, Cheng-Shang Chang, and Ching-Ming Lien, "On the throughput of multicasting with incremental forward error correction,'' to appear in *IEEE Transactions on Information Theory,* March 2005.

[A.8] Cheng-Shang Chang, Duan-Shin Lee, and Ying-Ju Shih , "Mailbox switch: a scalable two-stage switch architecture for conflict resolution of ordered packets," *IEEE INFOCOM 2004.*

[A.9] Isaac Keslassy, Cheng-Shang Chang, Nick McKeown, and Duan-Shin Lee, "Optimal load balancing," to be presented in *IEEE INFOCOM 2005.*

[A.10] Cheng-Shang Chang, Duan-Shin Lee, and Chao-Lin Yu, "Generalization of the Pollaczek-Khinchin formula for throughput analysis of input-buffered switches," to be presented in *IEEE INFOCOM 2005.*

[A.11] Yarsun Hsu, "Design considerations for low power distributed sensor network,"*Proceedings of the Workshop for International Collaboration in SoC and Embedded System Technologies*, Seoul, Korea, April 22-24, 2004

[A.12] Whai-En Chen, Kwei-Bor Chen, Nen-Fu Huang, "Fast and Scalable Multi-TCAM Classification Engine for Wide Policy Table Lookup," IEEE AINA2005, March 2005, Taipei, Taiwan.

[A.13] Nen-Fu Huang, Rong-Tai Liu, Chih-Ho Chen, Y.T. Chen, Li-Wen Huang, "A Novel URL Lookup Engine for Content-Aware Multi-gigabit Switches," IEEE AINA2005, March 2005, Taipei, Taiwan.

Sub-project 2：Optical Networking and QoS Technologies

Journal Papers:

[B.1] Maria C. Yuang, Po L. Tien, and J. Shih, "QoS Scheduler/Shaper for Optical Coarse Packet Switching IP-over-WDM Networks," *IEEE Journal on Selected Areas in communications*, vol. 22, no. 9, Nov. 2004, EI., SCI..

[B.2] S. W. Lee, Maria C. Yuang, Po L. Tien, and S. H. Lin, "A Lagrangean Relaxation based Approach for Routing and Wavelength Assignment in Multi-granularity Optical WDM Networks," *IEEE Journal on Selected Areas in communications*, vol. 22, no. 9, Nov. 2004, EI., SCI..

[B.3] D. Z. Hsu, S. L. Lee, P. M. Gong, Y. M. Lin, Steven S. W. Lee, and Maria C. Yuang, "High-Efficiency Wideband SOA-Based Wavelength Converters by Using Dual-Pumped Four-Wave-Mixing and an Assisted Beam," *IEEE Photonic Technology Letter*, vol. 16, no. 8, pp. 1903-1905, Aug. 2004, EI., SCI..

[B.4] Jason Jyehong Chen, "Dispersion-compensating optical digital filters for 40Gb/s Metro Add-Drop Application", *IEEE Photonic Technology Letter*, vol. 16, no. 5, May 2004, EI., SCI..

[B.5] Y. Chang, Y. Lin, Jyehong Chen, and G. Lin, "all optical NRZ-to-PRZ format transformer with an injection-locked Fabry-Perot laser diode at unlasing condition," *Optics Express*., vol. 12, no. 19, Sept. 2004, SCI..

[B.6] Huan-Yun Wei, and Ying-Dar Lin, "A Survey and Measurement-Based Comparison of Bandwidth Management Techniques," to appear in *IEEE Commun. Surveys and Tutorials*, 2005, EI., SCI..

[B.7] Huan-Yun Wei, Ching-Chuan Chiang, Ying-Dar Lin, "Co-DRR: An Integrated Uplink and Downlink Scheduler for Bandwidth Management over Wireless LANs," to appear in *IEICE Transactions on Communications*, 2005, EI., SCI..

Conference Papers:

[B.8] S. W. Lee, Maria C. Yuang, and Po L. Tien, "A Lagrangean Relaxation Approach to Dynamic Routing and Wavelength Assignment for Multi-granularity Optical WDM Networks," *IEEE GLOBECOM*, Nov. 2004, EI..

[B.9] Maria C. Yuang, Po L. Tien, J. Shih, Steven S. W. Lee, Yu-Min Lin, Frank Tsai, and Alice Chen, "Optical Coarse Packet Switched IP-over-WDM Network (OPSINET): Technologies and Experiments," *IEEE/SPIE APOC*, Nov. 2004, EI..

[B.10] Z. Zhu, W. Chen, Y. Chen, J. Sun, D. Huang, and Jyehong Chen, "Cascaded-able Cline-reconfigurable Optical Add-drop Multiplexer," *IEEE ECOC*, 2004, EI..

[B.11] Ying-Dar Lin, Shih-Chiang Tsao, and Un-Pio Leong, "On-the-Fly TCP Path Selection Algorithm in Access Link Load Balancing," *IEEE GLOBECOM*, 2004, EI..

[B.12] Iwei Chen, Ying-Dar Lin, Yineng Lin, "Tunnel Minimization and Relay for Managing Virtual Private Networks," *IEEE GLOBECOM*, 2004, EI..

[B.13] Huan-Yun Wei, Shih-Chiang Tsao, Ying-Dar Lin, "On Shaping TCP Traffic at Edge Gateways," *IEEE GLOBECOM*, 2004, EI..

[B.14] Yi-Neng Lin, Chiuan-Hung Lin, Ying-Dar Lin, and Yuan-Chen Lai, "VPN Gateways over

Network Processors: Implementation and Evaluation," *IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS'05)*, 2005.

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

Journal papers

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

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

[C.3] Lin, Y. -B. Per-user Checkpointing for Mobility Database Failure Restoration. Accepted and to appear in *IEEE Transactions on Mobile Computing*.

[C.4] Haung, Y. -R., and Lin, Y. -B., A bandwidth-on-demand strategy for GPRS. Accepted and to appear in *IEEE Transactions on Wireless Communications*.

[C.5] Fang, M., and Lin, Y. -B. Mobility Management and Signaling Traffic Analysis for Multi-tier Wireless Mobile Networks. Accepted and to appear in *IEEE Transactions on Vehicular Technology*.

[C.6] Wang, S. -Y. and Lin, Y. -B. Wireless Internet Simulation Using NCTUns 2.0: An Innovative Network Simulator and Emulator. Accepted and to appear in *Wireless Communications and Mobile Computing*.

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

[C.8] Pang, A. -C. and Lin, Y. -B. 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] Pang, A. -C. and Lin, Y. -B. VoIP Services for Mobile Networks, Novatica, Redes I nalambricas: *una nueva era en las Telecomunicaciones*, 167, Jan. -Feb., 2004.

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Sub-project 5：Network Security

Journal Papers

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Sub-project 6: Techniques and Applications of Overlay Networks

Journal Papers

[F.1] C. F. Lin, S. K. Liao, Y. C. Chung, and D. L. Yang, "A Rotate-Tiling Image Composition Method for Parallel Volume Rendering on Distributed Memory Multicomputers," *Journal of Information Science and Engineering*, Vol. 20, No. 4, July 2004, pp. 643-664. (SCI) (Times Cited: 0)

[F.2] S. K. Liao, Jim Z.C. Lai, and Y. C. Chung, "Time-Critical Rendering for Time-Varying Volume Data," Computers & Graphics, Vol. 28, No. 2, April 2004. (SCI, EI) (Times Cited: 0)

[F.3] T. Y. Huang, K. L. Huang, and Y. C. Chung, "Performance Analysis of Hard-Real_time Embedded Software," To appear in International Journal on Embedded Systems.

[F.4] T. C. Su, S. Y. Huang, C. L. Chan and J. S. Wang, "Optimal Chaining Scheme for Video-on-Demand Applications on Collaborative Networks," accepted by IEEE Transactions on Multimedia, 2004. (SCI, EI) (NSC 93-2752-E-007-004-PAE)

[F.5] C. W. Chen, J. K. Lee, P. C. Wey, J. S. Chen, "Support and optimization of Java RMI over Bluetooth environments," Concurrency and Computation:Practice and Experience, Wiley, (to appear) (SCI) (Times Cited: 0)

[F.6] H.C. Chen and A.L.P. Chen, "A Music Recommendation System based on Music and User Grouping," Journal of Intelligent Information Systems, Special Issues on Multimedia Applications, Kluwer Academic Publishers. (to appear) (SCI, EI) (93-2752-E-007-004-PAE)

[F.7] N.H. Liu, Y.H. Wu, and A.L.P. Chen, "Efficient kNN Search in Polyphonic Music Databases Using a Lower Bounding Mechanism," ACM Multimedia Systems Journal. (to appear) (SCI, EI) (93-2752-E-007-004-PAE)

[F.8] H.C. Hsiao, C.T. King, and C.-W. Wang, "Typhoon: Mobile Distributed Hash Tables," Jounral of Parallel and Distributed Computing, 2005 (to appear).

[F.9] H. C. Lin and S. S. Tzeng, "Double-Threshold Admission Control in Cluster-Based Micro/Picocellular Wireless Networks," Accepted, IEICE Transactions on communications, Nov. 2004.

Conference Papers

[F.10] D.Y. Chiu, D.Y. Lee, Y.H. Wu, and A.L.P. Chen, "A Fast Method to Build the RCE-network Classifier," Proc. of the 9th Conference on Artificial Intelligence and Applications (TAAI), Nov. 2004. (NSC 93-2752-E-007-004- PAE)

[F.11] Sheng-Kai Hung, Yarsun Hsu, "Reliable Parallel File System", 2004 International Computer Symposium, Dec 15-17, 2004. (NSC 93-2752-E-007-PAE)

[F.12] MingShen Lin, Yarsun Hsu, "Grid Enabled MPI: PACX-MPI Optimization", 2004 International Computer Symposium, Dec 15-17, 2004 (NSC 93-2752-E-007-PAE)

[F.13] H.C. Hsiao, M. Baker, and C.T. King, "A Peer-to-Peer Mechanism for Resource Location and Allocation Over the Grid," Proc. of the Second International Symposium on Parallel and Distributed Processing and Applications (ISPA'04), December 13-15, 2004, Hong Kong, China.

[F.14] H.C. Hsiao, C.T. King, and S.Y. Gao, "Making Exploitation of Peer Heterogeneity as a First Class Citizen for Resource Discovery in Peer-to-Peer Networks," Proc. of the First International Conference on Embedded on Ubiquitous Computing (EUC'04), August 25-27, 2004, Aizu, Japan. (NSC 93-2752-E-007-004-PAE)

[F.15] H.C. Hsiao, P.S. Huang, A. Banerjee, and C.T. King, "Taking Advantage of the Overlay Geometrical Structures for Mobile Agent Communications," Proc. of the 18th IEEE International Parallel and Distributed Processing Symposium (IPDPS'04), April 26-30, 2004, Santa Fe, NM, USA.

[F.16] Y. M. Sun, C. H. Yang, Y. C. Chung, and T. Y. Huang, "An Efficient Deadlock-Free Tree-Based Routing Algorithm for Irregular Wormhole-Routed Networks Based on the Turn Model," IEEE Proceedings of International Conference on Parallel Processing (ICPP 2004), Canada, August 2004, pp. 343-352. (NSC 93-2752-E-007-004-PAE)

[F.17] C. Y. Lin, Y. C. Chung, and J. S. Liu, "Performance Evaluation of Data Distributions with Load-Balancing for Sparse Arrays," Proceedings of IEEE International Symposiums on Parallel Architecture, Algorithms, and Networks (I-SPAN), Hong Kong, May 2004, pp. 207-212.

[F.18] X. Y. Lin, Y. C. Chung, and T. Y. Huang, "A Multiple LID Routing Scheme for Fat-Tree-Based InfiniBand Networks," Proceedings of IEEE International Parallel and Distributed Processing Symposiums (CD-ROM), USA, April 2004.

[F.19] C. M. Huang, K. C. Yang, and J. S. Wang, "Error Resilience Supporting Bi-Directional Frame Recovery for Video Streaming," to appear in Proc. of International Conference on Image Processing (ICIP) 2004. (EI)

[F.20] C. L. Chan, M. Jan, S. Y. Huang, and J. S. Wang, "Peer-to-Peer Video Delivery Scheme for Large Scale Video-on-Demand Applications," in Proc. of International Conference on Multimedia and Expo 2004 (ICME'04), 2004. (EI)

[F.21] C. Y. Cho, Y. T. Chuang, S. Y. Huang, and J. S. Wang, "Efficient Motion-Vector-Based Video Search Using Query by CLIP," in Proc. of International Conference on Multimedia and Expo 2004 (ICME'04), 2004. (EI)

[F.22] C. M. Huang, K. C. Yang, and J. S. Wang, "Support Fast Scan Operations with Video Streaming Technology," in Proc. of International Conference on Multimedia and Expo 2004 (ICME'04), 2004. (EI)

[F.23] W. D. Chien, Y. S. Yeh, and J. S. Wang, "Practical Channel Transition for Near-VOD Services," in International Conference on Multimedia and Expo 2004 (ICME'04), 2004. (EI)

[F.24] Y. S. Hsu, "Design considerations for low power distributed sensor network", Proc. of Workshop for International Collaboration in SoC and Embedded System Technologies, April 22-24, 2004, Seoul, Korea

[F.25] C. K. Chen, C. W. Chen, J. K. Lee, "Specification and Architecture Supports for Component Adaptations on Distributed Environments," Proc. of IPDPS 2004, Santa Fe, USA, April 2004.

[F.26] C. W. Chen, C. K. Chen, J. C. Chen, C. T. Ko, J. K. Lee, H. W. Lin, W. J. Wu, "Efficient Support of Java RMI over Heterogeneous Wireless Networks," Proc. of International Conference on Communications (ICC), Paris, June 2004.
[F.27] D.Y. Chiu, Y.H. Wu, and A.L.P. Chen, "An Efficient Algorithm for Mining Frequent Sequences by a New Strategy without Support Counting," Proc. of IEEE Conference on Data Engineering (ICDE), pp. 375-386, Mar.-Apr. 2004.
[F.28] H.C. Chen, C.H. Lin, and A.L.P. Chen, "Music Segmentation by Rhythmic Features and Melodic Shapes," Proc. of IEEE Conference on Multimedia and Expo (ICME). Jun. 2004.
[F.29] J.L. Hsu, A.L.P. Chen, and H.C. Chen, "Finding Approximate Repeating Patterns from Sequence Data," Proc. of International Conference on Music Information Retrieval (ISMIR), Oct. 2004.
[F.30] Y.S. Tzeng, H.C. Chen, and A.L.P. Chen, "A New Approach for Rating-Based Collaborative Music Recommendation Using Personal Preferences and Opinions From Trustable Users," Proc. of The IASTED Conference on Internet and Multimedia Systems and Applications (IMSA), 2004.
[F.31] C.H. Lee, C.W. Cho, Y.H. Wu, and A.L.P. Chen, "A Novel Representation of Sequence Data based on Structural Information for Effective Music Retrieval," Proc. International Conference on Database Systems for Advanced Applications (DASFAA), Lecture Notes in Computer Science, 2973: 393-404, 2004. (SCI)
[F.32] C.R. Lin, N.H. Liu, Y.H. Wu, and A.L.P. Chen, "Music Classification Using Significant Repeating Patterns," Proc. International Conference on Database Systems for Advanced Applications (DASFAA), Lecture Notes in Computer Science, 2973: 506-518, 2004. (SCI)
[F.33] H. C. Lin and S. S. Tzeng, "Double-Threshold Admission Control in Cluster-Based Micro/Picocellular Wireless Networks," Accepted, IEICE Transactions on communications, Nov. 2004.

Books:

[F.34] Y.S. Chen , "Web Recommendation Systems"遠流出版社

Book Chapters:

[F.35] Y.H. Wu and A.L.P. Chen, "Data Analysis," （a book chapter in Encyclopedia of Computer Science and Computer Engineering, John Wiley & Sons, unde review, manuscript sent in Jun. 2004.）

2. PATENT LIST

Sub-project 2：Optical Networking and QoS Technologies

[1] Po-Ching Lin, Ying-Dar Lin, "Early Blocking and Bypassing for Accelerating Web Content Filtering," ROC and USA pending, 2004.
[2] Ying-Dar Lin, et al., "Method of Request Scheduling for Differentiated Quality of Service at Intermediaries," ROC and USA pending, 2004.
[3] Ying-Dar Lin, et al., "Request scheduling for differentiated QoS at access gateway," ROC and USA pending, 2004.
[4] Dar-Zu Hsu, et al. "High-efficiency and wideband SOA-based wavelength converters by using four-wave- mixing with orthogonal pumps and an assisted beam," ROC (Pending Number: 92125817) and USA pending, , 2004.

[5] Jyehong Chen, et al., “Optical circulator”, USA Pate No. 6757451, June 29, 2004.

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

[1] Lin, Y. -B., Pang, A. -C., Chen, T. -S., and Feng, V., Multicast Mechanism for Mobile Networks (with CCL/ITRI). ROC Patent 205010 (June, 2004-March, 2022). Wireless VoIP
[2] Pang, A. -C., Lin, Y. -B., and Haung, Y. -R. System and method of providing voice communications for radio network (with CCL/ITRI). ROC Patent No. 185594, 2004.
[3] 曾煜棋,阮騰輝, “動態網路負載平衡方法以及系統”, Taiwan (pending)
[4] 曾煜棋,阮騰輝, “動態網路負載平衡方法以及系統”, USA (pending)

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

[1] 郭聖博, 李青松, 林俊佑, 曾煜棋, “使用混亂樣本策略之室內定位方法及系統”, Taiwan (pending).
[2] P. Agrawal and J. C. Chen, “Adaptive signaling for wireless packet telephony”, US6,775,253, issued by U.S. Patent and Trademark Office, August 10, 2004.
[3] J. K. Lee, J. C. Chen, C. W. Chen, and C. K. Chen, “Method and system for providing roaming of remote object procedure call in a heterogeneous wireless network environment”, pending, filed with U.S. Patent and Trademark Office and R.O.C. Patent and Trademark Office, May 2004.
[4] J. C. Chen, L. W. Lin and Y. W. Liu, “Method and system for dynamic agent assignment for mobile VPN (I)”, pending, filed with U.S. Patent and Trademark Office and R.O.C. Patent and Trademark Office, July 2004.
[5] J. C. Chen, L. W. Lin and Y. W. Liu, “Method and system for dynamic agent assignment for mobile VPN (II)”, pending, filed with U.S. Patent and Trademark Office and R.O.C. Patent and Trademark Office, July 2004.
[6] 陳志成、洪偉懷、周孜燦, 蜂巢式無線通訊網路與無線區域網路之整合簡訊服務系統及方法, 中華民國專利申請中, Oct. 2004.
[7] 許健平,張志勇,石貴平,游國忠,” HyperPen 及 HyperExam 之設計方法及其應用”, Taiwan (pending)
[8] 許健平,張志勇,張兆村,” 以藍芽技術實現 BlueCube 之平行計算與通訊環境”, Taiwan (pending)

Sub-project 5：Network Security

[1] S. S. Tseng (曾憲雄), W. C. Chen (陳威州), and C. Y. Wang (王慶堯), “Method for Detection of Manufacture Defects (製造上瑕疵偵測方法及其系統),” Taiwan (台灣). (2005. 02 Granted)

Sub-project 6: Techniques and Applications of Overlay Networks

[1] 林華君，朱永華，"Ad Hoc 無線網路中混合主動式與反應式的路由選擇法" 中華民國專利申請中。
[2] 林華君，江紹寧，"行動電話系統之資料庫滿溢問題的解決方法" 中華民國專利申請中。
[3] 李政崑，陳志成，陳呈瑋，陳崇凱，”提供異質性無線網路環境中遠端物件程序呼叫之漫遊方法與系統” 中華民國專利申請中。(專利權人:國立清華大學)
[4] H. C. Lin and P. C. Fung, “Method for Finding and Reserving Available Bandwidth in Multihop Mobile Wireless Networks,” U.S. patent, pending.
[5] H. C. Lin and S. S. Tzeng, “Double-Threshold Admission Control Method in Cluster-Based Micro/Picocellular Wireless Networks,” U.S. patent, pending.
[6] H. C. Lin and S. N. Jiang, “Method and System for Handling Mobile Database Overflow,” U.S. patent, pending.
[7] H. C. Lin and Y. H. Chu, “Method and System for Route Selection and Method for Route reconstruction,” U.S. patent, pending.
[8] 林華君，王建興，"分散式網路連結掃描之掃描點選擇法," 中華民國專利二二0六一三號，專利期間 93 年 8 月 21 日至 111 年 12 月 23 日。

3. INVENTION LIST

[1] **InfoProtector 3.0.**
InfoProtector is a software application designed for copyright protection and authentication of digital media. The current version (3.0) can process digital images in the BMP, TIFF, JPG, and GIF formats and also digital videos in the MPEG 1 format. Its functionality include: embedding an invisible watermark for copyright protection; adding annotations in multimedia files; and adding fragile watermarks for authentication purposes.

4. LIST OF WORKSHOP/CONFERENCE HOSTED BY THE PROGRAM

Main Project

[1] Workshop – 2004/05/18 Speaker : Professor Phillip C-y. Sheu (Professor, Department of Electrical Engineering & Computer Science;Professor, Department of Biomedical Engineering, University of California, Irvine. Topic：Pricing-based Congestion Control: Multicast Communications and Probabilistic Packet Marking
[2] Workshop – 2004/07/1 Speaker: Professor David H.C. Du（Department of Computer Science and Engineering University of Minnesota, Minneapolis, Minnesota, USA）. Topic：Network-Based Data Storage Systems and Its Applications
[3] Workshop – 2004/12/24 Speaker: Professor C.-C. Jay Kuo (Integrated Media Systems Center, Department of Electrical Engineering, University of Southern California). Topic：Digital Rights Management (DRM) Technologies and Systems

Sub-project 1：High Speed Networking Technologies

[1] 2004/07/14─Dr. Douglas Comer
(Distinguished Professor of Computer Science, Purdue University)
Title：An Overview of Network Processors (Participants：50)
[2] 2004/12/16─Mehyar, Mortada Talal Ghaleb
(PHD student from California Institute of Technology)
Title: Distributed Averaging on Peer-to-Peer Networks (Participants：40)
[3] 2004/12/30─Professor Shuo-Yen Robert Li (Bob)The Chinese University of Hong Kong
Title: Theory of Linear Network Coding (Participants：50)
[4] 2005/1/18─Professsor Lin,Yi-Long (Paul) 台灣電腦網路危機處理暨協調中心執行長
Title: 資通安全鑑識與數位證據 (Participants：50)
[5] 2004/12/21- Workshop on Compilers and Applications for Network Processors (Participants：80)

Sub-project 2：Optical Networking and QoS Technologies

[1] 2004/07/09-12 – Dr. Tingye Li, U.S. National Academy of Engineering and WDM Founder
Topic：WDM Technologies in Optical Networks
(Participants：30) (Maria C. Yuang)
[2] 2004/10/11-13 – Seminar, Prof. Biswanath Mukherjee, UC Davis
Topic：Optical Access Networks / Resilient Mesh Networks / Traffic Grooming in Mesh Optical Networks
(Participants：40) (Maria C. Yuang)
[3] 2004/07/16 - WLAN SOHO Router Benchmarking Workshop
(Participants：75) (Ying-Dar Lin)
[4] 2004/08/26 – Networking Test Technique Workshop
(Participants：115) (Ying-Dar Lin)
[5] 2004/12/6~10 – Asia-DSL Plugfest and Forum
(Participants：140) (Ying-Dar Lin)
[6] 2005/01/27 – Security Products Benchmarking Workshop
(Participants：90) (Ying-Dar Lin)

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

[1] Y. -C. Tseng, Vice Chair, Int' l Conf. on Distributed Computing Systems (ICDCS), 2004, Japan.
[2] Y.-B. Lin and Y.-C. Tseng, General Chairs: Mobile Computing Workshop, 2005, Taiwan. (to be held in 03/2005)

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

[1] Workshop: “Information Discovery and Sharing in Mobile Networks”, Speaker: Dr. Tao Zhang, Telcordia Technologies, U.S.A (Location: NTHU).
[2] Workshop: “Optimal Decision Fucsion with Applications to Target Detection in Wireless Sensor Network”, Speaker: Prof. Yu-Hen Hu –Dept and Computer Engineering University of Wisconsin-Madison, USA (Location: NCTU).
[3] Workshop: “Advanced Technologies and Applications for Next Generation Information Networks”, Speaker: Prof. Chi-Hsiang Yeh, Queen's University, Canada (Location: NCTU).

Sub-project 5：Network Security

Workshop

[1] Workshop : Data mining and network applications workshop III , 2004/04/24 , Miaoli . (Participants : 28)
[2] Workshop :Data mining and network applications workshop IV , 2004/10/29 , WNIC(Taipei). (Participants : 31)

Training Course

[1] 2004/09/23 , Tzung – Pei Hong : The application of fuzzy sets on data mining , NCTU . (Participants : 150)
[2] 2004/12/20 , Application and Monitoring for VoIP , H .E. Chen , NCTU . (Participants : 35)

Sub-project 6: Techniques and Applications of Overlay Networks

Workshops/Conferences

[1] 2004/07/19-20, The 1st Canada-Taiwan SOC Workshop, Banff, Canada(Participants：50)
[2] 2004/08/25-27-International Conference on Embedded and Ubiquitous Computing (EUC2004): PC vice chair
[3] 2004/08/31─The First SCAN Forum (Participants：110)
[4] 2004/12/7-8─The First Workshop on Grid Technology and Applications (Participants：120)
[5] 2004/12/21─Workshop on Compilers and Applications for Network Processors (Participants：100)
[6] 2005/01/11─Workshop on Compiler and SoC Architecture Designs (Participants：95)

Training Course

[7] 93/7/29 中研院 2004 年同儕計算暑期研討會**:** P2P Computing: An Introduction (3 hours) (Participants：100)
[8] 93/9/24 通訊教育改進計畫短期課程 (中正大學) P2P Short course (7 hours) (Participants：100)

5. LIST OF PERSONAL ACHIEVEMENTS OF THE PIS

Sub- project 1：High Speed Networking Technologies

[1] Prof Cheng-Shang Chang was elected to an IEEE Fellow in 2004.
[2] Prof. Cheng-Shang Chang is the TPC co-chair for Performance 2005, Oct 3-7, Juan-les-Pins, France.
[3] Prof. Yarsun Hsu and Prof. Duan-Shin Lee are TPC members of Performance 2005.
[4] Prof. Nen-Fu Huang is the Steering Committee member of Ipv6 Summit 2004, Taipei, Taiwan, and the TPC member of IEEE AINA conference 2005.
[5] Prof Nen-Fu Huang is the guest Editor of IEEE JSAC on special issue of Ipv6 overlay networks, September 2004.
[6] Prof. Nen-Fu Huang received the Technology Transfer Award from the National Science Council (NSC) of Taiwan, 2004.
[7] 黃能富教授指導學生(鄔培麟, 陳志豪, 黃遠芳, 曾偉嘉)獲 NICI 行政院 IPv6 推動計劃辦公室之 2004 IPv6 程式設計競賽第一名
[8] 黃能富教授指導學生陳琮元獲日本 2004 IPv6 程式競賽創意組 Excellent Award

Sub-project 2：Optical Networking and QoS Technologies

[1] 2004/11/07 楊啟瑞教授應 IEEE APOC'04 國際會議邀請專題演講
Topic：Optical Coarse Packet Switched IP-over-WDM Network (OPSINET): Technologies and Experiments
[2] 2004/07/21 林盈達教授應資策會邀請專題演講及座談
Topic: 台灣往通產業總體檢-產品技術面
[3] 2004/08/12 林盈達教授應 Fortinet 公司邀請專題演講
Topic: Trends in Network Security Product Development
[4] 2004/09/02 林盈達教授應 IFPI 倫敦總部邀請專題演講
Topic: P2P Application Behaviors

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

Yi-Bing Lin

- Y.-B. Lin received AAAS Fellow in 2004
- Member of Editorial Board, IEEE Transactions on Wireless Communications
- Member of Editorial Board, IEEE Transactions on Vehicular Technology
- Member of Editorial Board, ACM/KAP Wireless Networks
- Editor, IEEE Personal Communications Magazine
- Senior Technical Editor, IEEE Network
- Advisory Board, Intl. Journal of Ad Hoc and Ubiquitous Computing
- 92 學年度大專院校通訊科技專題製作競賽大專組特優獎
- 研發 IPv6 轉移機制之 Socket-Layer Translator 與 FTP-AL
- 2003, NCHC 國家高速電腦中心 第三屆 軟體設計比賽 佳作
- 2004, NICI IPv6 軟體設計比賽 亞軍
- 2004, IPv6 Application Contest in Japan, Top Prize
- 2004 IPv6 程式設計比賽 第二名

Y.-C. Tseng (以下併列子計畫三、四，Form 3 中未計入，以免重覆計算)

- Editorial Board, Tamsui Oxford Journal of Mathematical Sciences.
- Associate Editor, The Computer Journal, Oxford University Press (2001~present).
- Editorial Board, Journal of Information Science and Engineering, 08/2002~07/2005.
- Editorial Board, Int' l Journal of Ad Hoc and Ubiquitous Computing, 2004-present.
- Editorial Board, Wireless Communications and Mobile Computing, Wiley, 2004-present.
- Editorial Board, Int' l Journal of Pervasive Computing and Communications, Troubador Pub., 2004-present.
- Yu-Chee Tseng, Outstanding Research Award (National Science Council, 國科會傑出研究獎, 2003~2005)
- Yu-Chee Tseng received 九十三年資訊月「傑出資訊人才獎」
- Yu-Chee Tseng received 中國電機工程學會, 九十三年度青年論文獎第一名, 指導教授(獲獎學生: 劉衍谷, 題目: 整合行動電話網路及無線感測網路之事件驅動訊息系統)
- Yu-Chee Tseng, 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").
- 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("An Ad Hoc Network-Based Home VoIP System",曾煜棋, 李淩, 李沛鴻, 陳建志; 共同指導: 吳坤熹教授), 2004.

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

Wen-Tsuen Chen

- 第八屆教育部國家講座
- 2004 台灣積體電路設計學會特殊貢獻獎
- 中華民國科技管理學會院士(Fellow)
- Steering Committee Chair: IEEE Int'l Conf. on Parallel and Distributed Systems, Newport Beach, Calif., USA, July 2004

Yu-Chee Tseng

- Outstanding Research Award (National Science Council, 國科會傑出研究獎, 2003~2005)
- 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("An Ad Hoc Network-Based Home VoIP System",曾煜棋, 李淩, 李沛鴻, 陳建志; 共同指導: 吳坤熹教授), 2004.
- Yu-Chee Tseng received 九十三年資訊月「傑出資訊人才獎」.
- Yu-Chee Tseng received 中國電機工程學會, 九十三年度青年論文獎第一名, 指導教授(獲獎學生: 劉衍谷, 題目: 整合行動電話網路及無線感測網路之事件驅動訊息系統)
- 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").
- Editorial Board, Tamsui Oxford Journal of Mathematical Sciences.
- Associate Editor, The Computer Journal, Oxford University Press (2001~present). (http://www3.oup.co.uk/computer_journal/)
- Editorial Board, Journal of Information Science and Engineering, 08/2002~07/2005.
- Editorial Board, Int'l Journal of Ad Hoc and Ubiquitous Computing, 2004-present.
- Editorial Board, Wireless Communications and Mobile Computing, Wiley, 2004-present.

- Editorial Board, Int'l Journal of Pervasive Computing and Communications, Troubador Pub., 2004-present.
- Vice Chair: IEEE Int'l Conf. on Mobile Ad-hoc and Sensor Systems (MASS), 2004, Florida, USA.

Jyh-Cheng Chen

- J. C. Chen, 九十三年度國立清華大學新進人員研究獎（全校六人獲獎）
- J. C. Chen, 九十二年度國立清華大學電機資訊學院新進人員研究獎（全院一人獲獎）
- J. C. Chen, Guest Editor, Special issue on "All-IP Wireless Networks", IEEE Journal on Selected Areas in Communications (J-SAC), May 2004 (with P. Agrawal, T. Zhang, and C. Sreenan)
- J. C. Chen, 2004 通訊大賽 Play Tech 組 第一名 (獎金新台幣一百萬), 主辦單位：經濟部工業局等, 獲獎學生：劉宗樺, 陳凱修, 陳端哲, 向榮, 林俐瑋
- J. C. Chen, Program Chair, IEEE International Conference on Information Technology: Research and Education (ITRE '05), Taiwan, June, 2005 (Co-chairs: P. Lorenz, University of Haute Alsace, France, and D. Zhao, University of Michigan, USA)
- J. C. Chen, TPC member, IEEE GLOBECOM, St. Louis, MO, USA, November 28 - December 2, 2005
- J. C. Chen, TPC member, IEEE Sarnoff Symposium, Princeton, NJ, USA, April 18-19, 2005
- J. C. Chen, TPC member, IEEE INFOCOM, Miami, FL, USA, March 13-17, 2005
- J. C. Chen, TPC member, IEEE Wireless Communications and Networking Conference (WCNC '05), New Orleans, LA, USA, March 13-17, 2005
- J. C. Chen, TPC member, IEEE International Conference on Information Technology: Research and Education (ITRE '04), London, England, June 28-July 1, 2004

Jang-Ping Sheu

- Editor, IEEE Transactions on Parallel and Distributed Systems, Aug. 2004 ~ present.
- Editor, International Journal of Ad Hoc and Ubiquitous Computing, Aug. 2004 ~ present.
- Distinguished Engineering Professor Award, The Chinese Institute of Engineers, 2003. (Award delivered by President Chen of Taiwan)
- Specially Granted Researchers, National Science Council, 1999 ~ 2002 and 2002 ~ 2005. Three-year grant for researchers won three times of distinguished research awards.

Chih-Yung Chang

- Editorial Board, Tamsui Oxford Journal of Mathematical Sciences. (2001~present).
- Associate Guest Editor, Journal of Internet Technology (JIT), Special Issue on "Wireless Ad Hoc and Sensor Networks", 2004.
- Associate Guest Editor, Journal of Interconnection Networks (JOIN), 2005.

Chin-Liang Wang

- Editor, IEEE Transactions on Communications, 1998 ~ present.

Chih-Yung Chang

- Area Chair: IEEE 19th International Conference on Advanced Information Networking and Applications(AINA 2005), Taiwan.
- Vice Chair: IEEE International Symposium on Wireless IP (WirelesssCom 2005), Hawaii, USA.

- Track Chair: The 3rd International Conference on Information Technology: Research & Education (ITRE 2005), Taiwan.
- Program Co-Chair of The 7th International Workshop on Multimedia Network Systems and Applications (MNSA'2005), Ohio, USA.
- Workshop Co-Chair: IEEE 19th International Workshop on Information Networking and Applications(AINA 2005), Taiwan.
- Workshop Publication Chair of The International Workshop on Mobile Systems, E-commerce and Agent Technology (MSEAT'2004, MSEAT 2005), California, USA.
- Workshop Publication Chair of The International Workshop on Mobile Systems, E-commerce and Agent Technology (MSEAT'2005), Banff, Canada.

Sub-project 5：Network Security

Honor/Awards

W. H Tsai

- Good paper award W. H. Tsai and Y. C. Chiu (2004) in Chinese Image Processing & Pattern Recognition Society
- Good paper award W. H. Tsai and C. J. Lai (2004) in Chinese Image Processing & Pattern Recognition Society
- Contest Awards in National Digital Achieve Project Contest on Digital Watermarking Technology (2004) – 1st Prize (with student Y. C. Chiu et al.)

S. M. YUAN

- Honor Award, "mGrid: Mobile Grid SDK", MobileHero 2004, Ministry of Economic Affairs, R.O.C, 2004

Keynotes Given by PI s

S. S. Tseng

- 2004/05/07~ 6/25 – S.S.Tseng , Data Mining .(Participants : 30)
- 2004/05/07 - S.S.Tseng , Data Mining Concepts and Applications .(Participants : 30)
- 2004/05/12 - S.S.Tseng , Data preprocessing and data reducing . (Participants : 30)
- 2004/05/21 - S.S.Tseng , Classification . (Participants : 30)
- 2004/05/26 - S.S.Tseng , Clustering . (Participants : 30)
- 2004/06/4 - S.S.Tseng , Association Rule Mining . (Participants : 30)
- 2004/06/10 - S.S.Tseng , Data Mining Applications . (Participants : 30)
- 2004/06/18 - S.S.Tseng , 數位落差資料探勘分析報 . (Participants : 30)
- 2004/06/25 - S.S.Tseng , Expert System . (Participants : 30)
- 2004/06/29 - S.S.Tseng , An Architecture Study of Knowledge Retrieving and Analysis for Network Anomaly Behavior , (CCL) . (Participants : 20)
- 2004/10/21 - S.S.Tseng , A Data-Mining-Based Solution for Yield Enhancement in Semiconductor Manufacturing , (TSMC) (Participants : 100)
- 2004/10/26 - S.S.Tseng , 網際網路與電信匯流之發展 , (NCCU) . (Participants : 50)
- 2004/12/23 - S.S.Tseng , 網際網路與電信匯流之發展---SIP/Enum 技術介紹 , (CHU) . (Participants : 50)

Y.C.Chen

- 2004/12/29 - Y.C.Chen , Wireless Multimedia: Far and Near (Prudience University) .

(Participants : 60)

Journal Editors

S. S. Tseng

- Editor of Journal of Internet Technology
- Editor of Fuzzy System

W. H Tsai

- Advisory Editor, Global Management Research

Sub-project 6: Techniques and Applications of Overlay Networks

(一) Honor/ Awards

[1] Best Paper Award, 2004 International Computer Symposium, December 15-17, 2004, Sheng-Kai Hung and Y. S. Hsu, "Reliable Parallel File System"

[2] Best Paper Award, The First International Conference on Embedded on Ubiquitous Computing (EUC'04), H.C. Hsiao, C.T. King, and S.Y. Gao, "Making Exploitation of Peer Heterogeneity as a First Class Citizen for Resource Discovery in Peer-to-Peer Networks."

(二) Keynotes Given by PIs

[1] 2004/06/06─A.L.P. Chen 教授於人工智慧論壇(東華大學)演講
題目: Mining Frequent Sequences by a New Strategy without Support Counting

(三) Journal Editors

[1] J. S. Wang: 中國電機工程學刊 (Journal of Chinese Institute of Electrical Engineer) 已列入 EI (Compendex Plus Database) 與 IEE (INSPEC Database)

[2] A.L.P. Chen is a coordinating editor of the following journal: World Wide Web: Internet and Web Information Systems, Kluwer Academic Publishers

[3] C.T. King: Associated editor of Journal of Pervasive Computing and Communication

6. LIST OF TECHNOLOGY TRANSFER

7. LIST OF TECHNOLOGY SERVICE

˙**教育部數位學習國家型計劃**

曾憲雄教授，中小學城鄉數位落差之學習指標修訂、調查與形成因素分析，計劃時程: 93 年 12 月~94 年 12 月。

IX. Appendix III List of "Top" Journals and Conferences

Top Journal papers :

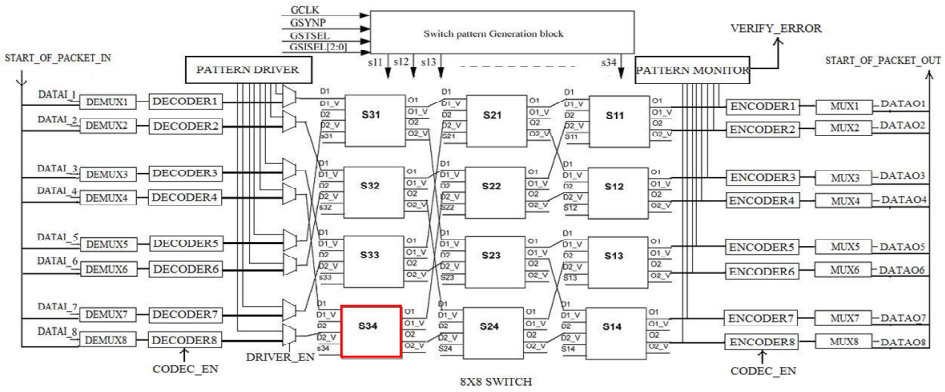
[1] IEEE Transactions on Information Theory (SCI 2.045)
[2] IEEE/ACM Transactions on Networking (SCI 2.408)
[3] IEEE Transactions on Automatic Control (SCI 1.553)
[4] IEEE Journal on Selected Areas in Communications (SCI 2.316)
[5] IEEE Transactions on Communications (SCI 1.562)
[6] IEEE/OSA Journal of Lightwave Technology
[7] IEEE Photonic Technology Letter
[8] IEEE Communications Magazine
[9] IEEE Transactions on Multimedia (Impact factor 2.253)
[10] Journal of Parallel and Distributed Computing

Top Conferences :

[1] IEEE INFOCOM (acceptance ratio 17%)
[2] ACM Sigcomm
[3] ACM Sigmetrics/Performance (acceptance ratio 14%)
[4] IEEE GLOBECOM (Global Telecommunications Conference)
[5] IEEE ICC (International Conference on Communications)
[6] IEEE/OSA OFC (Optical Fiber Communication Conference)
[7] ECOC (European Conference on Optical Communication)
[8] IEEE/SPIE APOC (Asia-Pacific Optical Communications Conference)
[9] IEEE Conference on Data Engineering (ICDE)
[10] International Conference on Database Systems for Advanced Applications (DASFAA)
[11] International Parallel and Distributed Processing Symposium
[12] International Conference on Parallel Processing
[13] International Conference on Image Processing

Sub- project 1：High Speed Networking Technologies

30Gbps symmetric TDM switch architecture

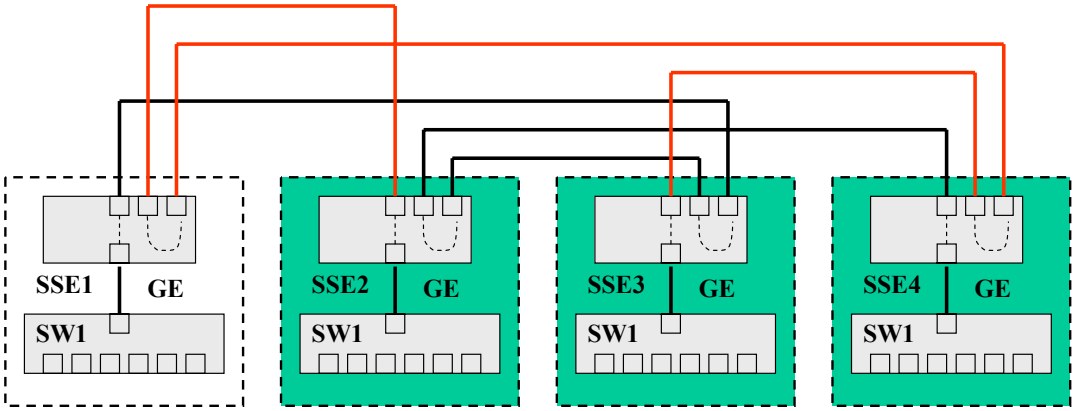


大學學術追求卓越發展延續計畫
下一世代資訊通訊網路尖端技術與應用

Performance summary

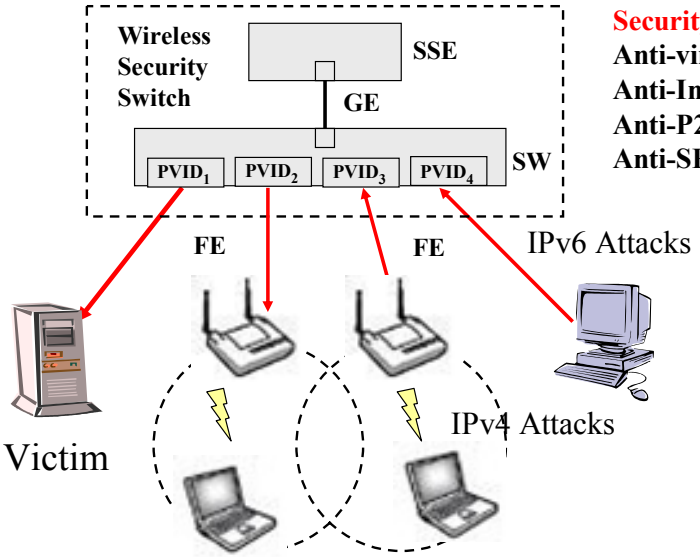
- A single chip with 8 inputs and 8 outputs
- Internal clock speed: 210 MHz (worst case)
- Power: 221.9622mW
- Chip size: 1531.45*u*m x1535.05*u*m
- Gate count: 44553
- Pin count: 50
- Total capacity: 33.84 Gbps
- Scalability (up to > 64x64=>260 Gbps)

Scalable HA/Load Balance Architecture for Security Switch



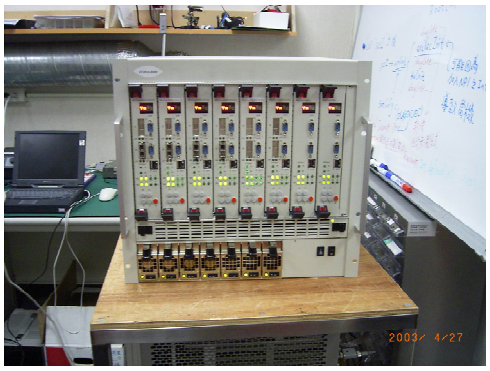
大學學術追求卓越發展延續計畫
下一世代資訊通訊網路尖端技術與應用

Prototyping of IPv4/IPv6 Wireless Security Switch



Security Service Engine
Anti-virus/worm
Anti-Intrusion
Anti-P2P/IM
Anti-SPAM

The 16Gbps chassis-based network processor platform for the SSE



Sub- project 2：Optical Networking and QoS Technologies

Figure 1. OPSINET-II Major Tasks

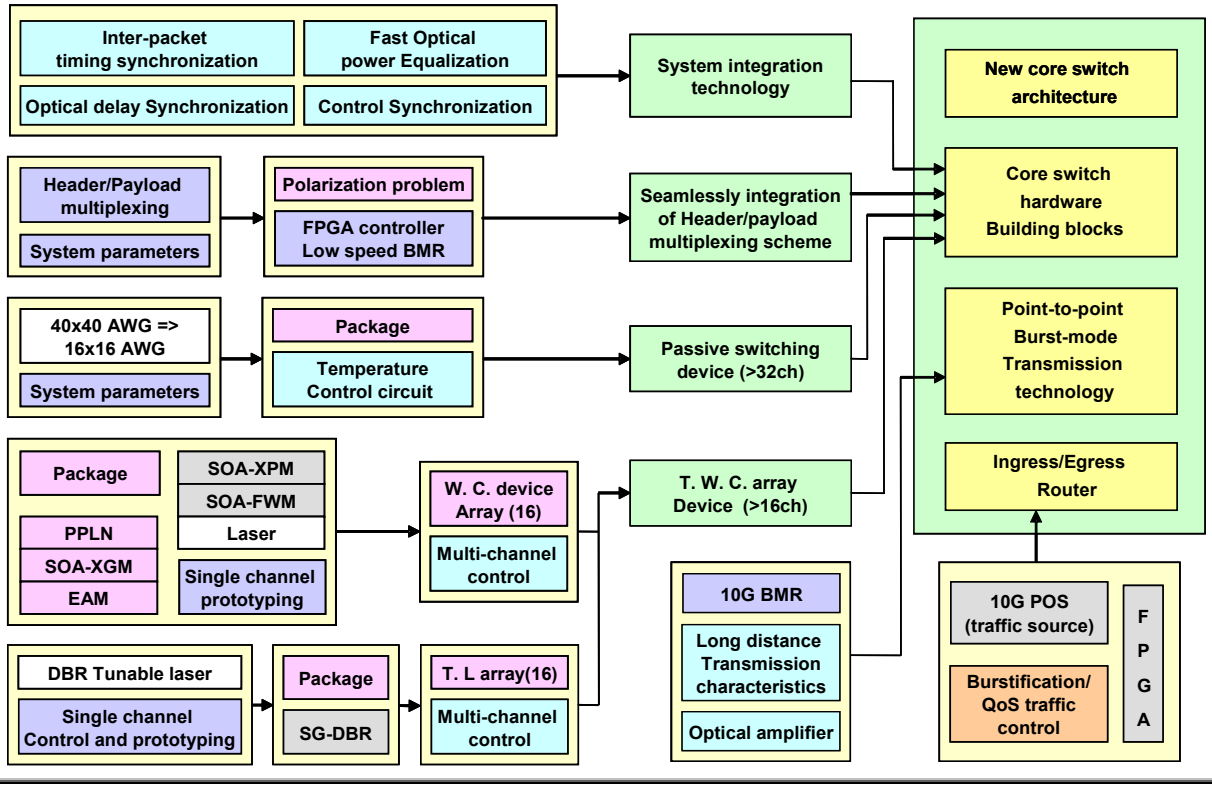
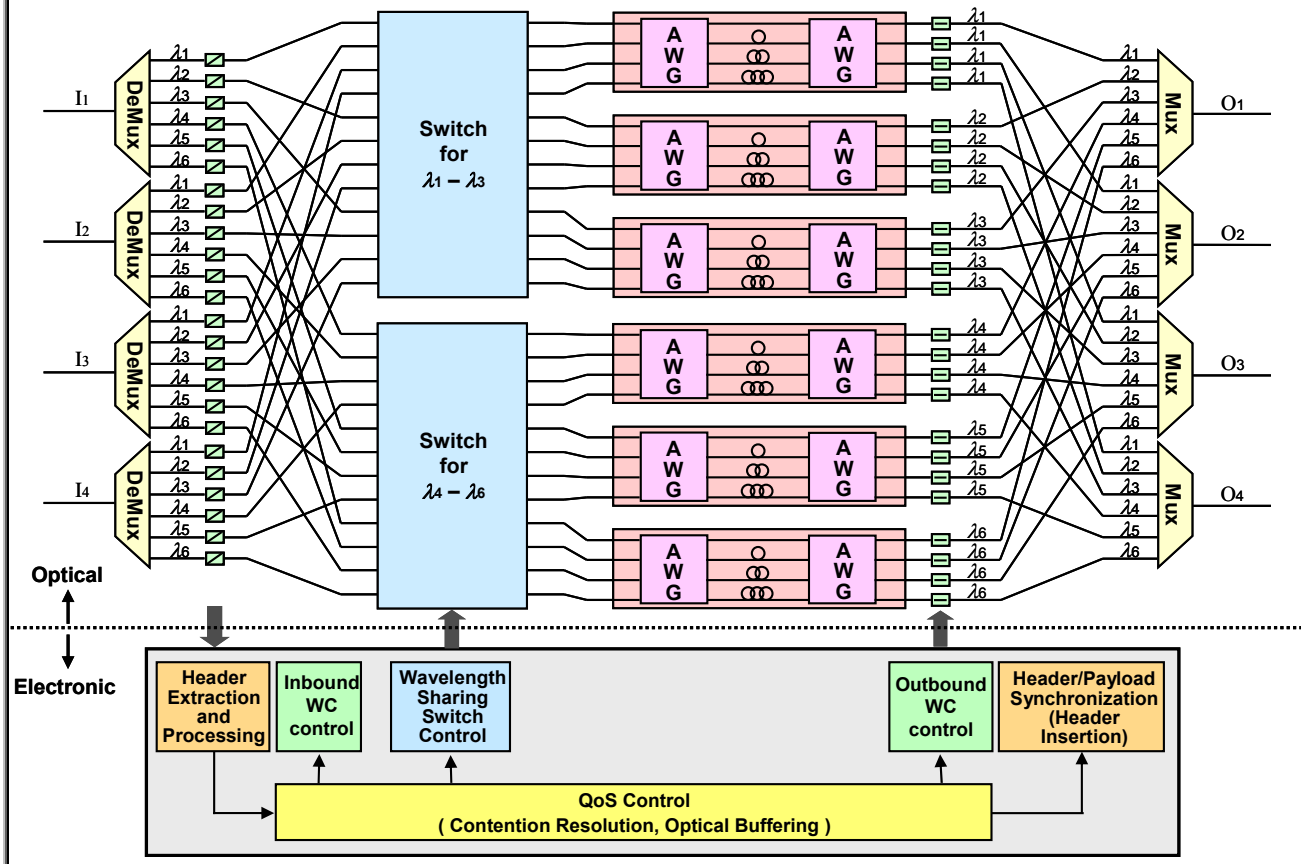
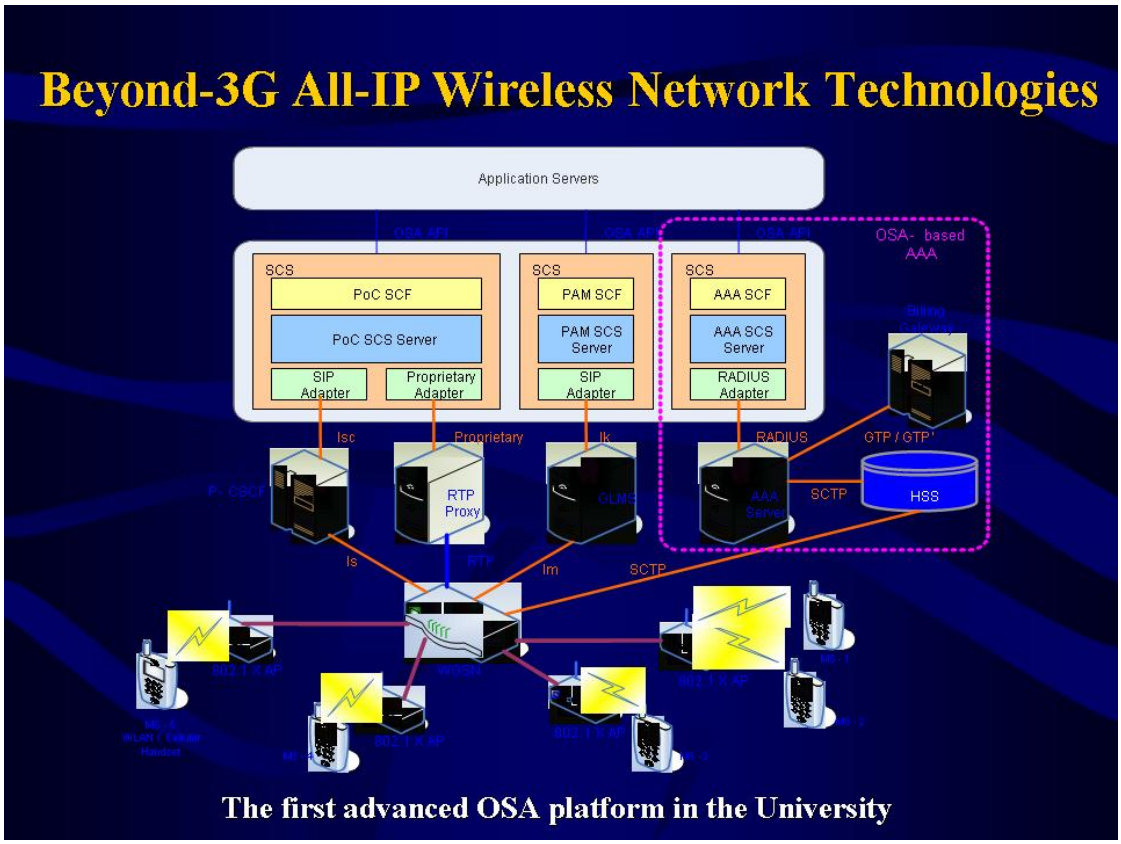
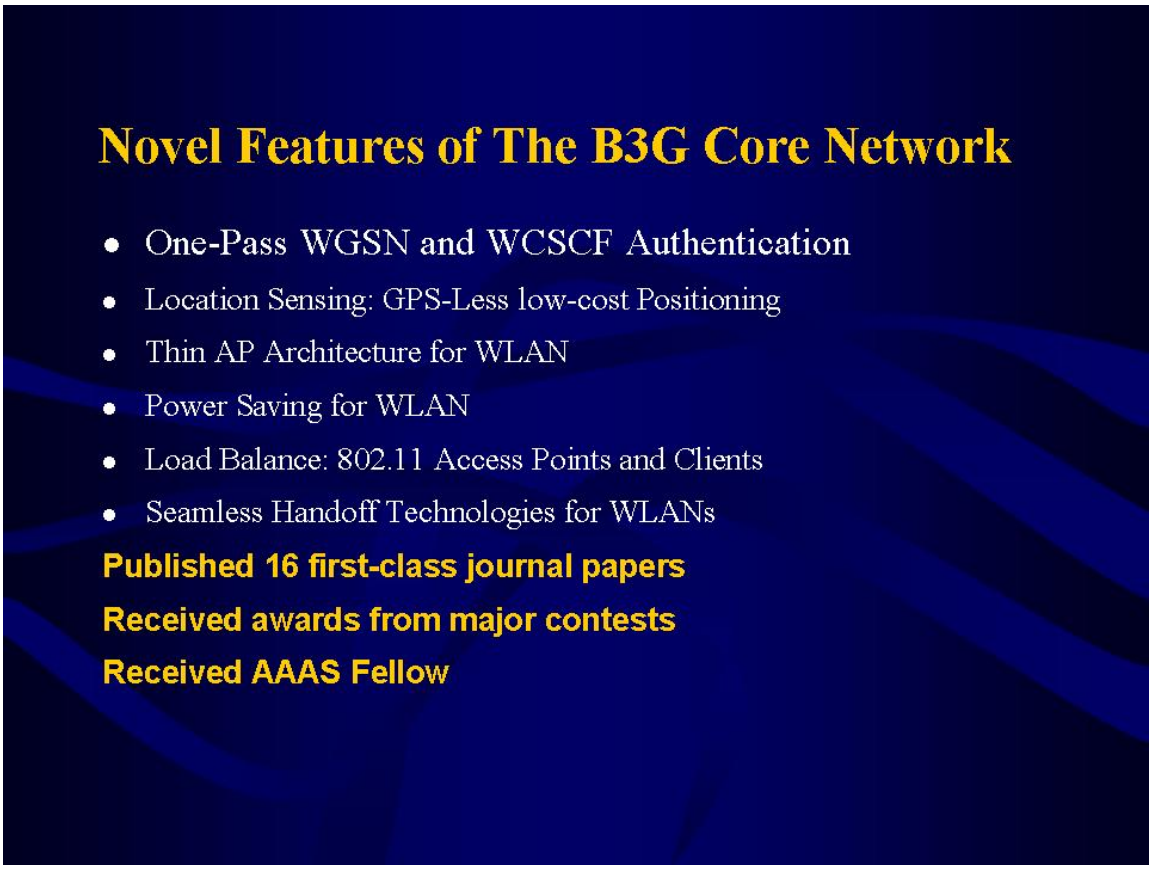


Figure 2. OPSINET-II Optical Core Switch Architecture



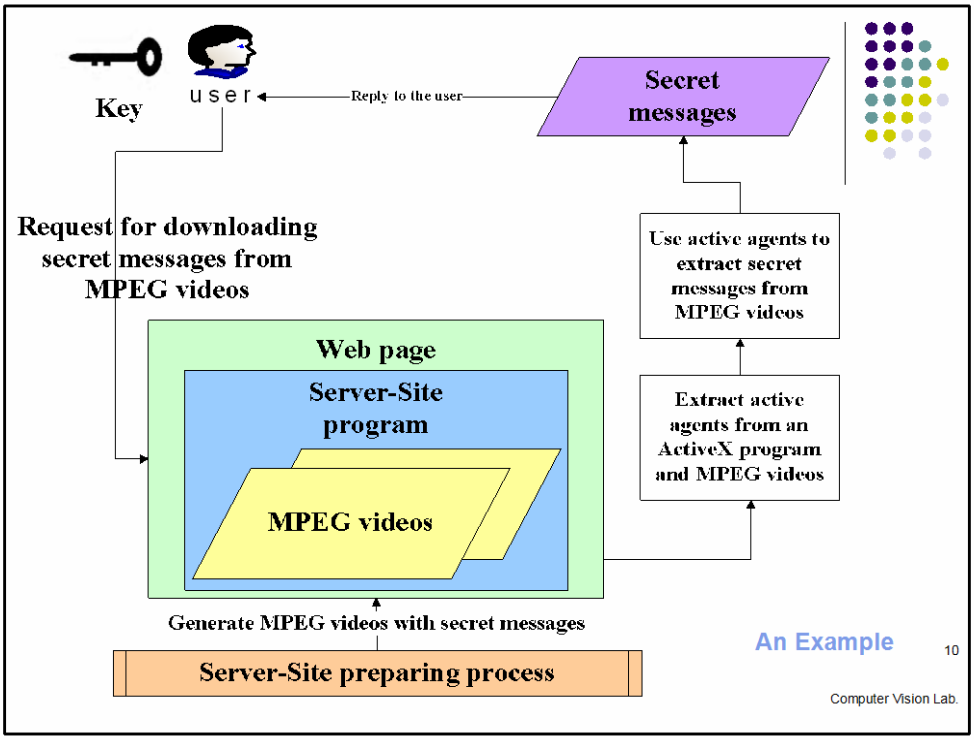
Sub-project 3: Beyond-3G All-IP Wireless Network Technologies

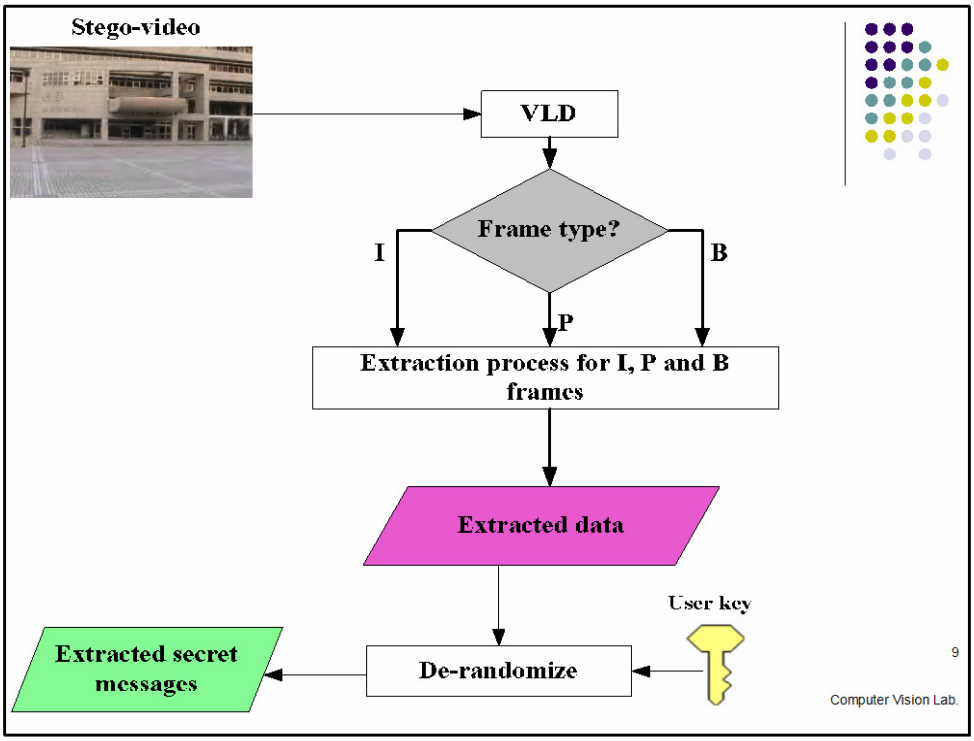


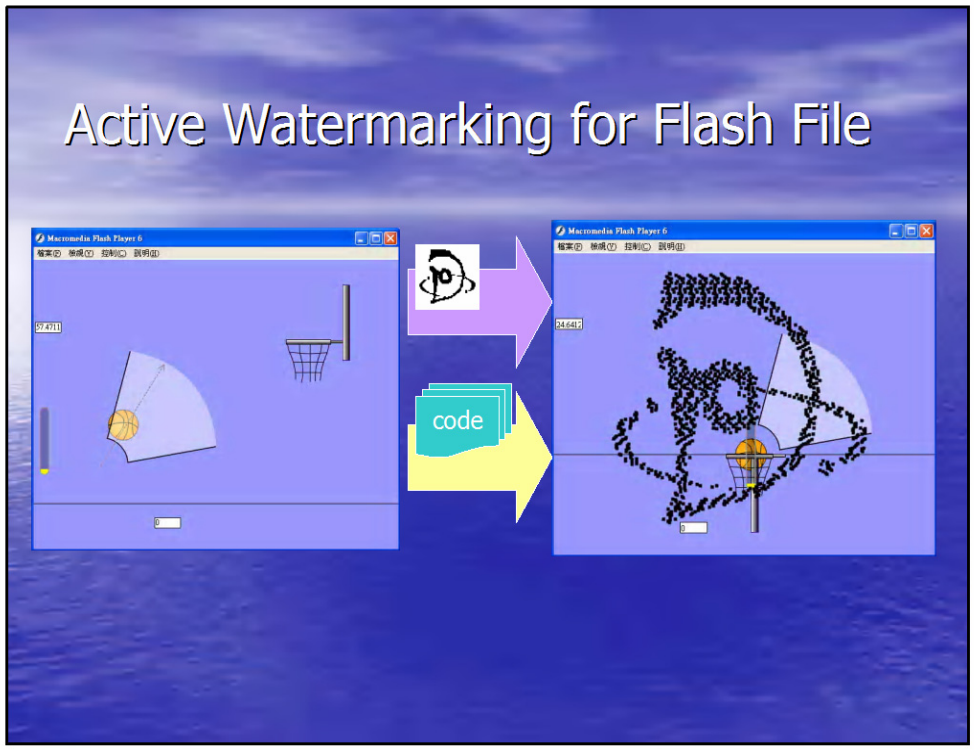


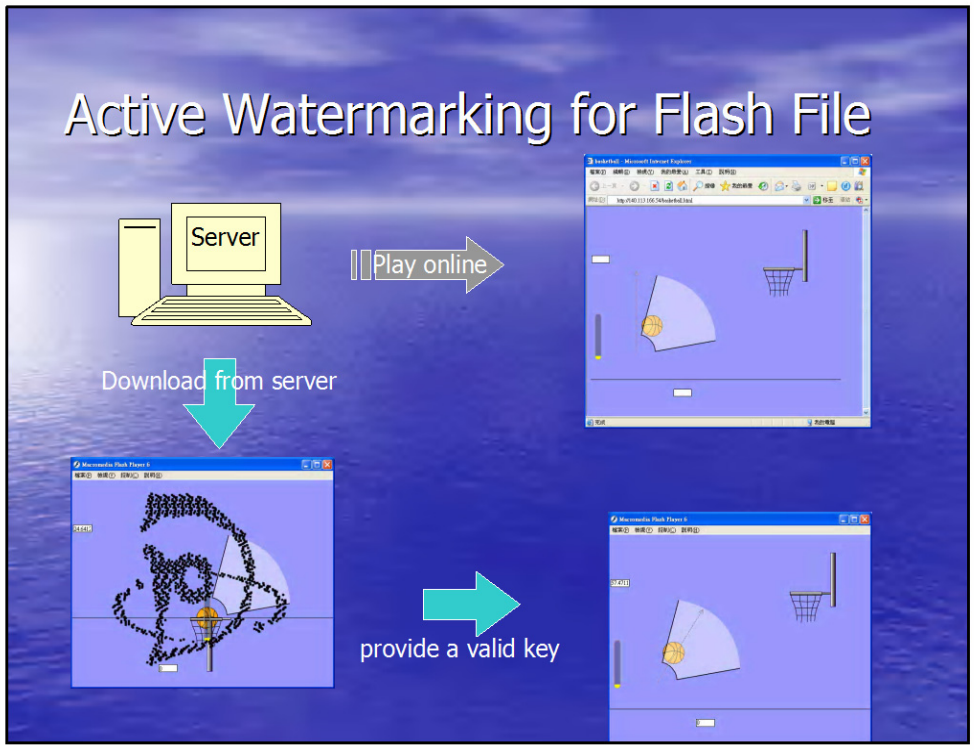
Sub- project 5：Network Security

Active Covert Communication by MPEG Videos

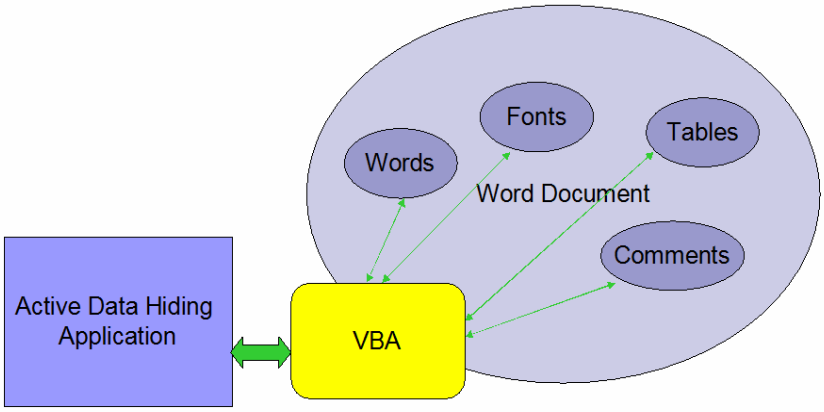

Key
user
Reply to the user
Secret messages
Request for downloading secret messages from MPEG videos
Use active agents to extract secret messages from MPEG videos
Web page
Server-Site program
MPEG videos
Extract active agents from an ActiveX program and MPEG videos
Generate MPEG videos with secret messages
Server-Site preparing process
An Example
10
Computer Vision Lab.


Stego-video
VLD
Frame type?
I
P
B
Extraction process for I, P and B frames
Extracted data
User key
Extracted secret messages
De-randomize
9
Computer Vision Lab.


Active Watermarking for Flash File
code

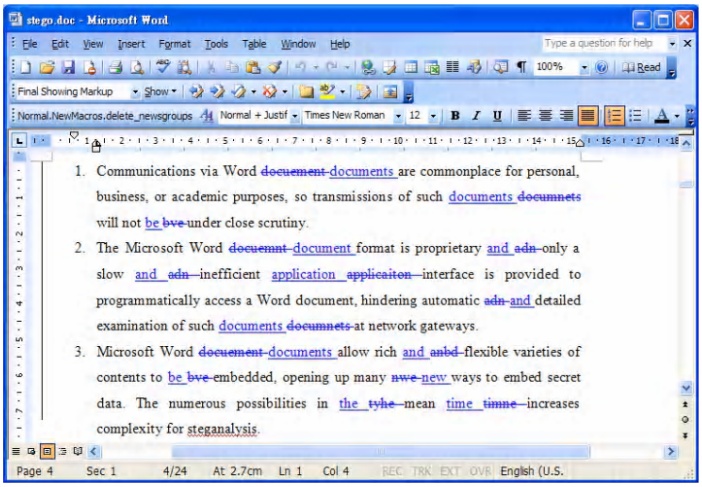

Active Watermarking for Flash File
Server
Play online
Download from server
provide a valid key

Active Data Hiding in Microsoft Word



Advanced Technologies and Applications for Next Generation Information Networks (II)

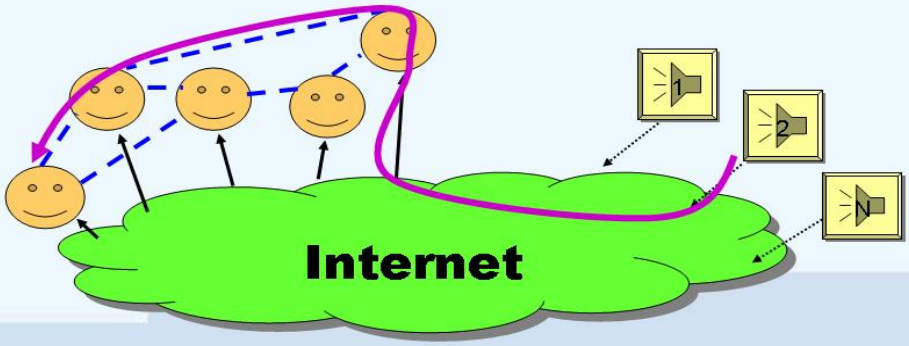
Active Covert Communication in Microsoft Word Document by Revision Tracking Technique



Advanced Technologies and Applications for Next Generation Information Networks (II)

Generic Overlay Infrastructure

- VC2A: overlay infrastructure for streaming data query, matching, storage, delivery, filtering, peer clustering, resource aggregate
  - Handling heterogeneity, dynamics, mobility



Generic Overlay Infrastructure

- VC2A supports various services:
  - Metadata indexing and similarity searches: resolving k identifiers using a single lookup?
  - Mobile agent (Mobilet) for monitoring and service deployment
  - Streaming content delivery: layered chaining
  - Component management and adaptations using ontology-based specifications for optimizations
  - Dynamic socket middleware for application layer roaming

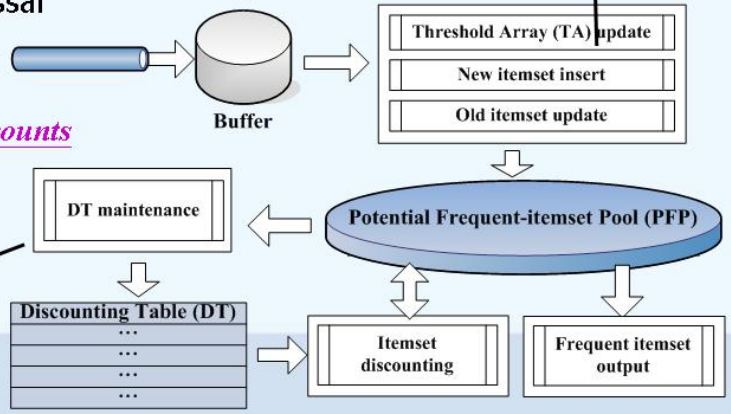
Streaming Data Management

- Top-K Queries for Virtual Music Channel
- Mining frequent itemsets on data streams

Accuracy guarantees
- No false dismissal
- No false alarm

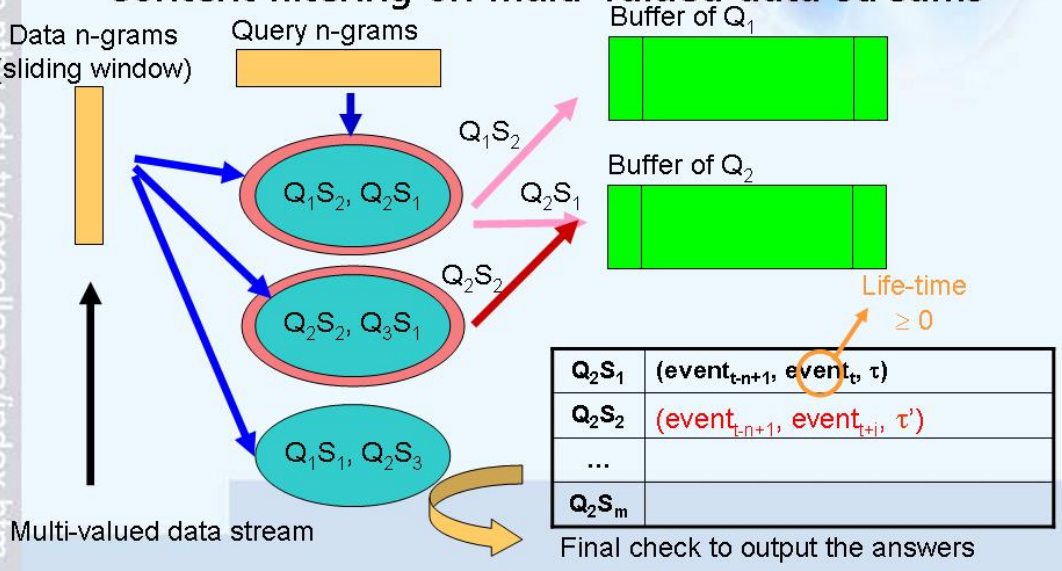
Ignore the potential counts

Estimate potential counts by TA



Streaming Data Management

- Content filtering on multi-valued data streams



XI. (Appendix V) Budget Adjustment of FY94

Main-project

原 核 定 補 助 情 形		擬申請變更用途及金額情形	
項　目	經　　費	項　目	經　　費
變更情形說明	1. 其他費用預算項目新增「交大研究群空間使用費」		

Sub- project 1：High Speed Networking Technologies

原 核 定 補 助 情 形		擬申請變更用途及金額情形	
項　目	經　　費	項　目	經　　費
1.其他費用	500,000 (1,215,000 中的 500,000)	人事費	500,000
變更情形說明	1. 碩士班研究生研究助學金計原 396，增為 518 獎助單位 博士班研究生研究助學金計原 672，增為 800 獎助單位 人事費由 3,263,996 元變更為 3,763,996 元。 2. 其他費用由原核定 1,215,000 擬變更為 715,000 元。		

Sub-project 2：Optical Networking and QoS Technologies

原 核 定 補 助 情 形		擬申請變更用途及金額情形	
項　目	經　費	項　目	經　費

人事費- 第1.2項 專任助理薪資及雇主負擔勞健保費 第 3.4 項 碩士生 192 獎助單元；博士生 660 獎助單元 第 6 項 臨時工資 第 7 項 博士後研究：2 名	 480,396 1,704,000 85,678 1,841,752	人事費- 第 1.2 項 專任助理薪資及雇主負擔勞健保費 第 3.4 項 碩士生 288 獎助單元；博士生 876 獎助單元 第 6 項 臨時工資 第 7 項 博士後研究：1 名	 490,074 2,328,000 107,435 886,317
國外差旅費	220,000	國外差旅費	520,000

變更情形說明	● 博士後研究原申請核定 2 名，其中 1 名田伯隆已於 94/2/1 起正式轉任本校電信系專任助理教授，薪資由學校支付，並繼續進行本計畫研究工作，原核定之人事費扣除另 1 名博士後研究羅志鵬實際應使用 886,317 後之餘額 955,435，則轉由其他人事費及國外差旅費使用。 ● 專任助理薪資原核定的年資(第五年*13.5)與實際年資(第五年*3;第六年 10.5)其薪資及雇主負擔勞健保費有差額 9,678。 ● 碩士研究生獎助單元比原核定(192 獎助單元)新增 96 獎助單元，為 288 獎助單元；博士研究生獎助單元比原核定(660 獎助單元)新增 216 獎助單元，為 876 獎助單元，需多增加研究生進行研究、分析、模擬驗證等工作。 ● 臨時工資，需要短期支援協助測試、驗證、分析等工作之臨時人員。 ● 國外差旅費，新增金額 300,000，主要運用於赴美與 ANDevices(光纖元件公司)進行討論合作並製作目前計畫進行之光纖都會實驗網路所需光纖元件、模組之 spec 及系統控制；並參訪考察下列大學、研究機構及公司之全光通訊網路及無線網路實驗室：1. Stanford University, University of Maryland, University of Florida, UC Davis. 2.Telcordia Technologies, Lucent Technologies. 3. OPVISTA(光纖系統公司)，進行研究交流及技術討論並商討可能之研究合作，期望在尖端領域技術上有所突破；並與國內光通訊領域之相關研究單位、業界及學術單位進行技術交流與討論。 ● 變更後人事費金額為 3,931,826；國外差旅費金額為 520,000；總核定金額不變，仍為 9,242,252。

新增共同主持人說明

田伯隆教授目前任職於交大電信系，專長領域為光纖通訊網路，特別是在光纖網路系統設計、光電整合、以及網路效能分析皆有獨到的經驗與能力。於 2000 ~ 2004 年期間曾參與教育部卓越計劃以及交大-工研院聯合研發中心光通訊網路研發工作，並協同設計建構國際第一套整合光電硬體以及 GMPLS 軟體控制技術之全光 IP-over-WDM 實驗網路。此實驗網路突破 WDM 網路系統中光電轉換的瓶頸，其技術層面涵蓋網路架構設計，光電元件整合，FPGA 系統實作，以及軟硬體的整合和測試。研發成果不僅發表多篇國際 A 級期刊論文及專利，並躋身世界少數完成光電通訊系統實作的研究團隊。
田教授因表現卓越，2005 年受交大電信系聘為助理教授。本計劃目前正積極進行光纖都會網路的研究和實驗網路的建構工作，急需光電整合以及網路控制技術的專才。因此，擬藉重田教授在這方面的專業素養以突破技術關鍵，並聘請其擔任本計劃之共同主持人，特此說明。

行政院國家科學委員會個人資料表

以下各項資料均將收錄於國科會資料庫內，其中有關個人的姓名、服務機關、連絡電話(公)及論文著述等，將公開於本會網際網路「研究人員」項下，提供外界查詢。至於其他如傳真、E-mail、學歷、經歷、專長等資料，為尊重個人意願，請圈選（同意、不同意）於網際網路上提供外界查詢。（如以往已經表示過意見者，可不必再勾選）。

一、基本資料

身分證號碼	Q 1 2 1 0 1 3 8 7 8		填表日期： 2005 / 02 / 23	
中文姓名	田　伯　隆	英文姓名	Po-Lung Tien (Last Name) (First Name) (Middle Name)	
國籍	中　華　民　國	性別	☑ 男 ☐ 女	出生日期	1969 年 03 月 26 日
聯絡地址	3 0 0 5 0 中華民國臺灣省新竹市大學路 1001 號國立交通大學電信工程系所			
聯絡電話	(公) (03) 573-1846　　(宅)			
傳真號碼	(03) 571-8876	E-MAIL	tbl@cm.nctu.edu.tw	

二、主要學歷

學校名稱	國別	主修學門系所	學位	起訖年月(西元年/月)
國立交通大學	中華民國	Department of Computer Science and Information Engineering	Ph.D.	1995 / 09 至 2000 / 06
國立交通大學	中華民國	Department of Computer and Information Science	M.S.	1993 / 09 至 1995 / 06
國立交通大學	中華民國	Department of Applied Mathematics	B.S.	1987 / 09 至 1992 / 06

三、現職及與專長相關之經歷

服務機構	服務部門／系所	職稱	起訖年月(西元年/月)
現職：國立交通大學	電信工程系所	助理教授	2005/02 至 Now
國立交通大學	資訊工程系所	研究助理教授	2000 / 06 至 2005/01

四、專長

1. Optical and Broadband Networking	2. Multimedia Communications	3. Applications of Soft Computing	4. Performance Modeling and Analysis

五、論文著述：

1998 迄今發表之學術性著作表列

A. 期刊論文

1. Liang, Shih T., Tien, Po L., and Yuang, Maria C., "Threshold-based Intra-Video Synchronization for Multimedia Communications," *IEICE Transaction on Communications,* vol. E81-B, no. 4, April 1998, EI., SCI..
2. Tien, Po L., and Yuang, Maria C., "Intelligent Voice Smoother for Silence-Suppressed Voice over Internet," *IEEE Journal on Selected Areas in Communications,* vol. 17, no. 1, Jan. 1999, EI., SCI..
3. Yuang, Maria C., and Tien, Po L., "Multiple access control with intelligent bandwidth allocation for wireless ATM networks," *IEEE Journal on Selected Areas in Communications*, vol. 18, no. 9, Sept. 2000, pp. 1658-1699, EI., SCI..
4. Yuang, Maria C., Tien, Po L., and Shih, J., "QoS Scheduler/Shaper for Optical Coarse Packet Switching IP-over-WDM Networks," *IEEE Journal on Selected Areas in communications*, vol. 22, no. 9, Nov. 2004, pp. 1766-1780, EI., SCI..
5. Steven S. W. Lee, Maria C. Yuang, and Tien, Po L., "A Lagrangean Relaxation based Approach for Routing and Wavelength Assignment in Multi-granularity Optical WDM Networks," *IEEE Journal on Selected Areas in communications*, vol. 22, no. 9, Nov. 2004, pp. 1741-1751, EI., SCI..

B. 研討會論文

1. Tien, Po L., and Yuang, Maria C., "Intelligent Voice Smoother for VBR Voice over ATM Networks," *IEEE INFOCOM*, 1998, EI..
2. Tien, Po L., and Yuang, Maria C., "Intelligent Voice Smoother for Silence-Suppressed Voice over Internet," *IEEE ICC*, 1998, EI..
3. Tien, Po L. and Yuang, Maria C., "Intelligent Voice Smoother for Silence-Suppressed Voice over Internet: Theory and Practice," *IEEE GLOBECOM*, 1998, EI..
4. Yuang, Maria C., Lo, Bird C., Tien, Po L., and Chen, Yu G., "An Intelligent Synchronization Platform with QoS Guarantees for Multimedia Communications," *IEEE ICC*, 1999, EI..
5. Yuang, Maria C., Lo, Bird C., Chen, Yu G., and Tien, Po L., "A Synchronization Paradigm with QoS Guarantees for Multimedia Communications," *IEEE GLOBECOM*, 1999, EI..
6. Yuang, Maria C., and Tien, Po L., "A Contention Access Protocol with Dynamic Bandwidth Allocation for Wireless ATM Networks," *IEEE ICC*, 2000, EI..
7. Yuang, Maria C., Shih, J., and Tien, Po L., "QoS Burstification for Optical Burst Switched WDM Networks," *IEEE OFC*, 2002, EI..
8. Yuang, Maria C., Shih, J., and Tien, Po L., "A QoS Packet/Burst Scheduler for Broadband Networks," *IEEE ICC*, 2002, EI..
9. Yuang, Maria C., Tien, Po L., and Shih, J., "QoS Contention Control for Optical Coarse Packet Switched IP-over-WDM Networks," *Conference on Optical Internet (COIN)*, 2003.

10. Yuang, Maria C., Shih, J., and Tien, Po L., "Traffic Shaping for IP-over-WDM Networks based on Optical Coarse Packet Switching Paradigm," *IEEE/OSA European Conference on Optical Communication (ECOC)*, 2003, EI..
11. Steven S. W. Lee, Maria C. Yuang, and Tien, Po L., "Optical Tunnel Allocation for Coarse Packet Switched IP-over-WDM Networks," *IEEE GLOBECOM*, 2003, EI..
12. Steven S. W. Lee, Maria C. Yuang, and Tien, Po L., "A Lagrangean Relaxation Approach to Routing and Wavelength Assignment for Multi-granularity Optical WDM Networks", IEEE GLOBECOM, 2004, EI..

C. 專書及專書論文

13. Yuang, Maria C., and Tien, Po L., Chapter- Voice over Wireless LAN using Intelligent Control, in Book- *Soft Computing in Communications*, Editor-Prof. Lipo Wang (Singapore), Springer-Verlag, 2003.

D.近五年專利獲得與申請表列

14. Tien, Po L., et al., "Voice Smoothing Techniques for multimedia Communications," ROC Patent No. 115598, 6/1/2000-6/1/2018.
15. Tien, Po L., et al., "Intermedia Synchronization System for Communicating Multimedia Data in a Computer Network," US Patent No. 6,480,902 B1, 11/12/2002-5/25/2019.
16. Tien, Po L., et al., "MPEG-compatible Intermedia Synchronization Mechanism and System for Multimedia Communications," ROC Patent No. 166691, 9/21/2002-6/1/2018.
17. Tien, Po L., et al., "Stepwise QoS Scheduling Method in Output-Buffered Switches for Broadband Networks," ROC Patent No. 530511, 5/1/2003- 9/6/2021.
18. Tien, Po L., et al., "Multiple Access Control System with Intelligent Bandwidth Allocation for Wireless ATM Networks," ROC Patent No. 172562, 2/11/2003- 2/11/2021.
19. Tien, Po L., et al., "QoS Burstification for Optical Burst Switched WDM Networks," ROC and USA pending, 2003.

六、研發成果智慧財產權及其應用績效：

專利 請填入目前仍有效之專利。「類別」請填入代碼：(A)發明專利(B)新型專利(C)新式樣專利。

類別	專利名稱	國別	專利號	發明人	專利權人	專利期間	國科會計畫編號
A	Voice Smoothing Techniques for Multimedia Communications	ROC	115598	Tien, Po L., et al.	Tien, Po L., et al.	6/1/2000 | 6/1/2018	
A	Intermedia Synchronization System for Communicating Multimedia Data in a Computer Network	USA	6480902	Tien, Po L., et al.	Tien, Po L., et al.	11/12/2002 | 5/25/2019	
A	MPEG-compatible Intermedia Synchronization Mechanism and System for Multimedia	ROC	166691	Tien, Po L., et al.	Tien, Po L., et al.	9/21/2002 | 6/21/2018	

A	Stepwise QoS Scheduling Method in Output-Buffered Switches for Broadband Networks	ROC	530511	Tien, Po L., et al.	Tien, Po L., et al.	5/1/2003 | 9/6/2021	
A	Multiple Access Control System with Intelligent Bandwidth Allocation for Wireless ATM Networks	ROC	172562	Tien, Po L., et al.	Tien, Po L., et al.	2/11/2003 | 2/11/2021	

七、近三年內執行及申請中之研究計畫：

計　畫　名　稱 （本會補助者請註明編號）	計畫內擔任之工作	起迄年月	補助或委託機構	申請(執行)情形
下一世代資訊通訊網路尖端技術及應用 分項計畫六: 下一世代網路之關鍵性系統及網路技術	博士後研究員	89.1.01 | 93.3.31	教育部卓越計畫	第四年計畫執行中
支援下一代無線與 FTTx 擷取之光纖都會網路技術 (I) NSC-92-2213-E-009-115 (II) NSC-93-2213-E-009-048 (III) NSC-94-2213-E-009-015 子計畫一: 光纖都會核心網路技術研究 (I) NSC-92-2213-E-009-117 (II) NSC-93-2213-E-009-049 (III) NSC-94-2213-E-009-001	博士後研究員	92.8.01 | 95.7.31	國科會	執行中
寬頻網際網路端對端技術之研究(II)(III) 子計畫四: 寬頻網際網路上區域無線網路之頻寬存取控制技術 (II) NSC-90-2213-E-009-087 (III) NSC-91-2219-E-009-037	博士後研究員	90.8.01 | 92.7.31	國科會	已順利結案
寬頻網際網路服務品質保證(I)(II)(III) 子計畫二: 寬頻網際網路之允入控制及訊務排程 (I) NSC-87-2219-E-009-009 (II) NSC-89-2219-E-009-087 (III) NSC-89-2219-E-009-001	博士後研究員	87.5.1 | 90.7.31	國科會	已順利結案
ATM 網路訊務管理及信號系統(I)(II)(III) 子計畫四: ATM 網路 ABR 訊務管理及訊務源模型之研究 (I) NSC-88-2213-E-009-085 (II)NSC-89-2213-E009-107 (III) NSC-90-2213-E-009-	博士後研究員	87.8.1 | 90.7.31	國科會	已順利結案

支援 ATM 網路中 ABR 資料流的動態回饋式傳輸率控制-理論與實務 NSC-87-2213-E-009-006	博士研究生	86.8.1 ｜ 87.7.31	國科會	已順利結案
多媒體通訊關於 MPEG II 視訊資料之媒體同步機制設計及其雛型建構 NSC-86-2213-E-009-109	博士研究生	85.8.1 ｜ 86.7.31	國科會	已順利結案
光封包交換網路中碰撞解決技術研究	計畫主持人	92.1.1 ｜ 92.12.31	工研院	已順利結案
OBS DWDM 網路架構設計與效能分析	博士後研究員	91.1.1 ｜ 91.12.31	工研院	已順利結案
IP-over-DWDM 網路上之服務品質保證研究	博士後研究員	89.8.1 ｜ 90.12.31	工研院	已順利結案
由 ATM 網路為骨幹連結無線通訊及 CATV 網路而能保證服務品質整合型網路: 頻寬控制及流量控制	博士研究生	87.7.1 ｜ 88.6.31	工研院	已順利結案
由 ATM fiber-based 網路為骨幹連接無線通訊網路而能保證服務品質之整合型網路(I)(II)	博士研究生	85.7.1 ｜ 87.6.31	工研院	已順利結案

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

原核定補助情形		擬申請變更用途及金額情形	
項目	經費	項目	經費
研究設備費	290,000 元	人事費	290,000 元
出席國際會議	120,000 元	國外差旅費	120,000 元
子計畫四 人事費 博士後研究	792,529 元	子計劃三 人事費 博士後研究	792,529 元

變更情形 說明	2. 原人事費 4,400,000 元，調整後為 4,690,000 元， 其中增加 290,000 元由研究設備費撥入。 ● 碩士班研究生研究助學金原 720 獎助單元，變更為 864 獎助單元。 ● 臨時工資原 66,404 元，變更為 68,404 元。 3. 原研究設備費 1,890,000 元，調整後為 1,600,000 元，其中減少 290,000 元，撥入人事費。 ● 研究設備費用途說明新增「OSA 平台」。 4. 原博士後研究員 0 元，調整後為 792,529 元，其中用途說明如下: ● 博士後研究員原子計畫四核定一名,已聘任黃啟富博士(起聘 94.1.15)，支援子計畫三及四之研究工作，由於國防役服務於交通大學，故調整其人事費於子計畫三，黃博士之工作內容仍依原規劃進行。 ● 黃博士人事費由子計畫四撥入子計畫三計 746,500 元，94.4.1 至 95.1.31 月支 55,000 元(10 月計)，95.2.1~95.3.31 月支 57,000 元(2 月計)，年終獎金 55,000 元(1.5 月計)，共為 746,500 元(55,000*10+57,000*2+55,000*1.5=746,500)。 ● 人事費雇主勞健保費新增 46,029 元 (1911*12+1692*9.5+2809*2.5=46028.5)，變更為 83,625 元。 5. 原出席國際會議 240,000 元,變更後為 120,000 元,其中減少 120,000 元撥入至國外差旅費。 6. 原國外差旅費金額 60,000 元，調整後為 180,000 元，其中增加 120,000 元由出席國際會議撥入。

Sub-project 4: Wireless Ad Hoc and Sensor Networking Technologies

原核定補助情形		擬申請變更用途及金額情形	
項　目	經　　費	項　目	經　　費
1.子計畫四人事費-博士後研究員	803,372 (3,434,811 中的 803,372)	子計畫三-博士後研究員	803,372
2.研究設備費	600,000 (1,213,780 中的 600,000)	人事費-兼任助理	600,000

變更情形說明	3. 人事費由本計劃的博士後研究員(黃啟富)-803,372 元，轉至第三分項的人事費-博士後研究員(黃啟富)-803,372 元，(55,000*9.5=522,500,55,000*1.5=82,500, 57000*2.5=142,500, 勞健保費-(1,946+2,692)*12=55,872, 總合為 803,372)。人事費由 3,437,811 元變更為 2,631,439 元。 4. 人事費-碩士班研究生研究助學金原 576 獎助單元增為 756 獎助單元，博士班研究生獎助金原 504 獎助單元增為 624 獎助單元。(人事費原核定為 2,631,439 元，變更為 3,231,439) 5. 研究設備費由原核定為 1,213,780 擬變更為 613,780 元。

Sub-project 6: Techniques and Applications of Overlay Networks

原核定補助情形		擬申請變更用途及金額情形	
項目	經費	項目	經費
1.人事費-兼任助理費用	211,353 (2,856,000 中的 211,353)	其他費用	211,353
2.出席國際會議	60,000 (210,000 中的 50,000)		60,000
3.國外差旅	20,000 (740,000 中的 30,000)		20,000
變更情形說明	6. 人事費由部分兼任助理費用變更為博士後研究員<u>蕭宏章</u>從 4 月支薪到 7 月協助計畫研究進行共 281,076 元=63,000*4+保險 5,064*4+離 63,000*4*0.07*0.5)。人事費由 4,367,203 元變更為 4,155,850 元。 7. 其他費用由原核定 708,000 變更為 1,000,000 元。 8. 國外差旅費用由原核定 740,000 變更為 720,000 元。 9. 出席國際會議費用由原核定 210,000 變更為 150,000 元。		