下一世代資訊通訊網路尖端技術與應用(二)

子計畫二

光纖網路及服務品質保證技術

Optical Networking and QoS Technologies

子計畫主持人

楊啟瑞教授 國立交通大學資訊工程系所

參與教授：林盈達 教　　授　國立交通大學資訊工程系所

鄭聖慶 博　　士　工研院電通所視訊與光通訊組

陳智弘 副　教授　國立交通大學光電工程系所

田伯隆 助理教授　國立交通大學電信工程系所

李三良 教　　授　國立台灣科技大學電子工程系

April 20, 2007

後卓越計畫第三年度經費執行狀況

	核定金額	實支數	餘額	執行率
業務費	6,358,500	5,989,404	369,096	94.19%
研究設備費	1,750,000	1,725,228	24,772	98.58%
國外差旅費	440,000	440,000	0	100%
管理費	688,500	688,500	0	100%
合計	9,237,000	8,843,132	393,868	95.73%

Outline

- **Technologies and Significant Contributions**
  - **Part I: Optical Networking Technologies**
  - **Part II: Broadband QoS Technologies**
- **計畫整體性成果**

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- **Technologies and Significant Contributions**
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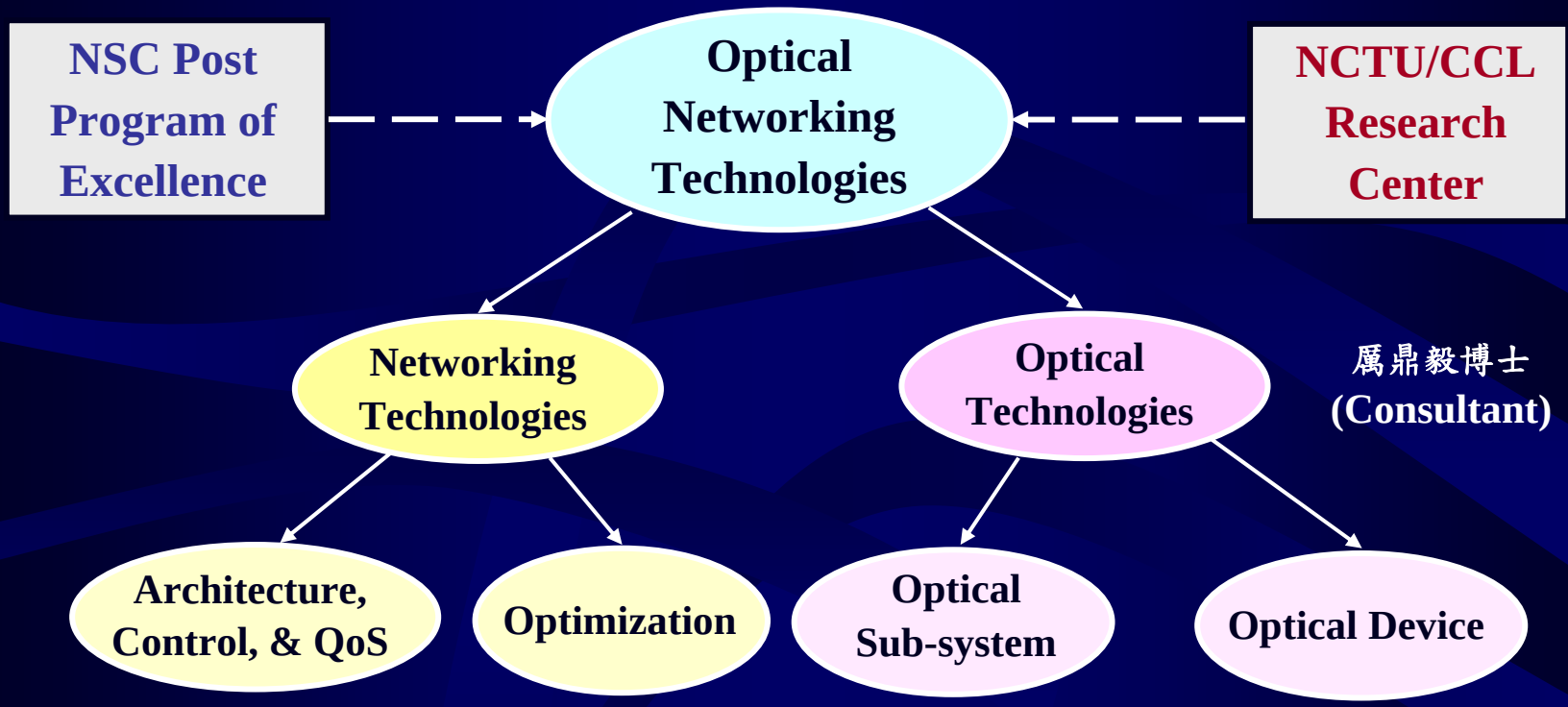
Part I:

Optical Networking Technologies

Project at a Glance



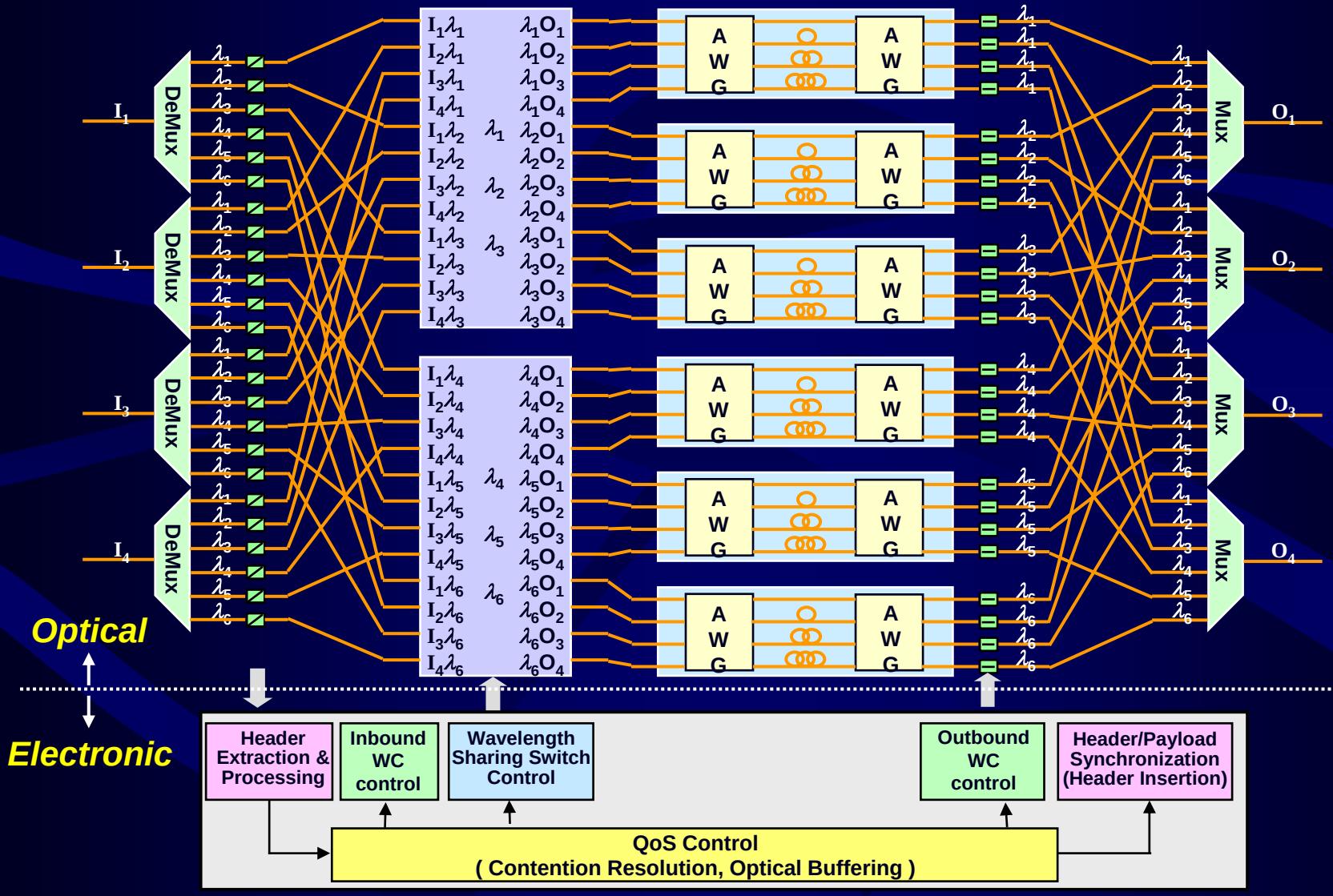
Road Map and Breakthrough

	2000~2004	*2005~2006*	*2007~2008*
Optical Network Testbed	Optical Packet Switched IP-over-WDM Network (OPSINET, OPSINET-II/10G)	High-Performance Optical Packet Switched Metro Area Network (HOPSMAN)	Distributed-control Hybrid Passive Optical Network (DHPON)
Techno-logy	OCPS, QOPS	HOPSMAN MAC and Optical System	DHPON MAC and Optical System

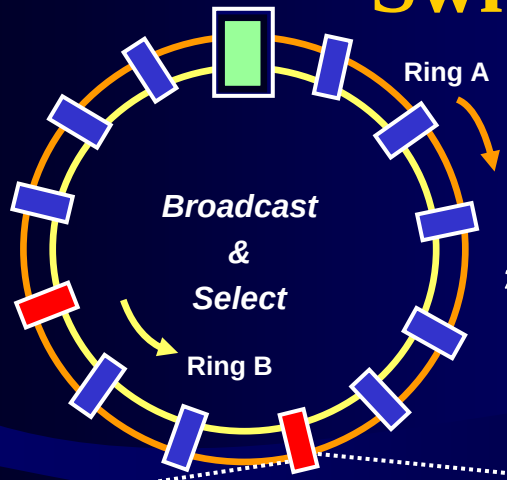
Technology	*State-of-the-art*	*Breakthroughs*
All optical packet-switched metro network	DAVID MAN, European IST	• Achieve all optical slot eraser- directly deleting packets in the optical domain within **5** *n*s • Complete four-wave-mixing based filter- converting wavelength within **40** *n*s tuning delay • Analyze and achieve the design of High performance MAC with Triple-play support • Finish the design of **10** Gbps high speed CDR circuit

All Optical WDM Packet Switching System

- 研究並實現高效能光纖交換器及控制系統 (10 Gbps)

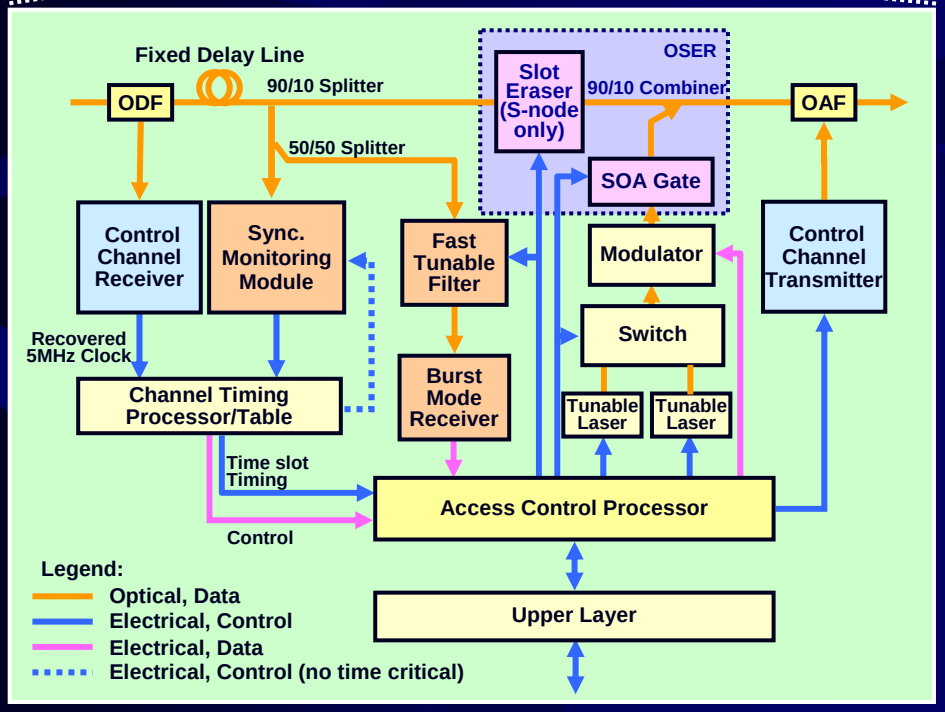


HOPSMAN: High-Performance Optical Packet Switched Metro Network



λ_0: control channel

λ_1~ λ_n : data channel



【高速全光光分封交換】

利用光交換原理，直接於光層進行封包擷取，不需高速電子交換

【完成高效率MAC研發】

保證各節點所需之頻寬，並可保障節點間的公平性

【創新硬體設計】

- 完成全光 slot eraser，可在 5 ns 內將不需要之光封包直接於光層移除，大幅提高頻寬再利用率
- 完成四波混合式高速全光濾波器，可於 40 ns 內調整濾波通道

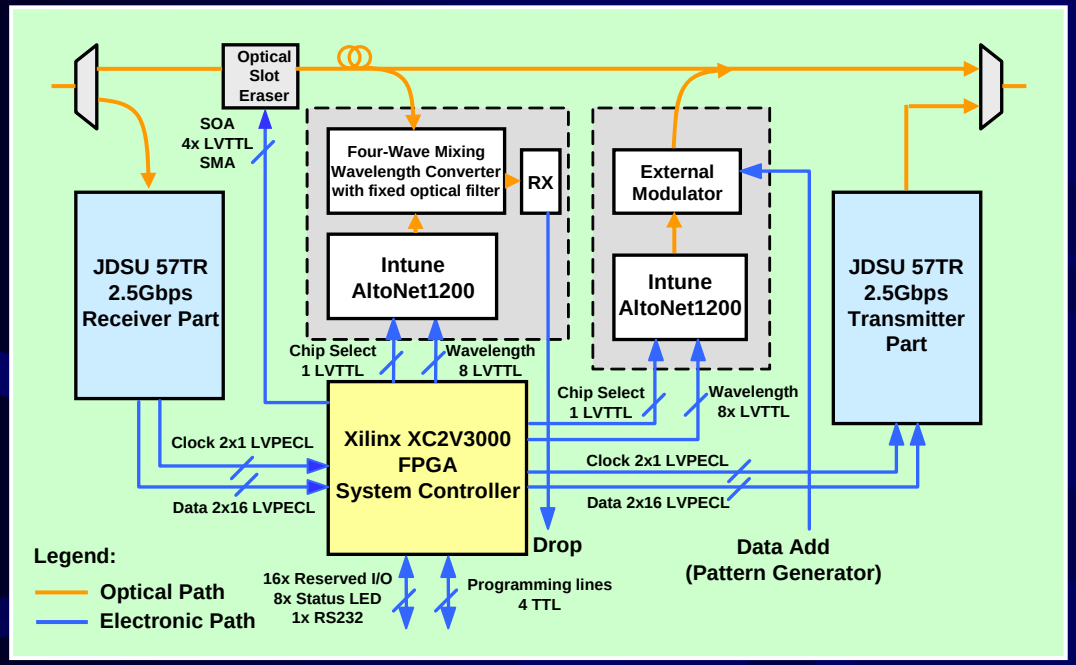
【高速CDR研發】

本計劃已完成 10 Gbps 高速 CDR 電路設計

【實驗網路建置】

本計劃已完成含三個節點之實驗網路建置，每個節點由一 FPGA MAC controller 所控制，並於光層直接進行光封包收送

HOPSMAN Testbed: Central Controller



- Design of optical metro network architecture
- Design of access node architecture and control
  - MAC scheme with QoS
  - Access node architecture
  - Optical subsystems

Part II:

Broadband QoS Technologies

Road Map and Breakthrough

	2000~2004	*2005~2006*	*2007~2008*
Network QoS	Private fairness by TCP rate shaping (PostACK)	Public fairness by TCP-friendliness (WARC)	Private fairness by request scheduling (MSF-RS, MRRS)
Content QoS	Software accelerator (4-in-1 Proxy)	Algorithmic accelerator (BH)	Hardware accelerator (BFAST)

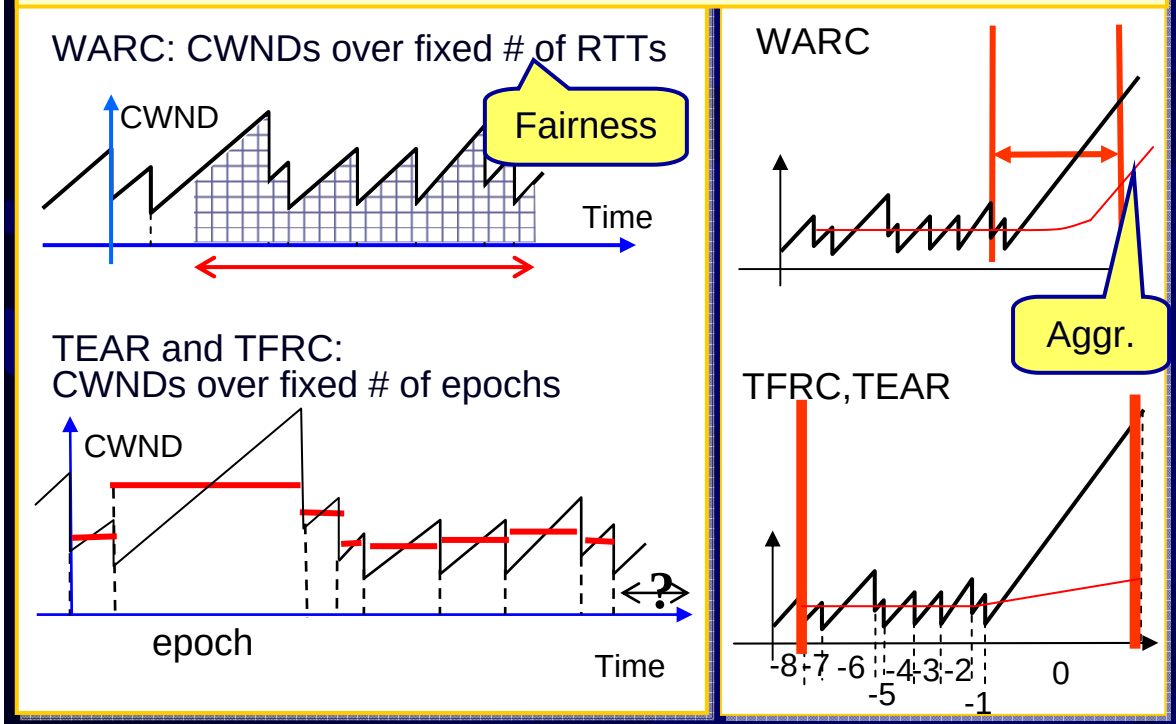
Technology	*State-of-the-art*	*Breakthroughs*
Deep Packet Inspection by BFAST	John Lockwood, Washington Univ., Bloom Filter-based	Scalability (# patterns): 30K (BFAST) v.s. 3K (BF-based) Simplicity (# filiters): O(n) (BFAST) v.s. $O(n^2)$ (BF-based)

Window-Averaging Rate Control (WARC):

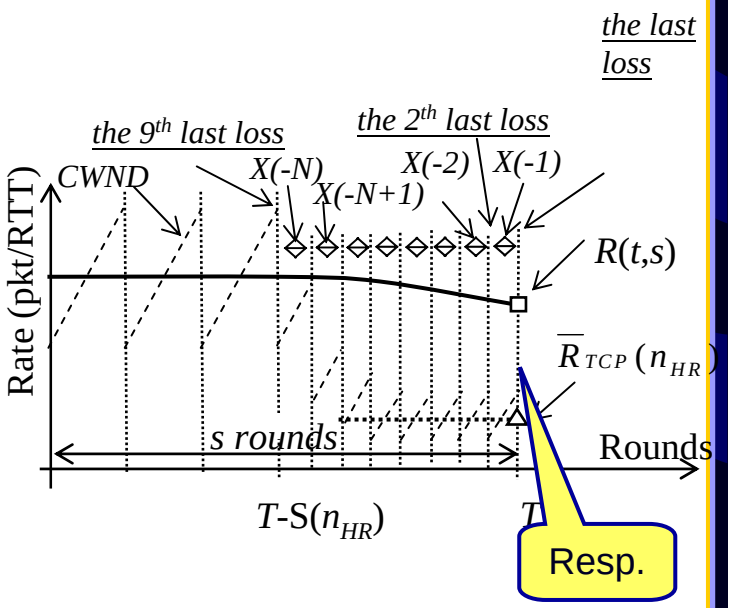
Best TCP-equivalence for streaming traffic

Fixed-CWNDs Real-time estimation (RTE)	- Fairness even under non-periodic losses - Smoothness and Fast aggressiveness
History-reset (HR) procedure	- Fast responsiveness after N losses
Fluid-based TO mechanism	- Fairness under heavy-losses
One-RTT reduction procedure	- Smoothness under a FIFO link

Fixed-CWNDs RTE



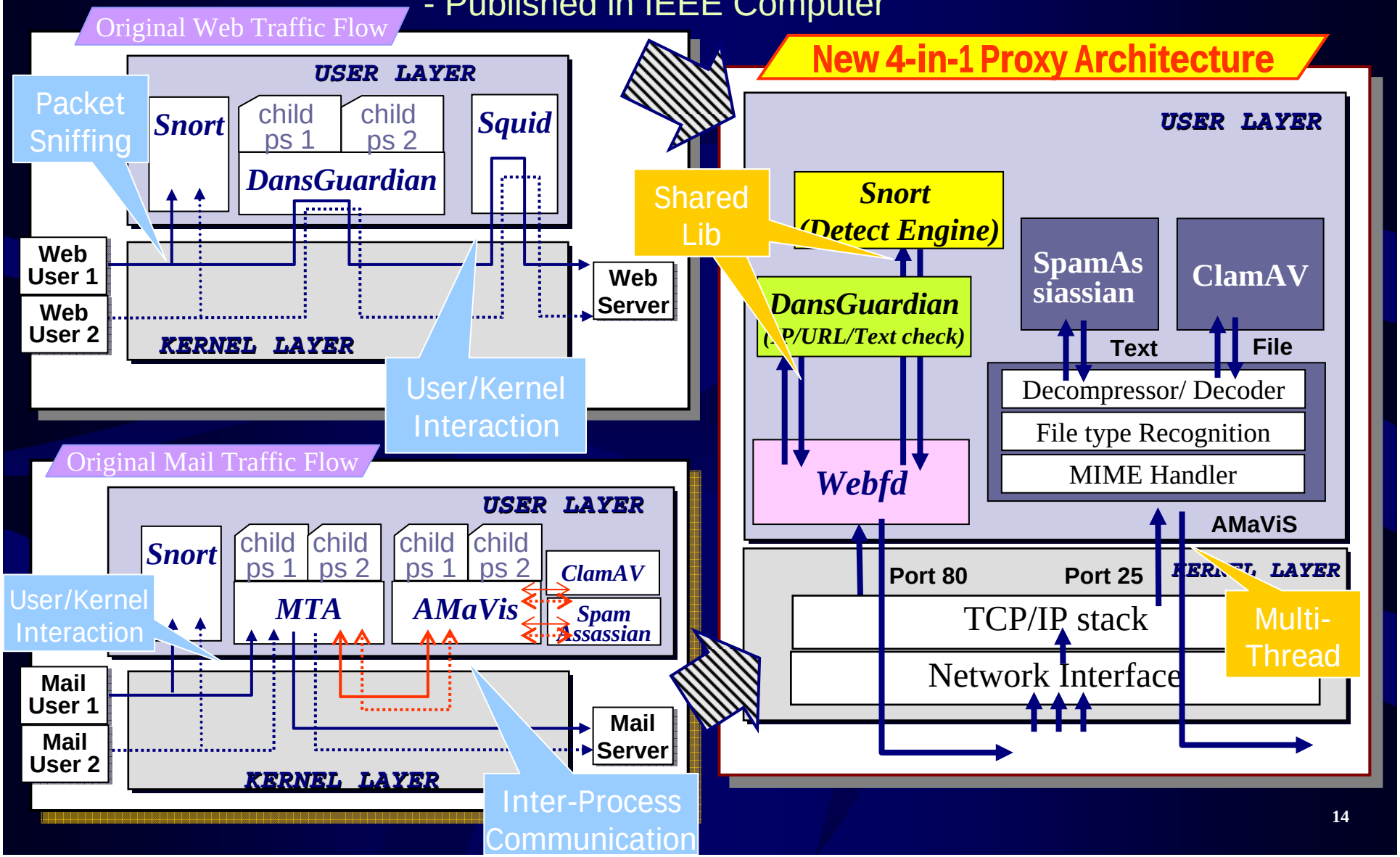
HR Procedure



4-in-1 Proxy Architecture

Improved throughput: 200% for web traffic, 500% for Mail traffic

- Reducing IPC and reusing modules
- Published in IEEE Computer



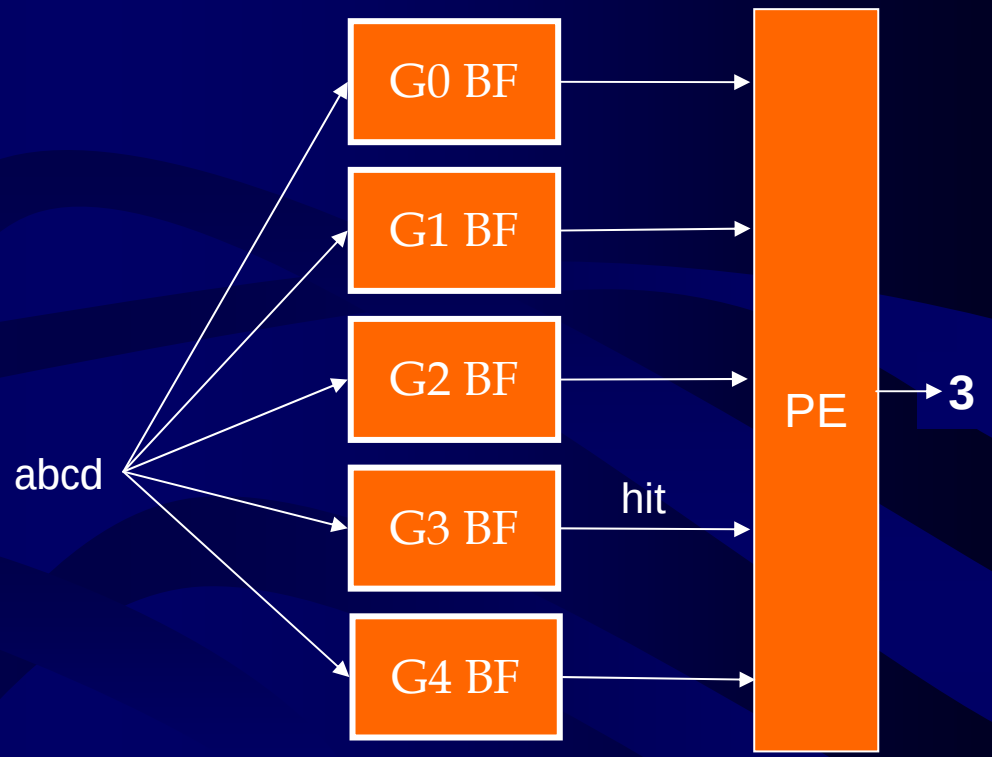
The BFAST algorithm

Most scalable hardware design for deep packet inspection

- `Pattern1: abcdefgh`
- `Pattern2: xyzabcdw`
- `Shift table`

abcd →

block	shift	block	shift
abcd	1	xyza	4
bcde	3	yzab	3
cdef	2	zabc	2
defg	1	abcd	1
efgh	0	bcdw	0
		*	5



- **False positive at a lower group: shift less**
- **False positive at a higher group : the same**

Main features:

1. sub-linear running time
2. less hardware complexity
3. high scalability

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- **Technologies and Significant Contributions**
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- 計畫整體性成果

計畫整體性成果

- 國際交流及學術合作
- 產學合作與成果推廣
- 系統整合成就
- 量化成果

整體性成果:國際交流及學術合作(1/2)

- 訪問美國Stanford University並拜訪Opvista光纖通信網路公司(2007/1)
- 與 AT&T Research 技術合作，共同開發 10G Burst Mode Receiver 關鍵技術(2006/11)
- 邀請 IEEE Communication Society's Elect President- Dr. Nim Cheung 於交大作專題討論 (2006/5/31, 2007/03/02)
- 訪問 Stanford University- Prof. Leonid Kazovsky 並參觀光通訊網路實驗室(2006/6)
- 與 ANDevices光纖公司合作開發 Optical Slot Eraser 關鍵系統技術(2006/6)
- 訪問 University of California- Davis-Prof. Biswanath Mukherjee (2006/6)
- 與美國 University of Maryland- Prof. Ray Chen 進行光通訊技術合作
- 發表論文於法國坎城「European Conference on Optical Communication (ECOC2006)」，並參訪巴黎大學以及 Alcatel company光纖通訊網路實驗室 (2006/9)

整體性成果:國際交流及學術合作(2/2)

- 楊啟瑞教授將應邀至APOC'07會議發表專題演講: "Technology and Experimentation of A High-performance Optical Packet-Switched Metro WDM Network "(2007/10)
- 李詩偉博士（本研究團隊工研院研究人員）應邀至 APOC'06會議發表專題演講: "A 10G QoS-Enabled Optical Packet-Switching System: Technology and Experimentation" (2006/9/5)
- 拜訪 Polytechic University (Jonathan Chao) (2007/1)
- 拜訪 Cisco 實驗室及 UC Berkeley (Vern Paxson) (2007/1)
- 拜訪法國 NSS 實驗室及 Alcatel (2006/9)
- 拜訪Cisco San Jose (Frank Lin) (2006/4)
- IEEE Senior Member (2006/12)
- In scholar.google.com, well-cited paper over 247 citations (2006/12)

  "Multi-hop Cellular: A new architecture for wireless communications," Infocom 2000.

整體性成果:產學合作與成果推廣

- 與工研院(CCL-NCTU 聯研中心)合作建構OPSINET-II及HOPSMAN光纖實驗網路
- IEEE Communication Society's Elect President- Dr. Nim Cheung參觀並展示研究成果 (2006/5/30-31)
- 工研院交大網路測試中心：通訊產業推動計畫中Security, WLAN, Switch, Router, VoIP產品測試

  合勤科技, 智邦科技, 鑫能興業, 中磊電子, 研華科技, 友旺科技, 遠訊科技, 文佳科技, 亞盛科技, 華邦電子, 蘆爾發科技, 展達通訊, 岱昇科技, 星通資訊, 神腦國際, F5Alcatel, 聯合光纖, 台灣電子檢驗中心, 磐儀科技, 明泰科技, 智捷科技, Aruba, 創傑科技, 廣達電腦, 台灣固網
- Intel: WiMax Base Station & Testing
- Cisco: Attack Session Extraction from Real Traffic, Cisco 補助超過10萬美元
- 成立瑞昱交大聯合研發中心於電資大樓808, 瑞昱半導體每年出資一千萬台幣，由全職工程師與教授及研究生共同開發IEEE 802.11s turnkey solution

整體性成果:系統整合成就

- **OPSINET-II**：建構國際第一個整合光電硬體以及GMPLS控制之全光IP-over-WDM核心網路平台雛形系統 (phase-II, 10Gbps)（楊啟瑞教授）
- **HOPSMAN**：建構能提供triple-play之光纖都會型實驗網路（楊啟瑞教授）
- **Content-aware Security and QoS Gateway**：以掃瞄content來達到安全過濾目的十機一體閘道器(林盈達教授)
- **P2PADM**：Pear-to-Pear Administration Package (林盈達教授)
- **Stream-based Anti-Virus Mail Proxy** (林盈達教授)
- **kP2PADM**: In-kernel P2P Administration Package (林盈達教授)
- **SoC Hardware Software Co-Design for Deep Packet Inspection** (FPGA and Linux implementation on Xlinix ML310) (林盈達教授)

整體性量化成果

成果統計時間：2006/04/01～2007/03/31

期刊論文	會議論文	專利	雛型系統	研討會	競賽得獎
Accepted 12 In revision 3	10	USA patents 2 ROC patents 7 申請中 5	6	4	1

主要期刊論文發表(1/4)

Journal papers : (2006/4/1 ~ 2007/3/31)

1. **Maria C. Yuang, Po L. Tien, J. Shih, Steven S. W. Lee, Y. M. Lin, F. Tsai, and A. Chen, "Optical Coarse Packet-Switched IP-over-WDM Network (OPSINET): Technologies and Experiments," *IEEE Journal on Selected Areas in Communications*, vol. 24, no. 8, Aug. 2006, EI., SCI..**
2. **C. T. Lin, W. R. Peng, P. C. Peng, Jason (Jyehong) Chen, C. F. Peng, B. S. Chiou, and S. Chi, "Simultaneous Generation of Baseband and Radio Signals Using Only One Single-Electrode Mach–Zehnder Modulator with Enhanced Linearity," *IEEE Photonic Technology Letter*, vol. 18, 2006, EI., SCI..**
3. **Ming-Fang Huang, Jason (Jyehong) Chen, Kai-Ming Feng, Chung-Yu Lai, Chia-Chien Wei, Tse-Yu Lin, Sien Chi, Zhonghua Zhu, Yung Jui Chen, Yin-Chieh Huang, and Shih-Jung Chang, "Add/Drop Applications in Fiber Ring Networks Based on a Reconfigurable Optical Add/Drop Multiplexer in a Re-circulating Loop," *Optics Communications*, vol. 267, Nov., 2006, EI., SCI..**
4. **C.C. Wei, and Jason (Jyehong) Chen, "Convergence of Phase Noise in DPSK Transmission Systems by Novel Phase Noise Averagers," *Optics Express*, vol. 14, no. 21, Oct. 2006, EI., SCI..**

主要期刊論文發表(2/4)

Journal papers : (2006/4/1 ~ 2007/3/31)

5. **Ming-Fang Huang, Kai-Ming Feng, Jason (Jyehong) Chen, Tse-Yu Lin, Chia-Chien Wei, and Sien Chi, "Wavelength-Interleaving Bidirectional Transmission System Using Unidirectional Amplification in a 5x100 km Recirculating Loop," *IEEE Photonics Technology Letter*, June 2006, EI., SCI..**
6. **Pen-Chun Peng, Wei-Ren Peng, Kai-Ming Feng, Hung-Yu Chiou, Jason (Jyehong) Chen, Hao-Chung Kuo, Shing-Chung Wang, and S. Chi, "OCDMA Light Source Using Directly Modulated Fabry-Pe/spl Acute/rot Laser Diode in an External Injection Scheme," *IEEE Photonics Technology Letter*, May 2006, EI., SCI..**
7. **Ying-Dar Lin, Shih-Chiang Tsao, and Un-Pio Leong, "On-the-Fly TCP Path Selection Algorithm in Access Link Load Balancing," *Computer Communications*, vol. 30, issue 2, Jan. 2007, EI., SCI..**
8. **Po-Ching Lin, Zhi-Xiang Li, Ying-Dar Lin, and Yuan-Cheng Lai, "Profiling and Accelerating String Matching Algorithms in Three Network Content Security Applications," *IEEE Communications Surveys and Tutorials*, 2nd quarter, 2006.**

主要期刊論文發表(3/4)

Journal papers : (2006/4/1 ~ 2007/3/31)

9. **Ying-Dar Lin, Chih-Wei Jan, Po-Ching Lin, and Yuan-Cheng Lai, "Designing an Integrated Architecture for Network Content Security Gateways," *IEEE Computer*, vol. 39, issue 11, Nov. 2006, SCI..**
10. **Ying-Dar Lin, Kuo-Kun Tseng, Tseng-Huei Lee, Chen-Chou Hung, and Yuan-Cheng Lai, "A Platform-Based SoC Design and Implementation of Scalable Automaton Matching for Deep Packet Inspection," to appear in *Journal of System Architecture*, EI., SCI..**
11. **Huan-Yun Wei, Ching-Chuan Chiang, and Ying-Dar Lin, "Co-DRR: An Integrated Uplink and Downlink Scheduler for Bandwidth Management over Wireless LANs," to appear in *IEICE Transactions on Communications*, EI., SCI..**
12. **Yi-Neng Lin, Yao-Chung Chang, Ying-Dar Lin, and Yuan-Cheng Lai, "Resource Allocation in Network Processors for Memory Access Intensive Applications," to appear in *Journal of Systems and Software*, EI., SCI..**

主要期刊論文發表(4/4)

Journal papers : (2006/4/1 ~ 2007/3/31)

13. **Kuo-Kun Tseng, Ying-Dar Lin, Tsern-Huei Lee, and Yuan-Cheng Lai, "A Fast Scalable Automaton Matching Accelerator for Embedded Content Processors," submitted to *ACM Transactions in Embedded Computing Systems*, in revision, Mar. 2007.**
14. **Shih-Chiang Tsao, Ying-Dar Lin, and Yuan-Cheng Lai, "Taxonomy and Evaluation of TCP-Friendly Rate-Control Schemes on Fairness, Aggressiveness, and Responsiveness," submitted to *IEEE Network*, in revision, Aug. 2006, EI., SCI..**
15. **Ying-Dar, Szu-Hao Chen, Po-Ching Lin, and Yuang-Chen Lai, "A Stream-based Mail Proxy with Interleaved Docompression and Virus Scanning," submitted to *Journal of Systems and Software*, in revision, May 2006, EI., SCI..**

主要會議論文發表(1/2)

Conference papers : (2006/4/1 ~ 2007/3/31)

1. **Maria C. Yuang, Steven S. W. Lee, Bird C. Lo, I-Fen Chao, Po-Lung Tien, Yu-Min Lin, Ching-Yun Chien, Jason J. Chen, and C. C. Wei, "Technology and Experimentation of A High-performance Optical Packet-Switched Metro WDM Network," invited talk on *SPIE APOC'07*, Oct. 2007, EI..**
2. **Maria C. Yuang, Po L. Tien, J. Shih, Steven S. W. Lee, Yu-Min Lin, and Jason J. Chen, "OPSINET-II: An Optical Coarse Packet-Switched IP-over-WDM Network," *OECC'06*, July. 2006, EI..**
3. **Maria C. Yuang, Po L. Tien, J. Shih, Steven S. W. Lee, Yu-Min Lin, and Jason J. Chen, "A 10G QoS-Enabled Optical Packet-Switching System: Technology and Experimentation," *SPIE APOC'06*, Sept. 2006, EI..**
4. **Maria C. Yuang, Steven S. W. Lee, Bird C. Lo, I-Fen Chao, Yu-Min Lin, Po L. Tien, Ching-Yun Chien and Jason J. Chen, "HOPSMAN: An Experimental Optical Packet-Switched Metro WDM Ring Network with High-Performance Medium Access Control," *ECOC*, 2006, EI..**
5. **Ming Fang Huang, Jianjun Yu, Jason (Jyehong) Chen, Gee-Kung Chang, and Sien Chi, "A Cost-Effective WDM-PON Configuration Employing Innovative Bi-directional Amplification," *OFC*, 2007, EI..**

主要會議論文發表(2/2)

Conference papers : (2006/4/1 ~ 2007/3/31)

6. **Chun-Ting Lin, Cheng-Feng Peng, Peng-Chun Peng, Jyehong Chen, Wei-Ren Peng, Bi-Shiou Chiou, and Sien Chi, "Simultaneous Modulation and Transmission of FTTH Baseband and Radio Signals on a Single Wavelength," *OFC*, 2007, EI..**
7. **Peng-Chun Peng, Chun-Chen Chiang, Jyehong Chen, Chun-Ting Lin, and Sien Chi, "Tunable Ultrafast and Ultraslow Light in Erbium Doped Waveguide at Room Temperature," *OFC*, 2007, EI..**
8. **C. T. Lin, P. C. Peng, J . H. Chen, C. F. Peng, C. C. Chiang, H. C. Kuo, S. C. Huang, and B. S. Chiou, "10 GHz Tunable Slow Light in Multi-Quantum Well Distributed Feedback Laser," *ECOC*, 2006, EI..**
9. **C. C. Wei, J. H. Chen, C. H. Fang, and C. Tsao, "20 GBps (2- bit/symbol) DPSK over Inverse-RZ Modulation Format Using a Single MZM," *ECOC*, 2006, EI..**
10. **Ying-Dar Lin, Po-Ching Lin, Meng-Fu Tsai, Tsao-Jiang Chang, and Yuan-Cheng Lai, "kP2PADM: An In-kernel Gateway Architecture for Managing P2P Traffic," *Proc. HotP2P*, Mar. 2007.**

專利申請及獲得(1/2)

專利申請及獲得

1. **Maria C. Yuang, et al., “Pdf-based Multi-user Estimator for Wireless LAN,” ROC Patent No. I231721.**
2. **Maria C. Yuang, et al., “QoS-oriented Burstification Method Supporting Various Grades of Burstification Delay Guarantee,” ROC Patent No. I234959.**
3. **Maria C. Yuang, et al., “Hexanary-Feedback Contention Access for Wireless Local and Access Networks,” ROC Patent No. I242993.**
4. **Maria C. Yuang, et al., “QoS-enabled Contention Control System for Wireless Local and Access Networks,” ROC Patent No. I263427.**
5. **Maria C. Yuang, et al., “Stepwise Quality-of-Service Scheduling Method in Output-Buffered Switches for Broadband Networks,” received the notice of allowance from USA Patent Office.**

專利申請及獲得(2/2)

專利申請及獲得

6. Ying-Dar Lin, et al., “Early Blocking and Bypassing for Accelerating Web Content Filtering,” USA Patent No. 7,082,429 & ROC Patent No. 200515201.
7. Ying-Dar Lin, et al., “Request scheduling for differentiated QoS at access gateway,” ROC Patent No. I269562, 2006.
8. Ying-Dar Lin, et al., “Method of Request Scheduling for Differentiated Quality of Service at Intermediaries,” ROC Patent No. I257216 and USA pending No. 11/222,770 , 2006.
9. Ying-Dar Lin, et al., “Integrating and Accelerating Content Classification and Management at P2P Gateways,” ROC and USA pending.
10. Ying-Dar Lin, et al., “A Hardware Accelerator Using Bloom Filters to Realize a Sub-linear Time String-matching Algorithm,” ROC and USA pending.

雛型系統

1. OPSINET-II: Optical Packet Switched IP-over-WDM Network (10 Gbps) (楊啟瑞教授)
2. HOPSMAN: High-performance Optical Packet Switching for Metro Area Networks (楊啟瑞教授)
3. P2PADM: P2P及Instant Message管理（軟體套件）(林盈達教授)
4. Stream-based Anti-Virus Mail Proxy (軟體套件) (林盈達教授)
5. kP2PADM: In-kernel P2P Administration Package (軟體套件)(林盈達教授)
6. SoC Hardware Software Co-Design for Deep Packet Inspection (FPGA and Linux implementation on Xlinix ML310) (林盈達教授)

Conferences(會議舉辦)

Conference (2006/4/1 ~ 2007/3/31)

1. **2006/4/11 如何確保10G網路的運作與效能研討會 (58人)**
2. **2006/5/18 網路技術與測試 (Triple Play／路由交換器／網路安全應用)研討會 (223人)**
3. **2006/7/26 Mimo及VoWifi測試技術研討會 (124人)**
4. **2006/8/24 IPS產品公開測試暨網安技術研討會 (55人)**

Contest (競賽得獎)

1. 陳智弘教授升等為國立交通大學副教授
2. 工業局-績優計畫獎 (2006年度頒發）