Subproject 2:

Next-Generation Optical Internet and QoS Technologies

Fifth Meeting

National Chiao Tung University

September 26, 2005

Outline

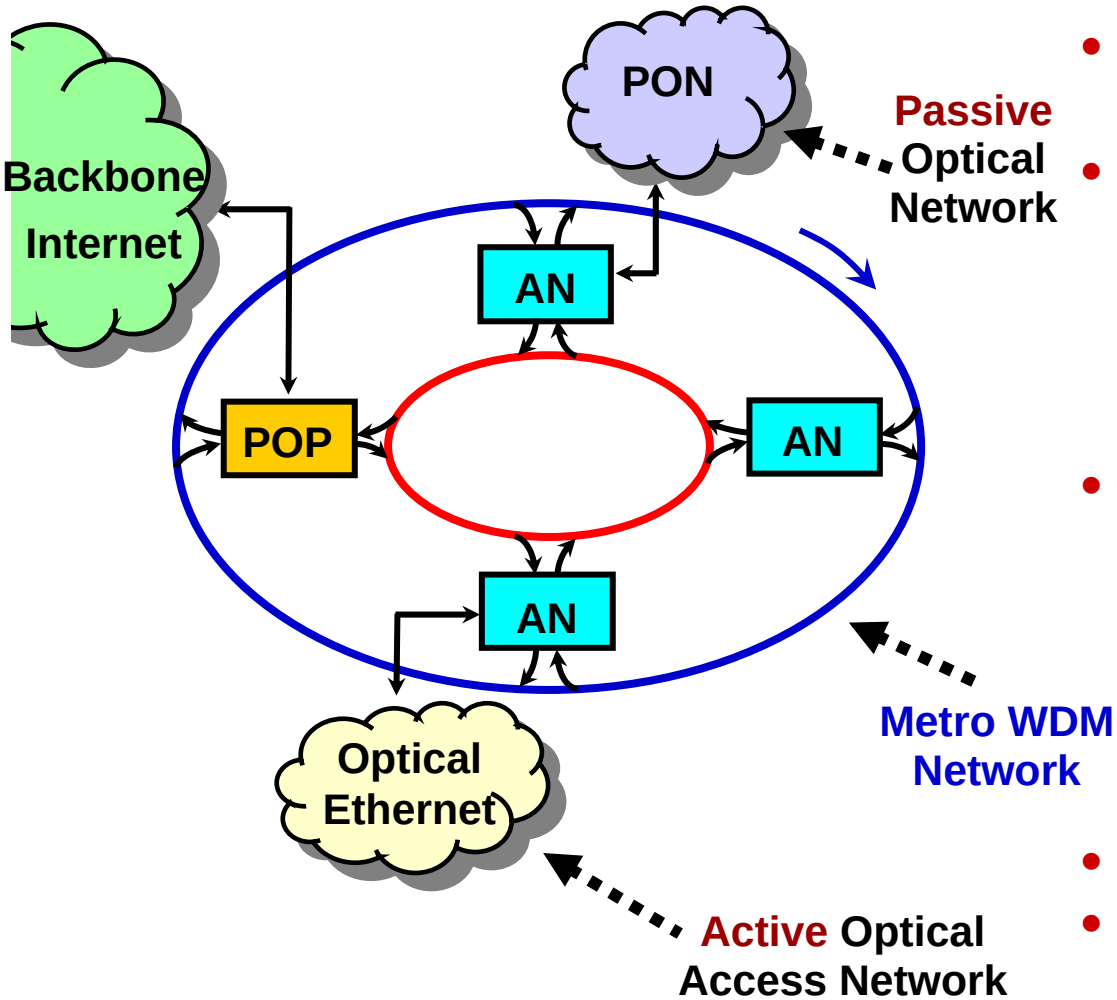
- **High-performance Optical Packet-Switched Metro Network (HOPSMAN): Technologies and Experimentation**
- **QoS Technology**
- 計畫整體性成果

HOPSMAN Design Principles

HOPSMAN = High-performance Optical Packet Switched Metro Area Network

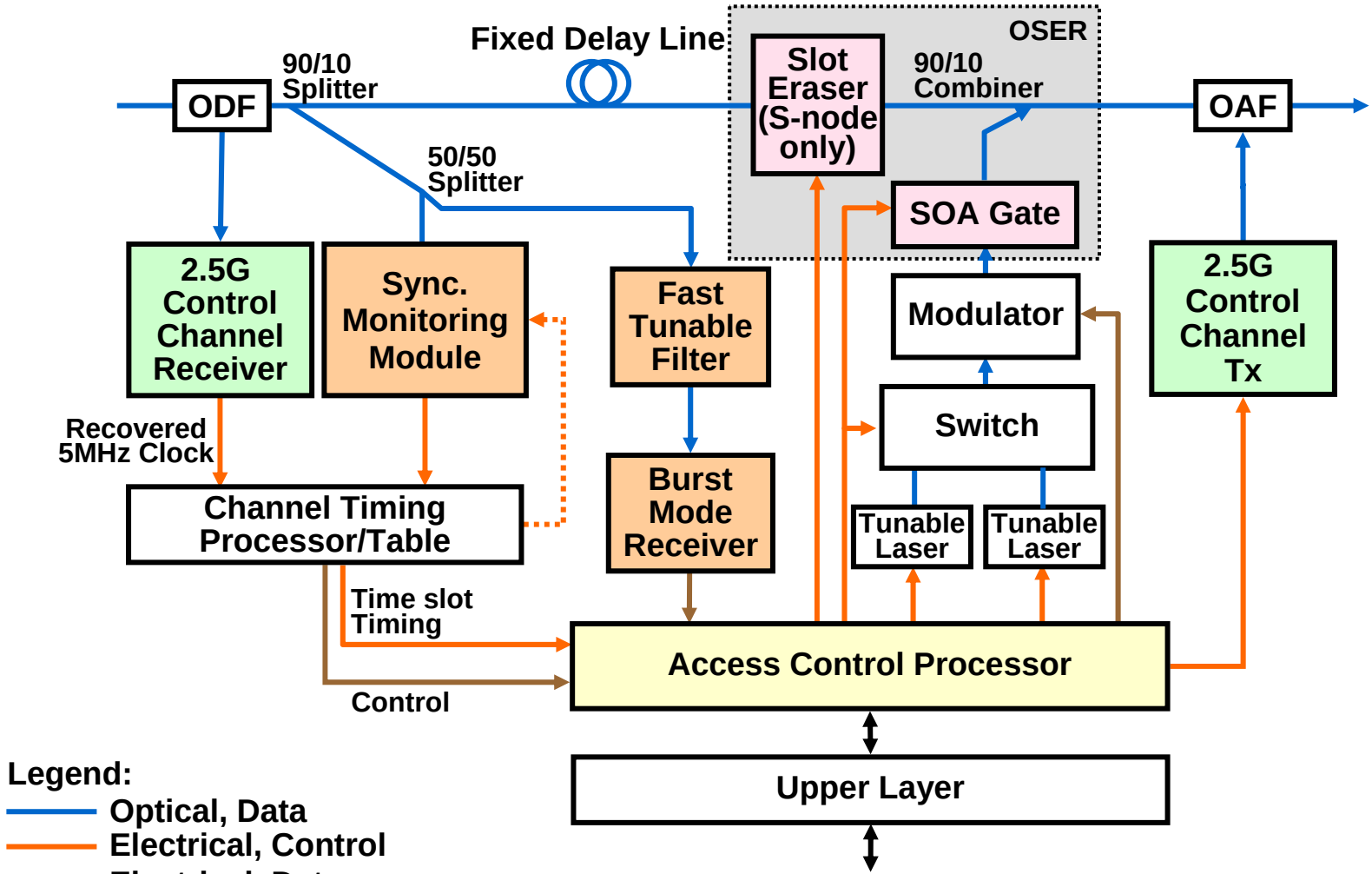
- **WDM optical packet-switched metro ring network**
  - **Virtually unlimited bandwidth**
  - **High-speed (10Gbps) optical packet add/drop**
  - **Elimination of high-speed electrical switch**
- **High performance**
  - **High delay-bandwidth performance**
    - **Low Load → ≈ random access, low delay and jitter**
    - **High Load → guaranteed per-user bandwidth**
  - **High scalability and modularity**
    - **Architecture remains unchanged with additional nodes, wavelengths, and transceiver ports**
  - **High reliability and fast restoration**

HOPSMAN- Major Tasks

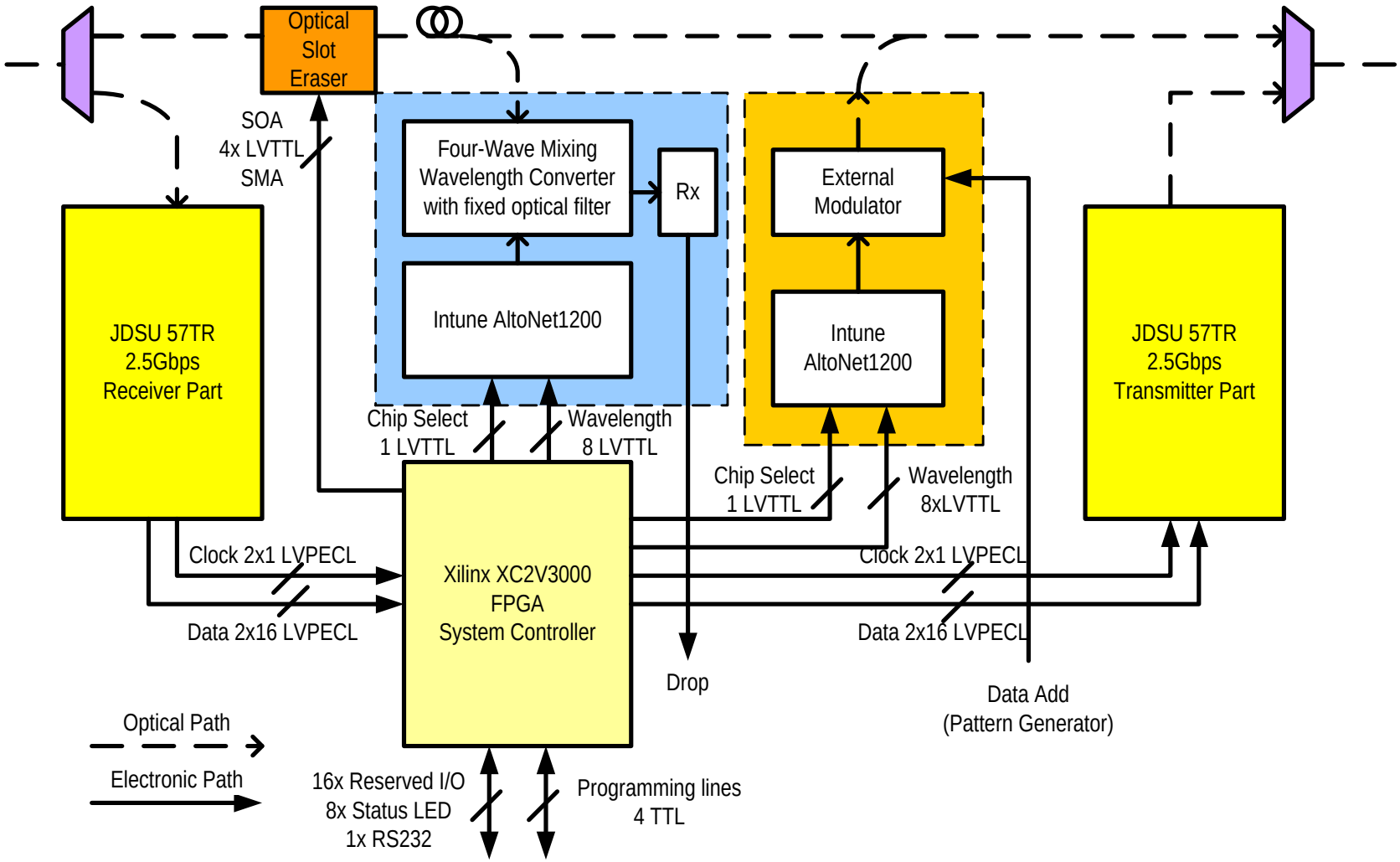


- Design of optical metro network architecture
- Design of AN architecture and control
  - MAC scheme with QoS
  - Access node architecture
  - Optical subsystems
- Design of optical access network architecture and control
  - MAC scheme with triple play support
  - Optical subsystems
- Traffic engineering/grooming
- ***Design and construction of an Optical metro/access network including all above***

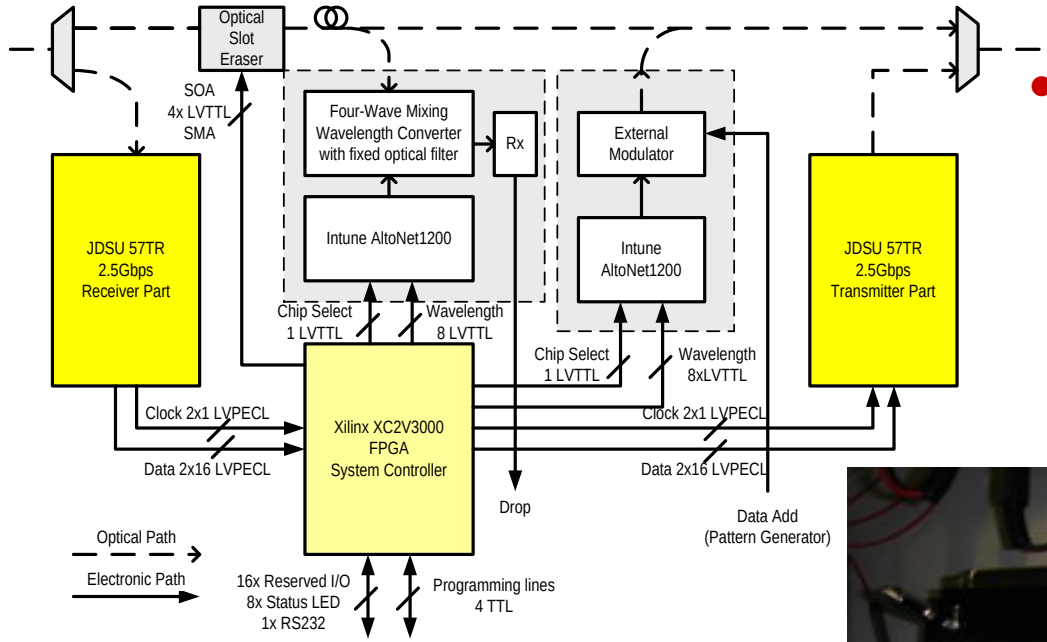
Metro WDM Network-
Optical Node Architecture



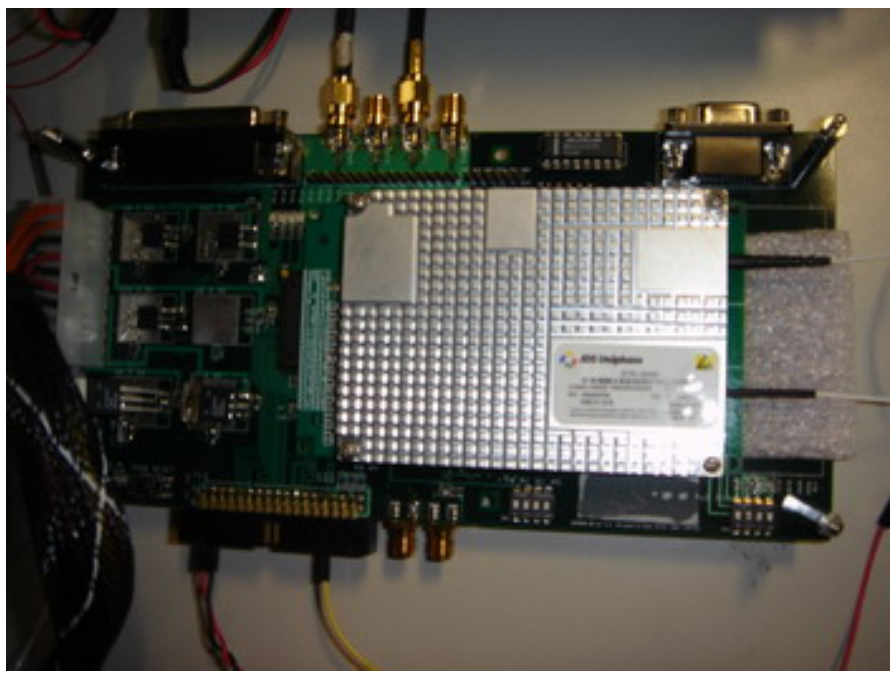
Hardware: Optical and Electrical Systems



System Central Controller + Transponder

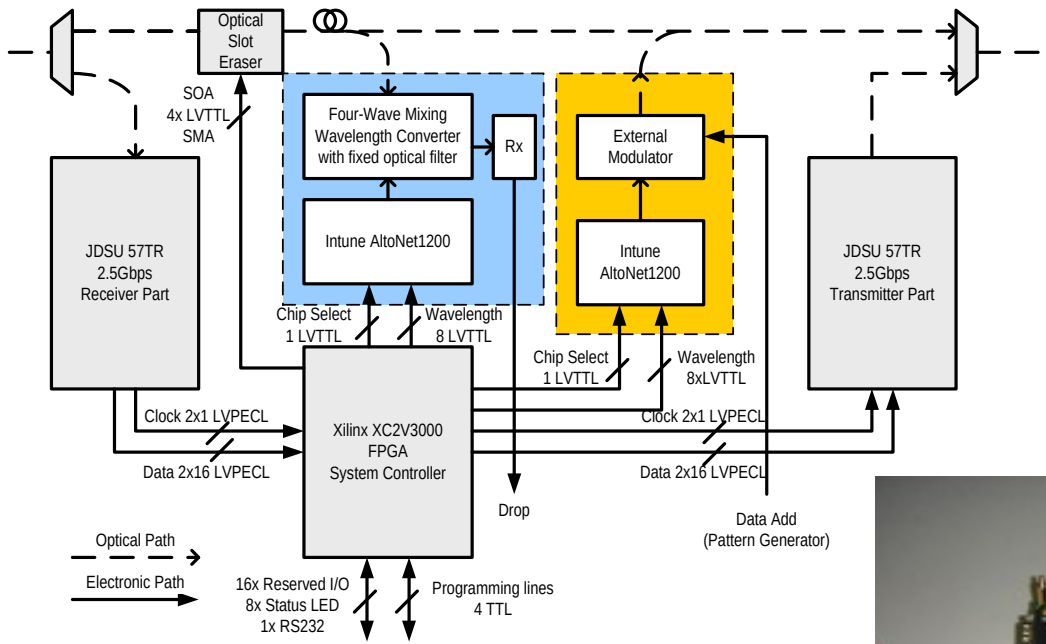


- **System Central Controller**
  - **Xilink XC2V3000 + FPGA**
  - **Digital clock manager**
  - **IP immersion architecture**
  - **180 MSPS**

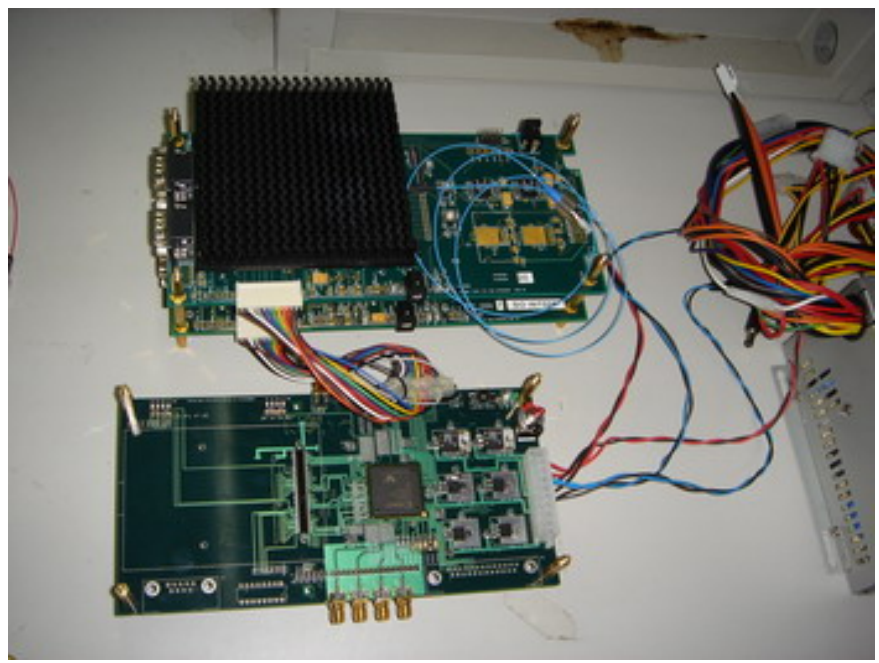


- **Transponder: JDSU 57TR transponder**
  - **DWDM compatible**
  - **Send/Receive at 2.5Gb/s**

Optical Tunable Transmitter and Receivers

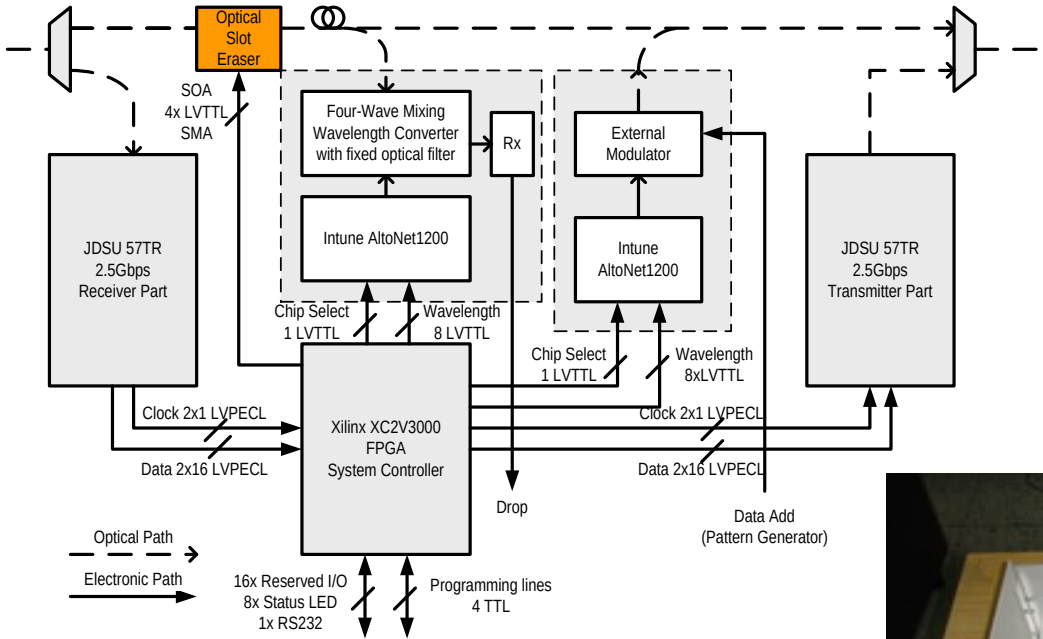


- **Fast Tunable Transmitter**
  - **Intune AltoNet 1200**
  - **Fast tuning < 200ns**
  - **Cover whole C-band (1530nm-1565nm)**



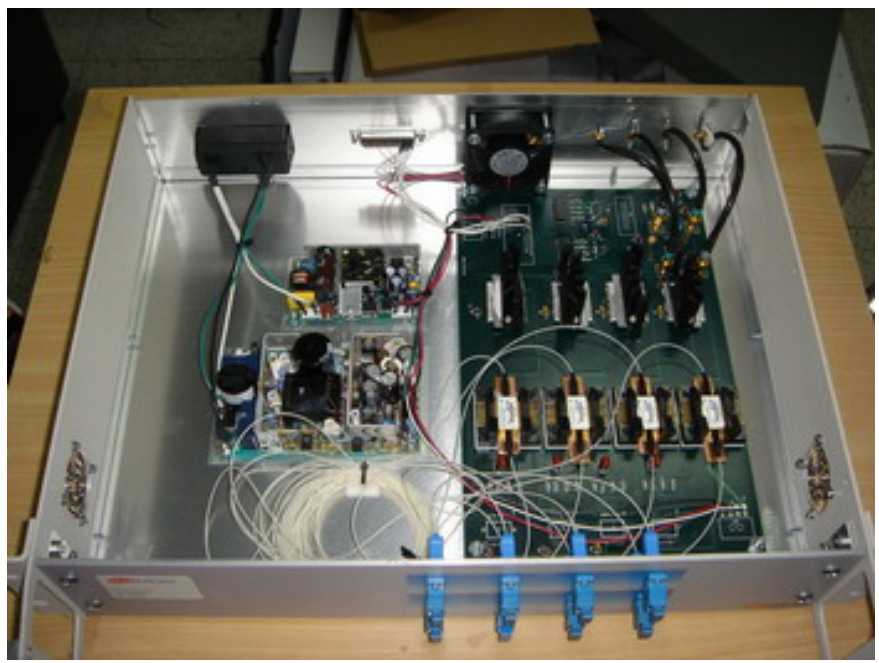
- **Fast Tunable Receiver**
  - **Intune AltoNet 1200**
  - **SOA Four-Wave-Mixing (FWM) wavelength conversion, super fast < 1ps**
  - **Fixed filter**

Optical Slot Eraser



- **Optical Slot Eraser is only facilitated at Server node due to costly optical erasing operation**

- **Optical Slot Eraser**
  - **Built by Semiconductor Optical Amplifier (SOA)**
  - **Very fast operation < 50ns**
  - **High on/off extinction ratio > 30dB**
  - **Lossless operation: SOA can provide up to 20 dB power gain**



Evolution of Wall

From Packet Networking to Content Networking

- **7-in-1 (NetBSD)**
  - Handling the problems in *TCP/IP layer*
  - NAT, Firewall, VPN, Router, BW mgnt., IDS, URL filter
- **10-in-1 (NetBSD)**
  - *Content-aware*
  - Anti-Virus, Anti-Spam, CF/Keyword
  - Reducing System Overheads: New Arch./Alg.
- **N-in-1 (Linux)**
  - *Easy* to add new modules
  - UPnP, APP Firewall, SSL-VPN, Wireless AP

Completed Research Tasks (~ 2005/6)

Content Networking with Deep Packet Inspection

- **System Performance**
  - Architecture:
    - ***4-in-1 proxy arch.:*** **Spam+ Virus+ IDS+ CF (Throughput** X 2)
    - ***Stream-based mail proxy for anti-virus***
    - ***Content security processing on network processors and ASIC***
    - ***P2P Traffic Management***
  - ***Algorithm:***
    - ***Profiling summary on string matching algorithm and application***
    - ***Adaptive generic signature matching engine***
- **Request Scheduling for Differentiated QoS**
  - ***Website gateway:*** **Multi-Resources Request Scheduling**
  - ***Access gateway:*** **Requestized-GPS with Window-base Service Rate Control**

New Research Tasks

Content Networking withDeep Packet Inspection

- **System Research**
  - Architecture:
    - ***WiMax Base Station on Network Processors***
    - ***Content security processing on network processors & ASIC/FPGA***
  - Methodology:
    - ***Extract and Replay of Attack Traffic***
    - ***P2P Traffic Management*** **(reducing false negative)**
- **Scheduling for Differentiated QoS**
  - Latency-driven Request Scheduling on Website gateway
    - ***Multiple Resources***
    - ***Multiple Servers***
  - **Request Scheduling on WiMax BS**

Research Tasks at NBL

From Test Service Provider to Test Solution Provider

- **WiMax (new!)**
  - **MAC design with mobility and roaming**
  - **Test plan and test bed at NBL**
- **SAN (new!)**
  - **iSCSI performance, conformance, interoperability testing**
- **Wi-Fi**
  - **Voice quality over WLAN with mobility and roaming**
- **Security**
  - **In-lab live testing with real traffic**
  - **Analyzing attacks, viruses, spams, and pornography**
- **Switch/Router**
  - **Automatic conformance and performance testing on L2/L3 switches**
- **VoIP**
  - **PSTN/VoIP interoperability testing**

計畫整體性成果

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

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HOPSMAN光纖都會實驗網路
- 與清大子計畫一進行光網路與高速電交換(Mailbox)整合
- IEEE Communication Society's Elect President, Dr. Nim Cheung參觀並展示研究成果 (2005/8/1-5)
- 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

整體性成果:國際交流及學術合作(1)

- 與美國大學University of Maryland-Prof. Ray Chen進行光通訊技術合作
- 訪問University of California Davis Prof. Biswanath Mukherjee (2005/6)
- 訪問ANDevices光纖公司，討論合作開發Burst-Mode Receiver關鍵技術(2005/6)
- 訪問Stanford University Prof. Leonid Kazovsky並參觀光通訊網路實驗室(2005/6)
- 邀請IEEE Communication Society's Elect President, Dr. Nim Cheung於交大作專題講（題目：Technology and Architecture Trends in Optical Networking) (2005/8/3)
- 楊啟瑞教授應APOC'04國際會議邀請專題演講(題目：全光網路IP-over-WDM) (2004/11/7)

整體性成果:國際交流及學術合作(2)

- 林盈達教授應資策會邀請專題演講 (題目：台灣往通產業總體檢-產品技術面) (2004/7/21)
- 林盈達教授應Fortinet公司邀請專題演講(題目: Trends in Network Security Product Development) (2004/8/12)
- 林盈達教授應IFPI倫敦總部邀請專題演講(題目: P2P Application Behaviors) (2004/9/2)
- (Industry-oriented)拜訪美國十個單位
  - 三個實驗室(UNH/IOL, ICSA, Veritest) ：國外測試實驗室定位
  - 三個測試設備廠商(Azimuth, IXIA, Spirent)：對測試的重視程度
  - 四個網路設備廠商(Fortinet, Cisco, Juniper, Alcatel)：市場領導廠商產品線發展
- (Academia-oriented)拜訪美國五位知名教授
  - ICIR的Sally Floyd : TCP-Friendly Algorithms, the future of the Internet
  - Caltech CSEE, Steven H. Low : Limit and application of Fast TCP
  - UCLA CS, Mario Gerla : Request Scheduling Algorithm
  - Berkeley EE, Kurt Keutzer : Architecture design for network processors
  - UCLA CS, Peter Reiher : Implementation over network processors

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)
- **HOPSMAN**：建構能提供triple-play之光纖都會型實驗網路
- **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)

整體性成果:量化成果

成果統計時間：**2004/04/01～2005/07/31**

期刊論文	會議論文	專利申請與獲得	雛型系統	研討會
11	**13**	**9**	4	8

Activities(學術活動)

- Conferences(會議舉辦)
- Contest (競賽得獎)
- 學術獎勵
- 產學合作

主要論文發表

Journal papers

1. **Yu-Chang Lu, Jason (Jyehong) Chen, Kai-Ming Feng, Pao-Chi Yeh, Tzu-Yen Huang, Wei-Ren Peng, Ming-Fang Huang, and Chia-Chien Wei, "Im Improved SPM Tolerance and Cost-Effective Phase-Modulation Duobinary Transmission over 230 km Standard Single-Mode Fiber Using a Single Mach-Zehnder Modulator", to be published at IEEE Photonics Technol. Lett.**
2. **Wei-Ren Peng, Yu-Chang Lu, Jason (Jyehong) Chen, Sien Chi, "Encoding ASK labeled CSRZ-DPSK payload by using only one dual-drive Mach-Zehnder Modulator with enhanced label performance", to be published at IEEE Photonics Technol. Lett.**
3. **C.C Wei, M. F. Huang, J.H. Chen, "Enhancing the Frequency Response of Cross Polarization Wavelength Conversion", IEEE Photonics Technol. Lett., pp. 1683-1685, Aug. 2005, SCI..**
4. **K. M Feng, M. F Huang, C. C. Wei, C. Y Lai, T. Y. Lin, J. H. Chen and S. Chi, "Metro Add/Drop Network Applications of Cascaded Dispersion-Compensated Interleaver Pairs Using a Re-circulating loop", IEEE Photonic Technol. Lett., pp.1349-1351, June 2005, SCI..**
5. **G. R. Lin, Y. C. Chang, Y. H. Lin, and J. H. Chen, "All Optical Data Format Conversion in Synchronously Modulated Single-Mode Fabry-Perot Laser Diode Using External Injection-Locking Induced Nonlinear Threshold Reduction Effect", IEEE Photonics Technol. Lett., pp. 1307-1309, March 2005, SCI..**

主要論文發表(cont.)

- **Conference papers**

1. **Maria C. Yuang, Po-Lung Tien, Julin Shih, Steven S. W. Lee, Yu-Min Lin, Yuan Chen, Frank Tsai, and Alice Chen, "QoS Contention Control for Optical Coarse Packet Switched IP-over-WDM Network," IEEE ITRE'05, June 2005, Hsinchu, Taiwan, EI..**
2. **Maria C. Yuang, Po L. Tien, J. Shih, Steven S. W. Lee, Yu-Min Lin, and Jason J. Chen, "A QoS Optical Packet-Switching System for Metro WDM Networks," accepted by ECOC'05, Sept. 2005, Glasgow, Scotland, EI..**
3. **Yu-Chang Lu, Jason (Jyehong) Chen, Kai-Ming Feng, Pao-Chi Yeh, Tzu-Yen Huang, Wei-Ren Peng, Ming-Fang Huang, Chia-Chien Wei, and Sien Chi, "A cost-effective phase-modulation-enhanced duobinary modulation to improved SPM tolerance using only one Mach-Zehnder modulator", to be published at ECOC 2005, Glasgow, U.K.**
4. **Wei-Ren Peng, Yu-Chang Lu, Jason (Jyehong) Chen, Sien Chi, "ASK/RZ-DPSK labeled signal generation using only one mach-zehnder modulator", to be published at ECOC2005, Glasgow, U.K.**
5. **M. F Huang, C. Y. Lai, J. H. Chen, K.M. Feng, C. C. Wee, T. Y. Lin and S. Chi, "Using a novel four-port interleaver to enable unidirectional amplification in a 210 km bidirectional transmission system", to be published at LEOS 2005, Sydney, Austrialia.**
6. **Kuo-Kun Tseng, Ying-Dar Lin, Tseng-Huei Lee, Yuan-Cheng Lai, "A Parallel Automaton String Matching with Pre-Hashing and Root-Indexing Techniques for Content Filtering Coprocessor," 16th IEEE International Conference on Application-Specific Systems, Architectures, and Processors, Samos, Greece, July 2005, EI..**

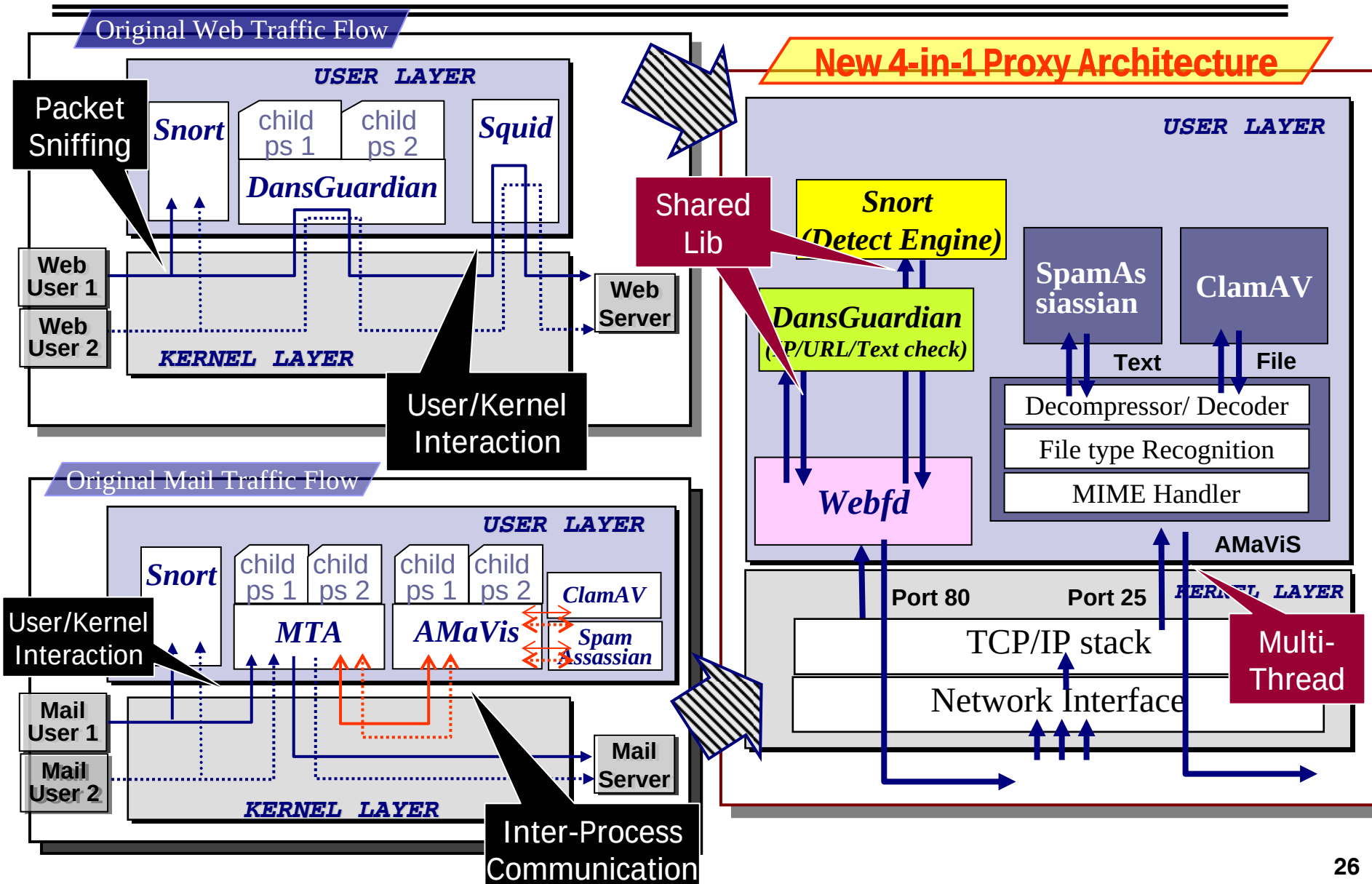
專利申請及獲得

經費運用情形

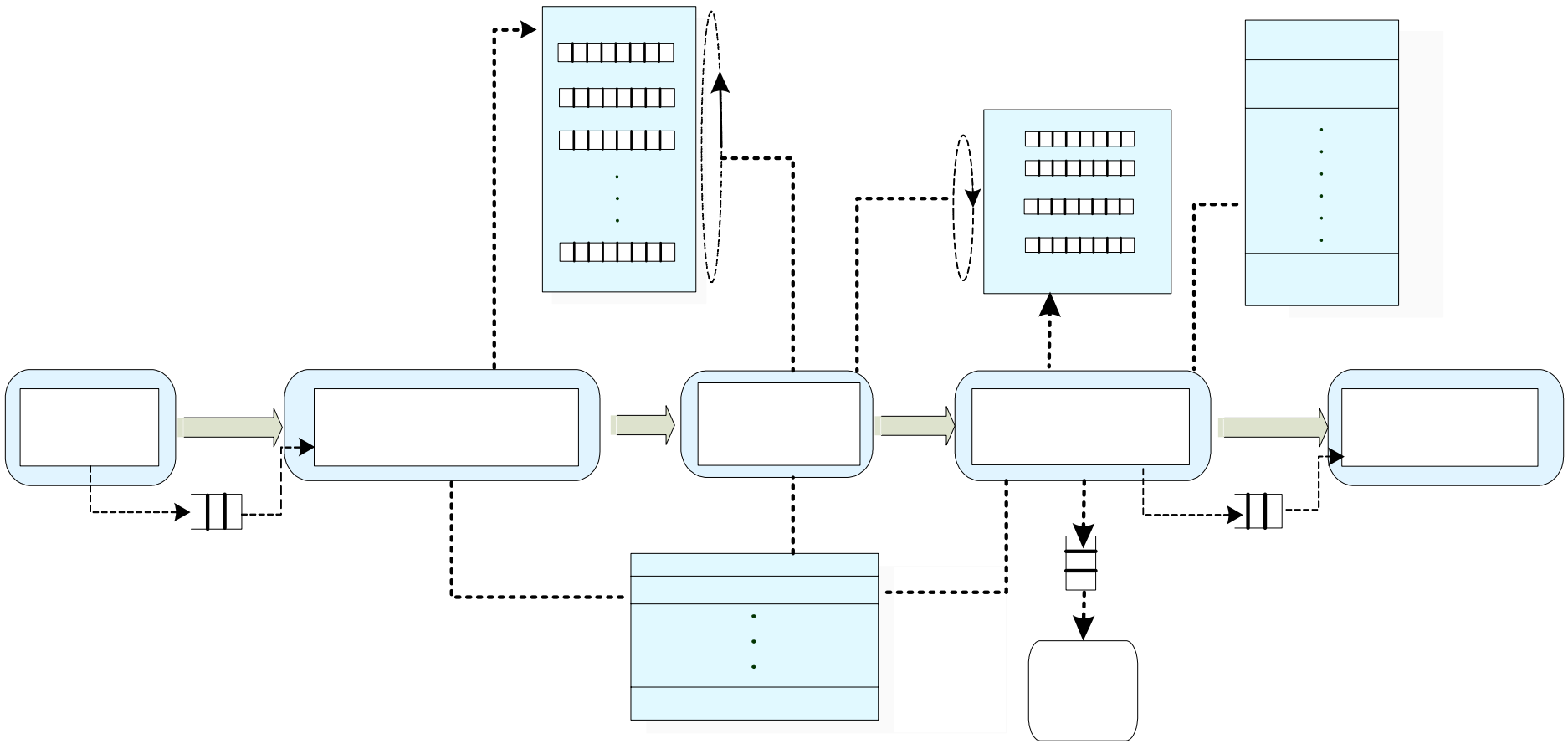
	核定金額	實支數	餘額	執行率
業務費				
研究設備費				
國外差旅費				
管理費				
合計				

Appendix

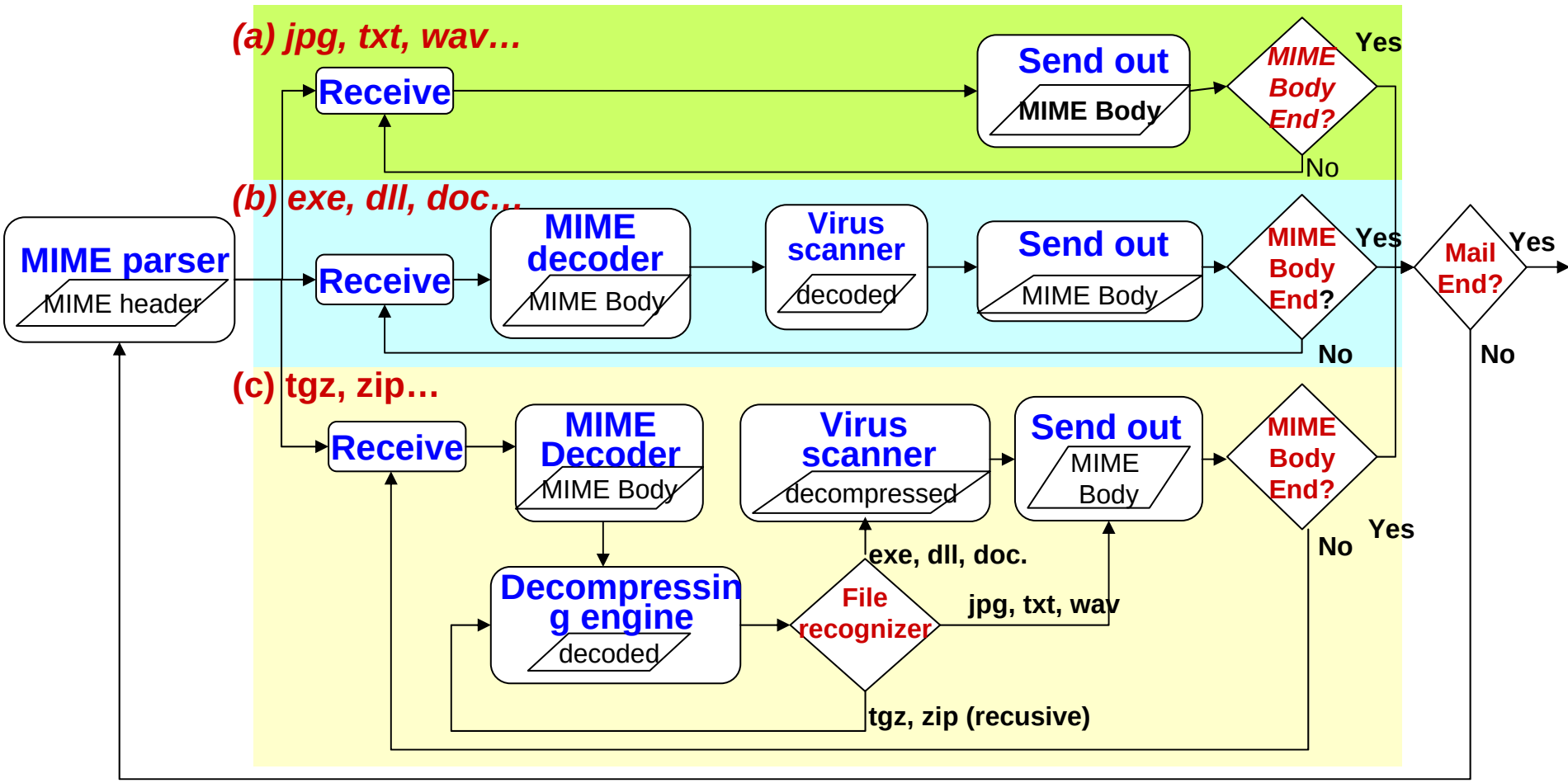
4-in-1 Proxy Architecture



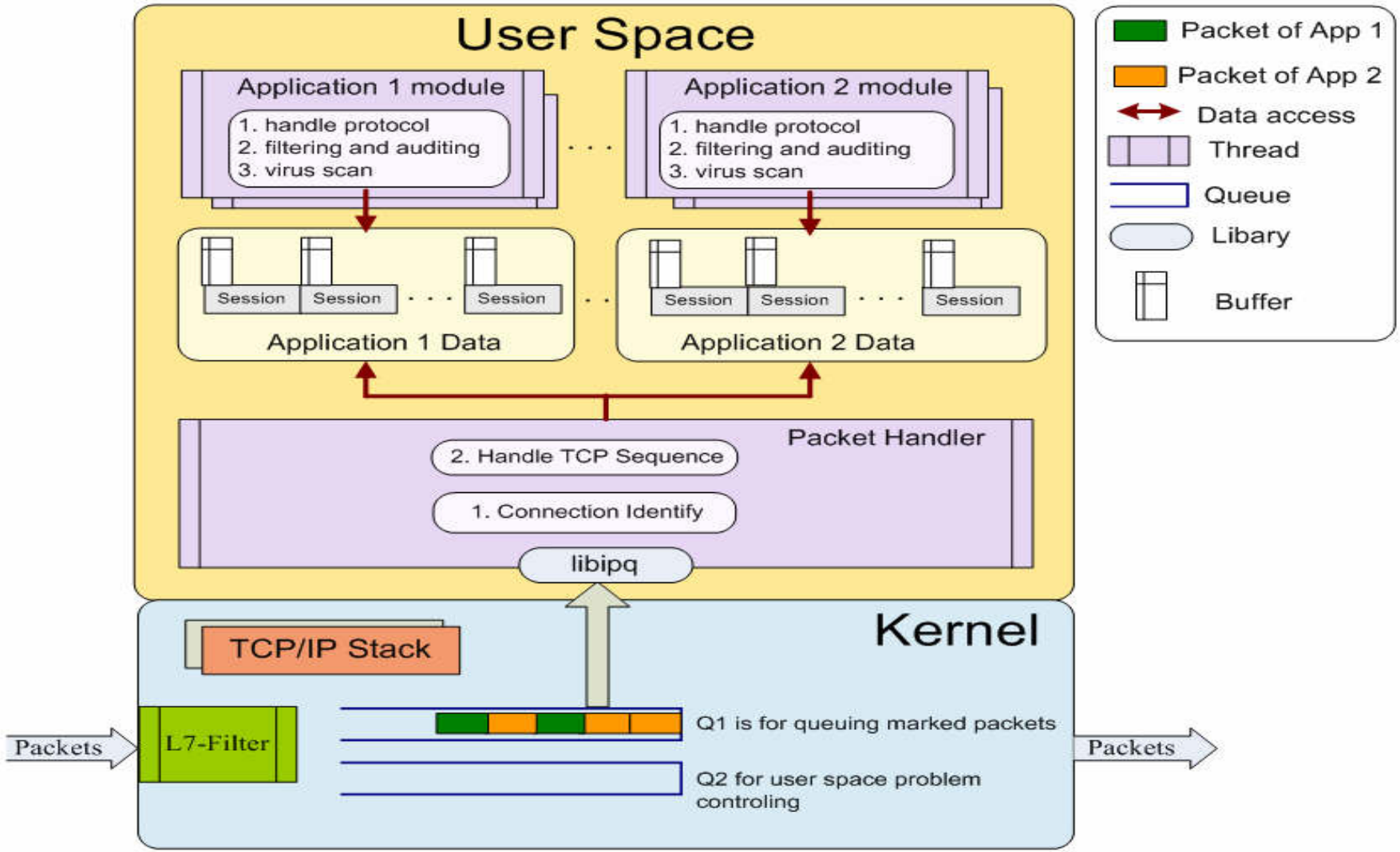
NIDS Processing on Network Processors



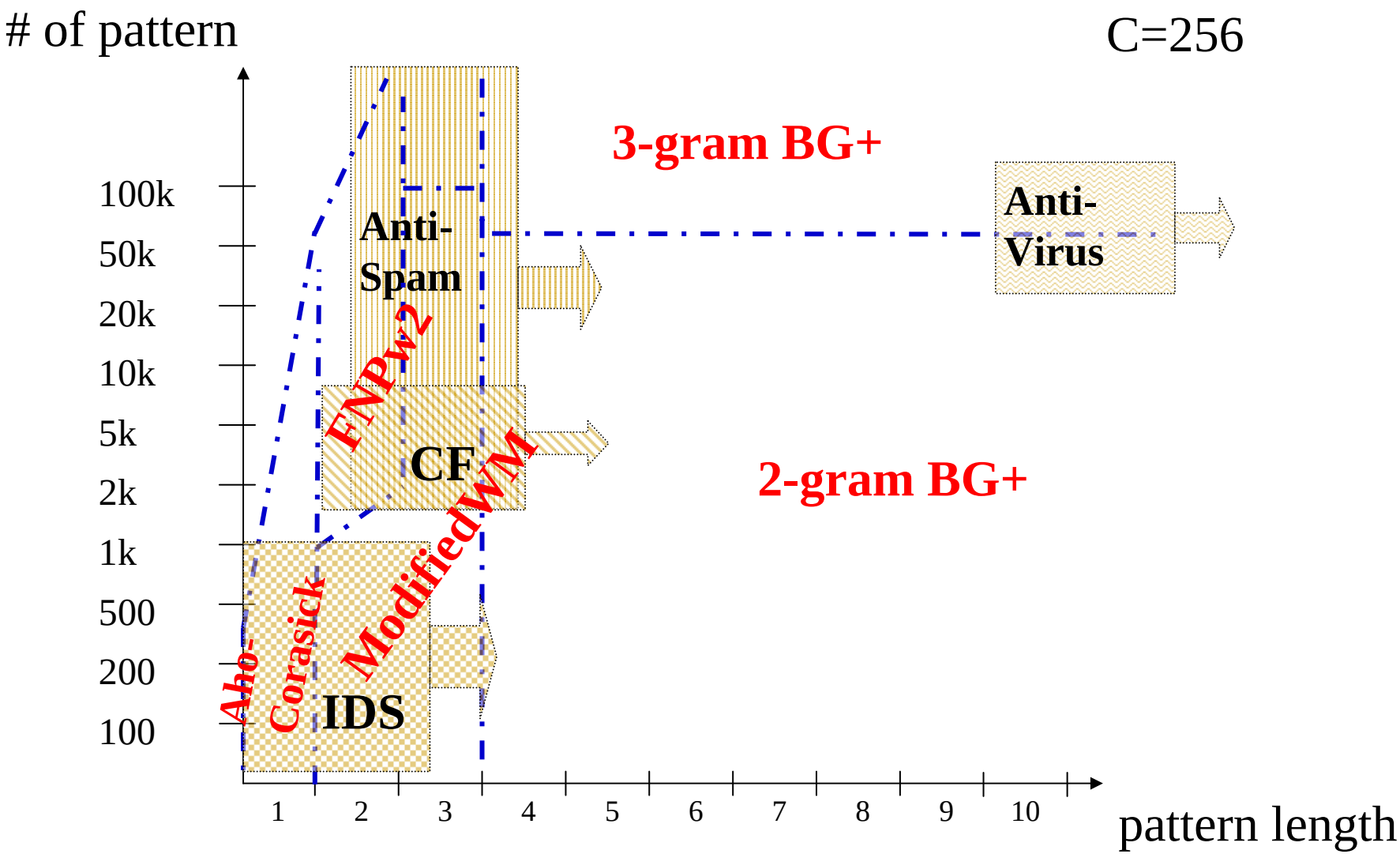
Stream-based Mail Proxy for Anti-virus



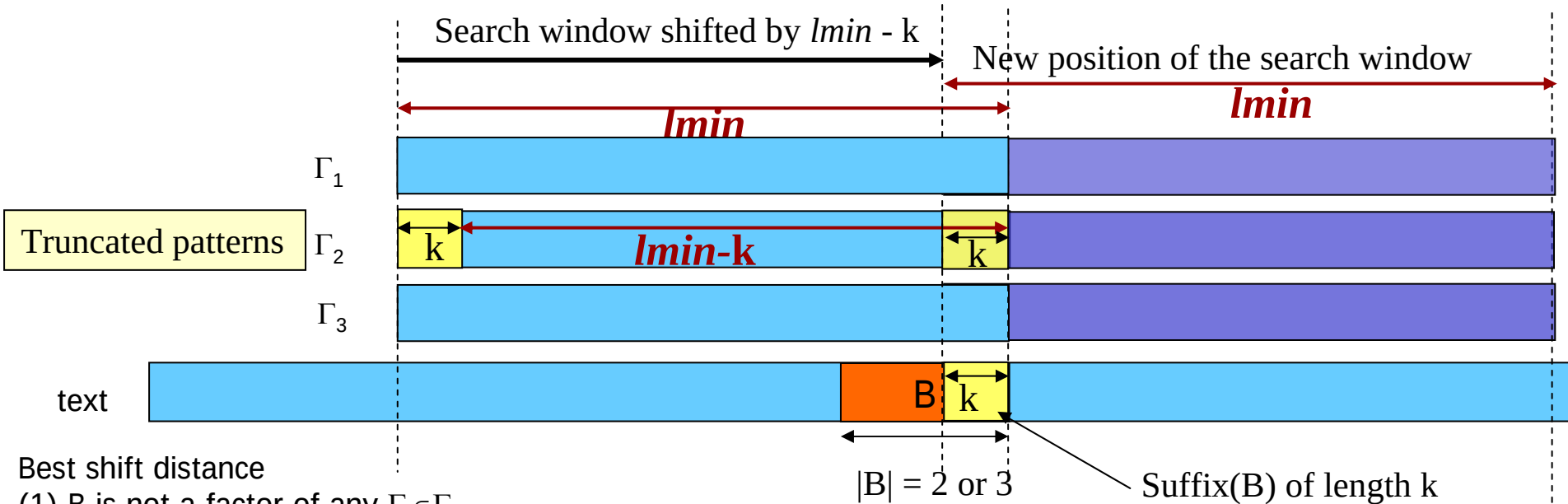
P2P Traffic Management Architecture



Profiling Summary on String Matching Algorithms and Applications



The BH algorithm : Adaptive Generic Signature Matching Engine



Best shift distance

(1) B is not a factor of any $\Gamma_i \in \Gamma$.

- No suffix of B is a prefix of any $\Gamma_i \in \Gamma$, SHIFT[h(B)] = *lmin*.
  - One suffix of B is a prefix of some $\Gamma_i \in \Gamma$.
    Let k be the maximum length of such a suffix. SHIFT[h(B)] = *lmin* – k.

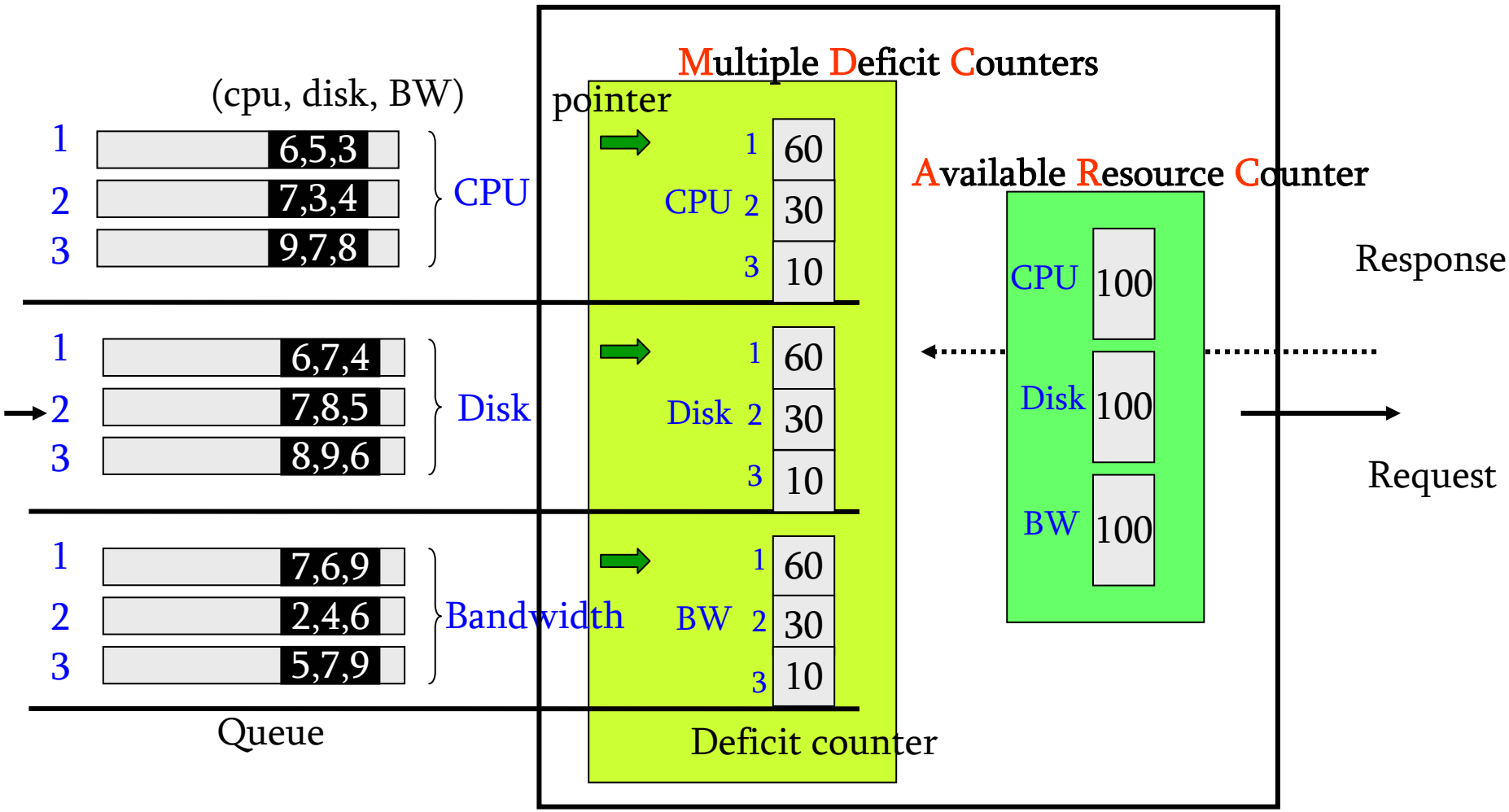
(2) B is a factor of some $\Gamma_i \in \Gamma$.

- Let *l* be the rightmost occurrence of B. SHIFT[h(B)] = *lmin* – *l*. Verify if SHIFT[h(B)] = 0

Psuedo-code of the BH algorithm

```
Preprocessing;  // Create the shift table
while (pos <= text_length) {
        shift ← SHIFT[t_{pos+m-|B|}];   // shift table lookup
        if  (shift == 0) {
            Look for more blocks to find new shift distance,
            or announce match if pattern is found.
        }
        pos ← pos + shift;
}
```

Website Gateway: Multiple Resource Request Scheduling



Access Gateway: Requestized GPS with Window-based Service Rate Control