# WDM 環狀全光網路中光槽排程之研究

學生：陳俊宇　　指導教授：田伯隆　教授

國立交通大學電信工程學系碩士班

## 摘　　要

在本研究中，著重之主幹網路為單一傳輸方向之環狀拓撲，且在主幹網路之下，以光纖連結至終端無線網路基地台，來達成無線網路與光纖網路之結合。此研究之目標是使用低成本的“wavelength insensitive”元件，採用 PSR (photonic slot routing)的概念，並對其加以改進，使其能達成動態頻寬分配，名為 Dynamic Slot Scheduling (DSS)。藉此達成即時性的網路應用，並且讓我們所研究的網路系統其效能，可以趨近使用高成本“wavelength sensitive”元件系統之系統效能。並在無線網路基地台部分配合使用 ROF (radio over fiber)技術，來實現「全光」“all optical”網路。希望能夠讓光纖網路不再受到成本之限制，使光纖網路更為普遍，全面提升網路的頻寬與速度，以符合現階段對網路頻寬與速度之需求。另外亦可讓本系統提供基礎的 QoS 服務。

# The Study on Photonic Slot Scheduling in All-optical WDM Ring Network

Student: Chun-Yu Chen Advisors：Dr. Po-Lung Tien

Department of Communication Engineering
National Chiao Tung University

## ABSTRACT

In this research, we study the uni-direction single ring backbone network. The nodes on the backbone ring connect to the wireless base-stations to access the wireless network. And we use the ROF (radio over fiber) technology in the bas-stations. In this way, the system can integrate the wireless network into the backbone optical network. The goal of our research is to implement “all optical” network by using the low cost “wavelength insensitive” devices. In order to achieve this purpose, we adopt the PSR (photonic slot routing) concept and improve it. We overcome the drawback of PSR and make our system can achieve dynamic bandwidth allocation which is named Dynamic Slot Scheduling (DSS). Make our system can support “real time” network applications. Through our research, we hope the optical network will become more popular and let people can use optical network instead of suffering the high price ever. Thus the system can offer the wide bandwidth and high speed. In addition, the most important goal of our research is to make the performance of DPSA system can approach the system which use high cost “wavelength sensitive” devices, and let our system can offer basic QoS (Quality of Service).

# 誌　　謝

本篇論文得以完成，最是要感謝的是我的指導教授田伯隆老師，由於他辛勤與耐心的指導，這篇論文才能得以完成。其他，如待人處世方面也由於田老師的細心指教讓我獲益良多。

同時也要感謝實驗室同學王偉豪、博士班學長劉啟賢、碩士班學弟陳恭利在研究與課業上的相互砥礪，讓我在碩士生涯的這兩年中，於專業知識與待人接物方面都有所成長與進步。

最後要感謝我的父母在生活上的支持與鼓勵讓我可以無後顧之憂的完成學業，最後謝謝所有曾經幫助我的人。

# 目　　錄


中文摘要 …… i

英文摘要 …… ii

致謝 …… iii

目錄 …… iv

圖目錄 …… v

表目錄 …… vi

Chapter 1 Introduction …… 1

Chapter 2 Background …… 4

2.1 Wavelength Sensitive Switching …… 4

2.2 Photonic Slot Routing (PSR) …… 8

2.2-1 Switching Node Architecture of PSR …… 12

2.2-2 Destination Constrain of PSR …… 18

Chapter 3 System Architecture …… 25

3.1 Network Architecture …… 25

3.2 Dynamic Slot Scheduling System …… 28

Chapter 4 Simulation Result and Performance Analysis …… 43

Chapter 5 Conclusions and Future Works …… 62

Reference …… 63

# 圖目錄


Figure 1: Format of a photonic slot …… 11

Figure 2: PSR node architecture …… 12

Figure 3: simply schematic of the node …… 13

Figure 4: Slot Switching …… 16

Figure 5: Slot Merging …… 17

Figure 6: Slot Copying …… 18

Figure 7: Destination Constrain of PSR …… 20

Figure 8: Network Architecture …… 26

Figure 9: simply schematic of the DSS switching node …… 30

Figure 10: DSS switching node architecture …… 31

Figure 11.1: Transmitting Step 3. …… 32

Figure 11.2: Transmitting Step 4. …… 33

Figure 11.3: Transmitting Step 5.1 …… 34

Figure 11.4: Transmitting Step 5.2 …… 35

Figure 11.5: Transmitting Step 5.3 …… 36

Figure 11.6: receive photonic slot …… 37

Figure 11.7: Optical Slot Erasing …… 37

Figure 12.1: flow chart of transmitting procedure …… 39

Figure 12.2: flow chart of transmitting procedure …… 40

Figure 13: electrical packet buffer length of tunable receiver WSS …… 45

Figure 14.1: packet lost probability of all methods …… 46

Figure 14.2: packet lost probability of all methods (log scale) …… 47

Figure 15: packet delay time-slot of all methods …… 49

Figure 16.1: high priority packet lost prob. …… 51

Figure 16.2: high priority packet lost prob. (log scale) …… 51

Figure 16.3: low priority packet lost prob. …… 52
Figure 17.1-1: sdl=1 high priority packet lost prob. …… 52
Figure 17.1-2: sdl=1 low priority packet lost prob. …… 53
Figure 17.2-1: sdl=2 high priority packet lost prob. …… 53
Figure 17.2-2: sdl=2 low priority packet lost prob. …… 54
Figure 17.3-1: sdl=3 high priority packet lost prob. …… 54
Figure 17.3-2: sdl=3 low priority packet lost prob. …… 55
Figure 17.4-1: sdl=4 high priority packet lost prob. …… 55
Figure 17.4-2 sdl=4 low priority packet lost prob. …… 56
Figure 18.1-1: high priority packet lost prob. …… 56
Figure 18.1-2: low priority packet lost prob. …… 57
Figure 18.2-1: high priority packet lost prob. …… 57
Figure 18.2-2: low priority packet lost prob. …… 58
Figure 18.3-1: high priority packet lost prob. …… 58
Figure 18.3-2: low priority packet lost prob. …… 59
Figure 18.4-1: high priority packet lost prob. …… 59
Figure 18.4-2: low priority packet lost prob. …… 60
Figure 19.1 differentiation of different priority packet lost prob. …… 61
Figure 19.1 differentiation of different priority packet lost prob. (log scale) … 61

## 表目錄

Table 1 Parameter Used in Simulation …… 43