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Welcome to: NIIT Network Research Group at NUST Institute of Information Technology

1. Historical Perspective

NIIT Network Research Group (NNRG) was established in 1999 by Dr. S. M. Hassan Zaidi. NNRG promotes education, research and outreach in the field of computer networks, and ultra-high speed data communications including photonics/wireless communications. Faculty members and students work in synergy to explore the problems in the application areas like network security, network programming, network protocols, data communication, wireless networks, sensor networks, and photonic networks. Its mission is to prepare the next-generation of researchers and developers in these areas by investigating challenging, high-impact research projects and building production-quality systems. It aims to represent a complementary mix of both theoretical and applied experimental research. NNRG will also organize and handle activities related to computer networks to increase students' awareness in the field of networking and cultivate an interest in this field.

2. Lab Facilities

The Network Research Lab. at NIIT has state of the art equipment for the research projects. The equipment includes:

2.1 Hardware

- LAN with over 160 networked workstations and servers
- 1 Cisco 2600 Series Router, and 5 Cisco 1700 Series Routers
- Stackable Hubs and Switches
- 4 MB dedicated connectivity to Internet

2.2 Software

- Simulators: Optsim, NS-2, Matlab
- VRVS video conferencing facility
- OS: Linux (Red Hat), Win2000 /NT/98
- Firewall: Winroute Pro, MS Proxy WinGate, Cisco IOS
- Packet Generator: Sock, PackGen
- Traffic capturing tools: TCPdump, WINDump, Ksnuffle

3. People

3.1 Faculty

- Dr. S. M. Hassan Zaidi. PhD University of South Florida (USA)
- Mr Ramzan, MS EE (Australia)
- Mr Kashif, MIT National University of Science and Technology (Pakistan)
- Mr Kamran Hussain, MS Communication Technology (UK)

3.2 International Collaborators

NNRG has formed a number of collaborations with foreign universities. Currently many research projects are underway with the collaborating organizations. A brief account of the projects and the universities is given.

3.2.1 University of North Carolina, Charlotte, USA Complex Adaptive Systems and Sensor Networks

Research team includes:

- Dr. Mirsad Hadzikadic
- Dr. Teresa Dahlberg
- Dr. S M H Zaidi
- Mr. Kashif Sharif

Survivable Passive Access Network (SPAN)

Research team includes:

- Dr. Yasin A Raja
- Dr. S M H Zaidi
- Mr. M. Umer Waseem

Raman Optical Amplifiers for Optical Networks

Research team includes:

- Dr. Yasin A Raja
- Dr. S M H Zaidi
- Mr. Kamran Ahmad

3.2.2 Florida Atlantic University, USA

Enterprise Application Security Frame Work

The research team working on this project is:

- Dr. Saeed Rajput
- Dr. S M H Zaidi
- Mr. Kashif Sharif
- Mr. Riaz Ahmed Shaikh

3.2.3 Tennessee Tech University, USA

Priority Swapping Inter-ONU Bandwidth Allocation Algorithm

Research team includes:

- Dr. Nasir Ghani
- Dr. S M H Zaidi
- Mr. Raheeb Muzafar

Priority Swapping Intra-ONU Bandwidth Allocation Algorithm

Research team includes:

- Dr. Nasir Ghani
- Dr. S M H Zaidi
- Mr. Usman Yunis

3.2.4 University of West of England Mobile Computing

Research team includes:

- Dr. Richard McClatchey
- Dr. Nigel Baker
- Dr. S M H Zaidi
- Ms. Madiha Zafar

3.2.5 North Carolina State University, Raliegh, USA Microelectronics Center of North Carolina (MCNC), USA Advanced Resource Reservation for Lambda based Grid Networks

Research team includes:

- Dr. Yu Feng (NCSU)
- Ms. Gigi Karmous (MCNC)
- Dr. S M H Zaidi
- Mr. Syed Waqar Hussain

3.2.6 Industrial Linkages

NNRG has industrial linkages with the following companies.

- **CARE**
Dr. Farrukh Kamran
Dr. Shoaib
- **RIMS**
Dr. Nadeem Lehrasib
- **ZTE Corporation, China**
Mr. Danial Fu

3.3 Administrative Associate

- Mr Ajmal Farooq
- Mr Muhammad Asim

3.4 Graduate Students

- Mr. Raheeb Muzafar MS Student
- Mr. Usman Yunis MS Student
- Mr. Muhammad Umer Wasim MS Student
- Mr. Syed Waqar Hussain MS Student
- Mr Qasim Bilal Lone BIT Student
- Mr. Ali Raza BICSE Student

3.5 Alumni

- Dr. Waqar Mahmood (PhD, USA)
- Mr. Ejaz Ahmad (MS, Australia)
- Mr. Ahsan Ch. (MS, Australia)

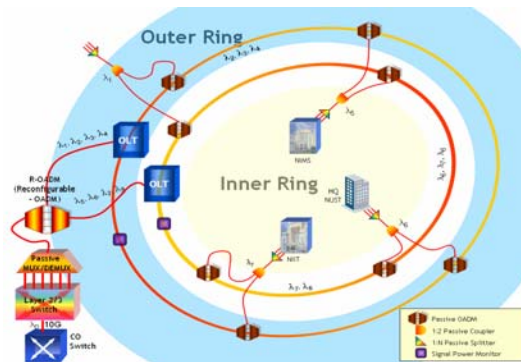
- Mrs. Ramla Ahmad (MIT, NUST)
- Mr M. Mahroof PhD Student
- Mr. Jawwad Ahmad MS Student
- Mr. Shahid Nawaz MS Student
- Ms. Madiha Zafar MS Student
- Mr. Riaz A Shaikh MS Student
- Ms. Mahreen Tariq BIT Student
- Mr. Usman Farooq BIT Student
- Mr. Ahmad Yar BIT Student
- Mr. Umer Farid BIT Student

4. Research

4.1 Current Research Projects

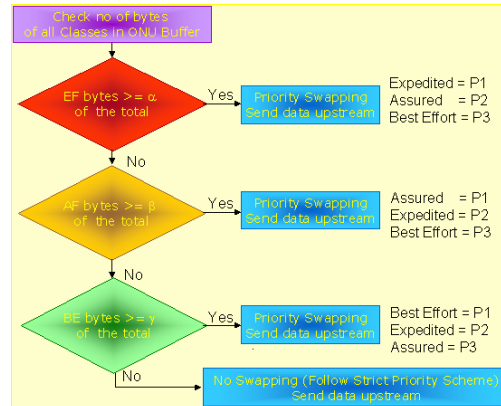
4.1.1 Photonic Networks

- *NH-PON (NUST Hybrid PON)*: The increase in the internet traffic is accelerating the demand for high-speed connectivity to the end users. Passive optical networks have proven to be one of the promising access solutions, providing desirable bandwidth to the end users. Therefore we propose to design a high capacity, cost effective hybrid WDM-TDM dual ring access solution for H-12 university campus based on PON technology. The model comprises dual fiber ring in order to compensate for reliability issue of the network. Each OLT transmits the composite WDM signal into its respective ring. Each passive OADM drops/adds its designated wavelengths in order to provide downstream/upstream transmission to a set of ONUs in TDM fashion. Therefore each ring can serve N number of TDM-PONs depending upon the number of transceivers and their configuration at the OLT.

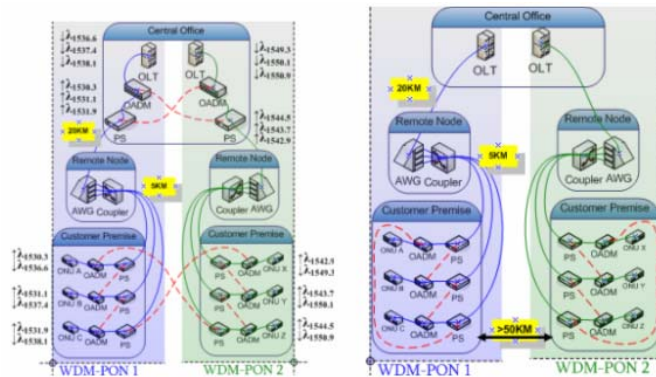


- *Priority Swapping Inter-ONU Bandwidth Allocation Algorithm*: Most DBA algorithms focus on OLT-ONU bandwidth allocation but EPON is expected to be a truly converged network supporting voice communication, videoconferencing, real-time and near real-time transactions and data traffic for which it must guarantee appropriate performance to such applications. Therefore we propose an intra-ONU Priority Swapping (PS) algorithm, supporting the three classes of differentiated services namely the Expedited Forwarding (EF), Assured

Forwarding (AF) and Best Effort (BE) classes. The proposed priority swapping solution is an intra-ONU bandwidth allocation algorithm focusing to stabilize the delays between the three classes of differentiated services by protecting low priority class (i.e., BE) packets from starvation through priority swapping while providing justifiable amount of bandwidth to higher priority (i.e., EF and AF) queues. The algorithm swaps the priorities of these classes based on the relative buffer sizes of these classes.



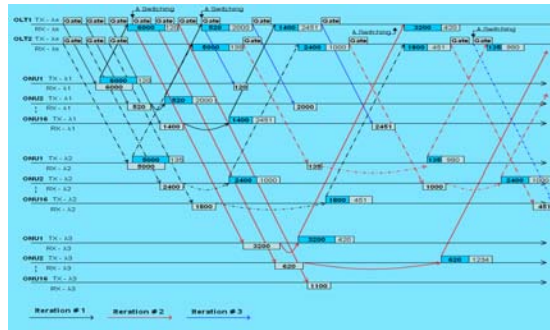
- Survivable Passive Access Network (SPAN):** Wavelength Division Multiplexed Passive Optical Networks are subjected to wide variety of incidental failures. Out of these failures mostly occur at physical layer like fiber cut, node failures etc, so it is preferred in WDM-PONs to provide fault management (survivability) at link layer level. In this research, our objective is to determine the factors, which can increase the scope of survivability at link layer, not available currently.



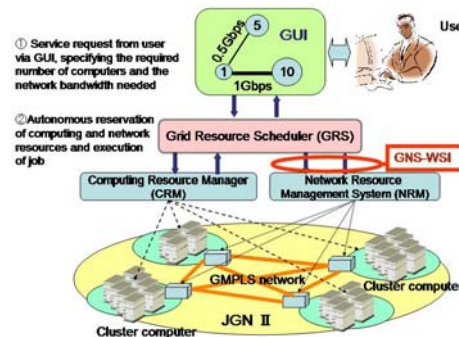
We propose “Survivable Passive Access Network” (SPAN), a new protection scheme for WDM-PONs. It is practical and cost effective architecture with underlying principle based on Free Spectral Range (FSR) characteristic of Array Waveguide Grating (AWG). SPAN is a multi-level protection scheme that has potential to be highly efficient in terms of performance budget and time budget. The SPAN architecture has been validated by simulations using a commercial software packages, named OptSim™.

- Dynamic Bandwidth Allocation using Sequential Channel Selection for Hybrid WDM/TDM EPON:** Hybrid WDM/TDM PON is identified an access solution

where the user traffic demands can be met in pay-as-you-grow paradigm, exploiting merits of current TDM PONs and future WDM PONs. *Dynamic Bandwidth Allocation* (DBA) for Hybrid WDM/TDM PON is challenge for any *Medium Access Control* (MAC) algorithm to justify the bandwidth demands of individual terminal equipment, i.e., *Optical Network Unit* (ONU). We propose a DBA algorithm with *Sequential Channel Selection* (SCS) keeping the scalability, fairness, simplicity (i.e., not to over load *Optical Terminal Equipment* (OLT) performance) and robustness issues upfront for Hybrid WDM/TDM PON. The main idea of SCS is to serve more number of TDM PONs (i.e., increased scalability) by allocating bandwidth dynamically with lesser tunable transceivers (i.e., reducing the overall cost of transceivers in the network) at the OLT. Wavelength channels for each PON are allocated statically and the OLT tunes its transceivers to each channel in round robin fashion providing bandwidth to each PON dynamically.



- An Efficient Advance Resource Reservation for Lambda based Grid Networks.* Lambda-Grids are virtual aggregations of geographically distributed computational elements tightly coupled with Reservation of lightpaths but its wide scale utilization has not yet been attempted. Consequently, there is a pressing need to not only provide a flexibility in the of options provided by the interface for setting up the lightpath according to the specific need of users which can be used to study the interplay of advance reservations with other strategies used for network resource optimization.

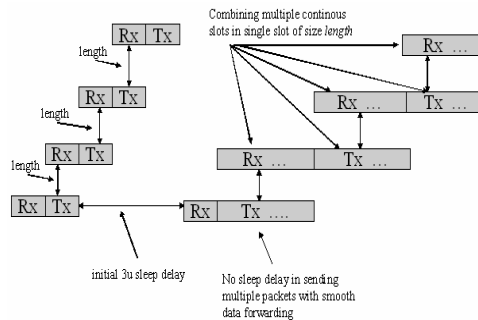


The pattern of user requests in an advance reservation scheme is significantly different from the pattern in an on-demand network environment. Advance reservation requests are not only a function of the time at which they arrive but

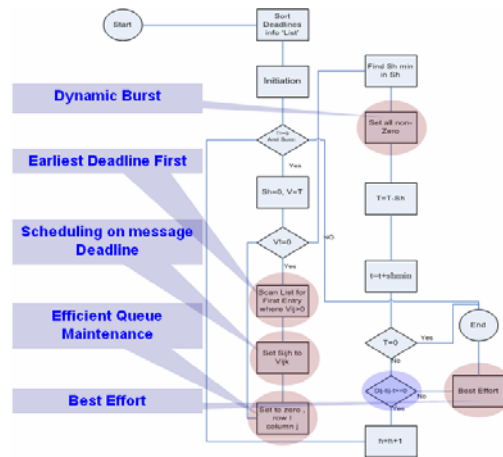
also of the time in the future for which the reservations are requested. Our goal is to improve the model for these requests for systems that support advance reservations.

4.1.2 Wireless Networks

- Latency and Energy efficient MAC (LEEMAC) Protocol:* Wireless sensor networks are appealing to researchers due to their wide range of application potential in areas such as target detection and tracking, environmental monitoring, industrial process monitoring, and tactical systems. However, lower sensing ranges result in dense networks, which bring the necessity to achieve an efficient medium access protocol subject to power constraints. Various MAC protocols with different objectives were proposed for wireless sensor networks. So this work focused mainly on latency issue for event critical applications. We propose LEEMAC, a Latency and Energy Efficient MAC Protocol which is an improvement of DMAC protocol in a sense that it gives us better latency and a slight improvement in energy efficiency than by DMAC which was designed and optimized for data gathering trees where data is collected from all the source nodes to the sink node. Since the sensor node that starts transmission after detecting an activity and processing the data knows exactly how much to transmit information. So we can have a length field only once in the MAC header of first packet of the burst in place of more data bit showing number of slots that should be renewed.



- Earliest Deadline First & Best Effort Scheduling Algorithm (E-BES):* Cellular telecommunication has evolved a great deal during the past decade. Service providers are shifting their focus from voice oriented services to data oriented services. UMTS (Universal Mobile Telecommunications Service) is a third-generation (3G) broadband, packet-based transmission of text, digitized voice, video, and multimedia over cellular networks. In UMTS systems, Radio Network Controller (RNC) is key sub-system that is responsible for providing high Quality of Service to end users. In E-BES, our objective is to improve the scope of QoS in cellular systems by introducing packet scheduling at RNC. This exhibits substantial efficiency in terms of packet loss, when compared to previous proposed algorithms (Priority Scheduling, Weighted Fair Queuing or Earliest-Deadline-First) for parameters like priority on basis of class type, deadline, and transmission power.



5. Future Initiatives of NNRG

- Center for Opto-Electronics at NUST:* Primary focus of the photonics center research is the advancement of research and development of photonic devices and their applications in the field of optical communications from components to the networks. In the development of such systems, we envision to creating technology with the capacity for remote reconfiguration, data provisioning, wavelength conversion and data, storage and routing. Developmental research areas include light sources (LEDs, semiconductor and fiber lasers), optical amplifiers and reconfigurable add/drop mux and interconnects. In the application of such devices, our research encompasses the design, simulations, fabrication, characterization and packaging of new components for chip-to-chip, board-to-board, and system to system optical interconnections.
- Photonic Research and Network Lab at NIIT:* A state of the art lab with latest equipment in terms of software as well as hardware including testbeds is planned to establish at NIIT in its new campus at H-12 Islamabad. To meet the high standards of latest technological advancements, it is necessary to maintain sufficient level of armory to move forward in this well advancing world and boost our research culture to prevail the technology in our country. Photonic Research and Network Lab will certainly cultivate national's talent into reality and benefit those who want to excel in their field and have bright future ahead.
- CDMA Research Group:* CDMA2000 being the 3rd generation wireless telecommunication technology is about to have exponential growth in Pakistan. It is predicted that there will be a demand of 100,000 people related to CDMA in Pakistan in near future. The group has been formed to i) work out the strategy of producing suitable professionals to fulfill the requirement of the upcoming job market ii) establish research in the CDMA area.

6. Publication

For list of publications please visit: www.nnrg.niit.edu.pk/publications.php

7. Contact

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