AC 2011-1832: ROLE OF HONET (HIGH-CAPACITY OPTICAL NETWORK AND ENABLING TECHNOLOGIES) A SERIES OF SYMPOSIA IN INTERNATIONAL COLLABORATION

Salahuddin Qazi and Yasin A Raja, State University of New York, Institute of Tech.

Salahuddin Qazi holds a Ph.D., degree in electrical engineering from the University of Technology, Loughborough, U.K. He is currently a full Professor and past chair of electrical engineering technology department at the SUNY Institute of Technology, Utica, New York. He teaches and conducts research in the area of fiber optics, wireless communications, nanotechnology and alternative energy. Dr. Qazi is a recipient of many awards including, the William Goodell award for research creativity at SUNYIT and engineering professionalism by Mohawk Valley Engineering Executive Committee, and forging closer relations with the IEEE Mohawk Valley section. Dr. Qazi is a senior member of IEEE and a member of American Society of Engineering Education.

M. Yasin Akhtar Raja is a Professor of Physics & Optical Science and ECE at the University of North Carolina (UNC) at Charlotte. He joined UNC Charlotte in 1990 and has served in various faculty positions and on several planning and program committees for establishing new Ph.D. programs, centers, and units. His research expertise spans from Nanophotonics and Optoelectronic devices and components for Optical Communication Networks. His Labs are currently is engaged in Nanophotonics and Optical Networks with a focus n passive optical networks (PON) for broadband access. He is a senior member of IEEE, ComSoc, SPIE, OSA, FTTH Council; and he has established the series of International Symposia "HONET-ICT" [http://honet-ict.org] with sponsorship of NSF since 2004. Prof. Yasin Raja received his Ph.D. in 1988 from the University of New Mexico, Albuquerque where he conducted a pioneering research in "VCSELs" (semiconductor lasers) at the center for high technology materials (CHTM). Dr. S M. Hassan Zaidi is currently, Dean at the School of Electrical Engineering and Computer Science (SEECS) at the NUST (National University of Science & Technology) Islamabad, Pakistan. Dr. Zaidi, has led a distinguished career in IT education, and has made significant contributions to the field of IT. He acquired his PhD degree in Computer simulation of high speed communication networks from University Of South Florida, USA. He has over 20 years of experience in teaching/ research and development in IT related fields and has published over 100 research papers in prestigious international Journals/conferences. Some of his notable research works include: Design of Opto Electronic Interconnect System for next generation super computers, a project funded by Defense Advanced Research Project Agency (DARPA) USA; Sensitivity enhancement of long-haul optical fiber communication systems funded by Graduate School University of South Florida USA; Design of a self-consistent solution for inter office ring network consisting of a cascade of optical amplifiers having an aggregate network capacity of 550 Gb/s for a full mesh traffic pattern, funded by Bell Communication Research USA. In 2006 he was distinguished visiting professor at Charlotte Research Institute, UNC Charlotte. Since then he has collaborated with several international scholars and researchers.

M. Yasin Akhtar Raja, Center for Optoelectronics & Optical Communications, UNC Charlotte, USA

M. Yasin Akhtar Raja is a Professor of Physics & Optical Science and ECE at the University of North Carolina (UNC) at Charlotte. He joined UNC Charlotte in 1990 and has served in various faculty positions and on several planning and program committees for establishing new Ph.D. programs, centers, and units. His research expertise spans from Nanophotonics and Optoelectronic Devices and Components for Optical Communication Networks. His Labs are currently is engaged in Nanophotonics and Optical Networks with a focus n passive optical networks (PON) for broadband access. He is a senior member of IEEE, ComSoc, SPIE, OSA, FTTH Council; and he has established the series of International Symposia "HONET-ICT" [http://honet-ict.org] with sponsorship of NSF since 2004. Prof. Yasin Raja received his Ph.D. in 1988 from the University of New Mexico, Albuquerque where he conducted a pioneering research in "VCSELs" (semiconductor lasers) at the center for high technology materials (CHTM).

Syed Muhammad Hassan Zaidi, NUST School of Electrical Engineering & Computer Science

Dr. Syed Muhammad Hassan Zaidi, is an illustrious researcher and practitioner in IT education, with credentials as a scholar of remarkable vision and commitment. He acquired his PhD from University Of South Florida, USA. During his distinguished academic research career spanning well over two decades, he has published over 100 research papers in prestigious international journals/conferences. He is the

recipient of several coveted honours and awards which notably include: NCR National IT Excellence Award for Research and Development and Gold Medal for the year 2000 2001; NCR National Excellence Award for IT Education in the year 2003. In September 2006, Charlotte Research Institute (CRI), USA conferred on him the status of "Duke Energy Distinguished Research Visiting Scholar. Dr Zaidi has the distinction of pioneering and co-chairing US-Pakistan International Symposium on High Capacity Optical Networks and Enabling Technologies (HONET), a regular annual event since Dec 2004. Very recently, he has won two President Gold medals for being proclaimed the BEST Researcher of the Year and the Best Teacher in Information Technology. Currently, Dr Zaidi is leading, from NUST-SEECS, Pakistan, a major collaborative research project with five famed international research groups. The partnership includes icons like Center for Optoelectronics & Optical communications, UNCC, USA; Stanford, Photonics Network Research Lab, Caltech Ultra-light research group; CMR Tennessee Tech University and Carolinas Micro-optics Triangle, USA. The project is focused on building a test-bed optical infrastructure for Global Lambda Integrated Facility (GLIF) Nodes. On 14th August 2008 he has won President's Pride of Performance Award for his meritorious services in the field of Information Technology at the National/International Level.

Role of HONET (High-capacity Optical Network and Enabling Technologies) A series of Symposia in International Collaboration

Abstract

The ability of the Internet to enable collaboration at global level is one of the most fundamental advances since the Industrial revolution. High-speed Internet, is driven by global optical networks utilizing various photonic- and network-technologies as enabling technologies for information technologies and telecommunications from the architectural, security, signal transport and application perspectives. In order to achieve such connectivity it is important to bring together professionals and practitioners from the academia, industry and government functionaries from around the world. The goals are to share knowledge and experience in the field of information and communication technologies (ICT) for global partnerships and collaborations aiding economic growth to support peace, prosperity and sustainability in the world. This has emerged as the vision of the HONET (High-capacity optical networks and enabling technologies).

The purpose of our paper is to share and discuss the results of holding a series of international symposia on High-capacity Optical Networks and Enabling Technologies (HONET) in different countries with a special focus on South Asia, Middle East and North Africa (SAMENA) region. These symposia started in 2004 with the sponsorship of NSF's Office of International Science and Engineering (OISE) and the first event was held at Islamabad, Pakistan as US-Pakistan International Workshop. This was organized by the University of North Carolina, Charlotte and hosted by the University of National University of Science and Technology (NUST) with the co-sponsorship of the Higher Education Commission of Pakistan (HEC). In 2005, the second event was held at the same place in Islamabad and was sponsored by NSF and several industry co-sponsors. Subsequently, the symposium was moved to Charlotte North Carolina, USA; Dubai UAE; Penang Malaysia; Alexandria Egypt, and Cairo Egypt. Details of organizing these symposia and the role of various participating organizations in different countries will also be discussed.

1.0 Introduction

The optical networks have emerged as one of the key technologies underpinning the knowledge based economy worldwide. Similar to the electronics and microelectronic technology that revolutionized life over the past half-century, optical and photonic technologies are likely to have an immense impact over the next quarter of the 21st century. In order to establish sustainable future and collaborative research it is important to bring together leading researchers and practitioners from academia, industry and government functionaries around the world with the objective of sharing knowledge and experience in the field of ICT for global partnerships and collaborations. In order to gain the support for accomplishing these objectives the authors contacted the office of International Science and Engineering (OISE) at NSF. The OISE supports programs to expand and enhance leading edge international research and education opportunities for U.S. scientists and engineers, especially at the early career stage. It specifically works to build and strengthen effective institutional partnerships throughout the global science and engineering

research and education community, and it supports international collaborations in NSF's national priority research areas [1].

While keeping this objective in mind, a proposal was submitted to NSF office of International Science and Engineering for holding the first US-Pakistan International workshop and symposium on "High-capacity Optical Networking and Enabling Technologies (HONET)," at Islamabad, Pakistan in December 2004. The proposal was submitted by the University of North Carolina [2], Charlotte, as a principal Investigator (PI) and SUNY Institute of Technology New York, [3] Utica, NY, as co-PI. The international PI and host for this symposium was the National University of Science and Technology [4] and the international co-PI was chosen to be the University of Arid Agriculture [5], both located in the city of Rawalpindi, a twin city of Islamabad, Pakistan. The international co-PIs were responsible for all aspects of hosting the symposium/workshop and bearing all the expenses of arranging and inviting local speakers and presenters. NSF was supposed to pay the travel and per diem expenses of US delegates (speakers and presenters) for the duration of the workshop.

Following the successful award of the proposal by NSF, a structured series of events were organized into four components consisting of technical talks, invited keynotes, panel discussions, and break-out focus group discussions as shown on the website http://honet-ict.org under the "Archive" tab and the link for HONET 2004 [6]. The participants included faculty, graduate students, government and industry professionals which numbered over 250. The team of US participants comprised 13 visiting experts including 7 faculty members, 2 PhD students, and 4 industry experts. The workshop was extremely successful in achieving the broader objectives and appraising a wide range of Pakistani participants with leading state-of-art research in optical networks - an enabler and backbone for high-speed internet.

The organizers of the first symposium were encouraged with the outcome and went on to organize a second symposium at Islamabad in 2005 using a format similar to the HONET 2004 before moving it to Charlotte, North Carolina in 2006. Subsequently, more International symposia/workshops were organized at Dubai UAE, Penang Malaysia, and Alexandria Egypt and recently at Cairo Egypt on December 19-21, 2010. The first five workshops/symposia were partially supported by the NSF office international science and engineering and the last two by the host, local industry, the participants and the other non-profit organizations in the host countries. Although the focus of HONET predominately remained optical Internet and associated information & communication and enabling technologies, a special theme was added each year to reflect the current state of technology and its applications. During the past seven years of organizing and holding these symposia and associated workshops over two thousand attendees consisting of faculty, engineers, students, delegates from different countries and CEOs of International businesses have participated in this knowledge sharing experience and were motivated for international collaboration. These symposia were attended by the nationals of Australia, Britain, Canada, China, Chile, France, Germany, India, Iran, Japan, Korea, Lebanon, Saudi Arabia, Taiwan, Turkey in addition to the five host countries making it a truly international forum for collaboration. This has resulted in a number of joint projects, exchange of faculty and students, publications of scientific papers and a book by the mutual collaboration of the participants. It has also benefitted the industry personnel in getting new ideas and forming linkage with others to improve their businesses.

Having introduced the topic in section 1, section 2 discusses the focus of the symposium and details of technical presentations. Section 3 gives details of the sponsoring organizations and venues. Section 4 discusses the results and conclusion of the paper. A list of references and links used in the paper is also provided at the end for the interested readers.

2.0 First HONET (2004 Symposium/Workshop)

The focus of the first international symposium [6] had an emphasis on optical internet and associated information & communication and enabling technologies. The general topics included but not limited to the following areas of interest.

- Optical Internet
- Grid-computing Networks
- Network Security
- Optical Wireless Communications
- Traffic Grooming
- Enabling Technologies (devices, components, and materials)

The symposia/workshops were divided in technical presentations, keynote speakers, panel discussions, and break-out focus group discussions as given below:

2.1 Technical Presentations

The topics of the technical presentations were divided into nine broad sessions, which were Optical Internet I, II & III, Wireless and Satellite Communications, Metro/Access Networks, Network Security, Enabling Technologies, Traffic Engineering in Optical Networks, and Grid/Multi-Agent Systems during the four days of symposium. Each session comprised between 3-5 talks by US, Canada, and Pakistani speakers, including students. The invited speakers were given 30-40 minute presentation slots, whereas local student speakers were limited to 15-20 minutes. All the presenters were required to submit full-length papers as well. The conference proceedings were compiled on a CD and were provided to all delegates and registered guests [7].

The technical presentations spanned a broad spectrum of technologies and at varying depth and levels. For example, many of the US speakers focused on high level technological trends in their respective areas. This was done in order to present a much-needed survey of the recent developments for the benefit of the Pakistani attendees. On the other hand the local faculty and student presentations delved into much more specific research problems, complete with algorithmic developments and analytical results. These detailed presentations exposed US experts to the ongoing research in Pakistan and proved invaluable in helping to identify future research and development.

2.2. Invited Keynote Speakers

The symposia/workshops featured seventeen highly-compelling invited keynote addresses from leading speakers. The invited papers were presented by the following speakers:

1. Dr. M. Yasin Akhtar Raja (*University of North Carolina, Charlotte, USA*).

Optical Networking Technologies and Emerging Paradigms for Ultra-broadband Optical Access.

2. Dr. Nasir Ghani (*Tennessee Tech, USA*).
   Advances in Metropolitan/Regional Optical Networking.
3. Dr. Salahuddin Qazi (*State University of New York Institute of Technology, USA*).
   Optical Wireless Communication: Challenges and Opportunities.
4. Dr. Qamar-ul-Islam (*National university of Sciences & Technology, Pakistan*).
   Satellite System Design for Broadband Applications
5. Mr. Kamran Ahmed (*University of North Carolina, Charlotte, USA*).
   Raman and Er:Yb co-doped Fiber Amplifiers for Optical Networks.
6. Mr. Peter S. Hayman (*PLM-FTTU, Alcatel, USA*).
   Progress and Potential in FTTP Deployment to Bridge the Bandwidth Gap.
7. Mr. Nathan Vander Horn (*Iowa State University, USA*).
   Light Trails: A passive Optical Networking Solution for Wavelength Sharing in Metro
8. Dr. Khurram Kazi (*CTO, ECDD Technologies, USA*).
   Ethernet Services Over Metro and Wide Area Networks: Standards Activities.
9. Dr. Mirsad Hadzikadic (*University of North Carolina, Charlotte, USA*).
   Security of Computer Networks.
10. Dr. Waqar Mahmood (*National University of Sciences & Technology, Pakistan*).
    Optical Interconnects Process Technologies.
11. Dr. Ahmed E Kamal (*Iowa State University, USA*).
    Traffic Grooming in Optical Networks.
12. Dr. Junaid Zubairi (*State University of New York, USA*).
    Traffic Engineering: Fault Management for Optical Networks.
13. Ms. Gigi Karmous-Edwards (*MCNC, USA*).
    Rethinking Intelligent Optical Control Planes for Grid Computing.
14. Dr. Arshad Ali (*National University of Sciences & Technology, Pakistan*).
    Grid Computing Paradigms.
15. Mr. Hadi Hamid (*University of North Carolina, Charlotte, USA*).
    Self-healing Networks-Automation in Optical Network Monitoring.
16. Dr. M Mahmud Awan (Chairman New England Fiber optic Council & President/CEO Regional Technology Corp., USA).
    A comparative performance review of communication choices.
17. Dr. S M Hassan Zaidi (*National University of Sciences & Technology, Pakistan*).
    Review of Routing and Wavelength Assignment Algorithms and Some Research Challenges for Optical WDM Networks.

2.3 Panel Discussions

In order to foster an enhanced interaction, panel discussions were held following each of the technical sessions. These sessions were chaired by various high-profile persons, including both the presenting speakers and several other invited experts. The panel discussions were extremely popular and brought out many pressing issues in the evolving Pakistan telecom landscape. In many cases, the ensuing discussions were so lengthy that the chairs had to request them to be taken off-line in the interest of time. Of particular value to the local attendees were the US experts' opinions of future technological and service evolutions as they pertained to the domestic market.

Given that the Pakistani broadband evolution was still in its infancy, it was projected that service providers in the country could learn a valuable lesson from the recent technological and market realignments that have transformed the US and European telecom landscapes. At the same time, the visiting US researchers were given a firsthand look at the networking sector in a developing country. It was reassuring to know that many networking personnel in Pakistan are well aware of the latest technologies, and in some cases, have even progressed towards limited deployments, such as DWDM (dense wave length division multiplexing) transport, PON (passive optical network) access, high-speed cable and other complementary technologies.

2.4 Break-Out Focus Working Groups

Two sets of focus working group meetings were held during the conference. The purpose of these meetings was to identify topics of mutual interest for students and researchers on both sides, and formulate potential future collaborations. Each focus group meeting started with the participants introducing themselves and describing their areas of interest. Interactive discussions followed in which joint areas of future research work were presented. At the end of each meeting, it was agreed to form a mailing list for each group in order to allow continued interactions between the team members. These meetings proved to be very fruitful and extremely well-attended. Some of the chosen topics included, Optical Internet, Grid-computing Networks, Network Security, Optical Wireless Communications, Traffic Grooming and Enabling Technologies. Based on the discussion the following research groups were identified. Each group included a US researcher, a researcher from the host country and a student.

- HONET-Optical Internet Research Group
- HONET-Traffic Engineering Research Group
- HONET-Wireless Research Group
- HONET-Security Research Group
- HONET-Grid Research Group
- HONET-Metro Access Research Group

Projects

The following joint projects were identified.

- Raman Fiber Amplifiers for Optical Networks.
- Complex Adaptive Systems and their usage in Routing and wavelength assignment algorithms.
- Multi-domain routing extensions for OSPF-TE routing protocols to provision multi-granularity DWDM and NGS domains.
- Distributed connection provisioning for multiple heterogeneous DWDM and NGS domains.
- Study performance of various source-based signaling setup approaches.
- Service survivability (restoration and protection) across heterogeneous DWDM and NGS optical domains.
- Resource provisioning for Layer 1 virtual private networks (L1 VPN).

2.5 Seventh HONET (2010 Symposium/Workshop)

In the subsequent symposia of HONET 2005, HONET 2006, HONET 2007, HONET 2008, and HONET 2009 [8, 9, 10, 11, 12] similar format to that of HONET 2004 was adopted for the technical presentations keeping the same core, although new topics and themes were added on emerging technologies and applications. For example, the theme of HONET 2007 was e-Applications (e-Education and e-Healthcare); HONET 2008 had theme of associated workshop as "Network Test & Monitoring" along with e-Government. HONET 2009 had theme of "Nanophotonics". In the HONET 2010 [13] besides the regular focus, a special theme on the "Green ICT, Energy efficient device and networks" was added with the following sessions and panels.

Sessions

1. Optical Internet
2. Nanophotonics and Enabling Technologies
3. (a) Green ICT –Energy Efficient Devices and Networks (b) Lasers, Solar Cells and LEDs
4. Wireless Mesh and Sensor Networks Applications
5. ICT Oriented Architectures
6. Optical Switching and Routing

Panels

1. High Speed Networking Technologies: Components-Systems-Services
2. Enabling Technologies: Lasers, LEDs, and Solar devices

3.0 Sponsoring Bodies and Venues

Efforts were made to organize the symposia in line with the objectives of HONET and its theme of "Bringing together professionals and practitioners from the academia, industry and Government functionaries from around the world with a goal to sharing knowledge and experience in the field of information & communication technologies for global partnership and collaborations aiding economic growth to support peace and prosperity." This involved contacting the faculty of the host countries, identifying the related industry and government functionaries and subsequently organizing the symposium/workshop as described below:

The first and the second International symposia were held at Islamabad, Pakistan in 2004 and 2005. These symposiums were sponsored by the University of North Carolina Charlotte and hosted by National University of Sciences and Technology, Pakistan. The co-sponsor included the National Science Foundation, Charlotte Research Institute [14], USA and Higher Education Commission [15], Pakistan in collaboration with SUNY Institute of Technology Utica, USA, University of Arid Agriculture, Pakistan and COMSAT Institute of Information Technology [16], Pakistan. Industrial sponsors included Pakistan Telecommunication Company Limited (PTCL), National Telecommunication Corporation and Charlotte Research Institute. The other sponsors included National Telecom Company (NTC), Alcatel, Nortel, Huawei, ZTE, Makkays and LTE – just to name a few majors. The technical sponsor was the IEEE Communication Society.

The third international symposium was held in Charlotte, North Carolina, USA. It was jointly organized by UNC Charlotte (Center for Optoelectronics and Optical Communications), and NUST(NIIT/SEECS) and co-sponsored by the NSF Office of International Science & Engineering , Charlotte Research Institute, North Carolina, IT Butler e-Services & Solutions, UAE. The sponsors included IEEE Communication Society, Micro Electronics Corporation of North Carolina, COMSATs Institute of Information Technology Pakistan, and SUNY Institute of Technology Utica, USA.

The fourth international symposium was held at Dubai, UAE in 2007. It was jointly organized by UNC Charlotte USA and United Arab Emirate University, Alain, and co-sponsored by IT Butler e-services of Dubai UAE and NUST, Islamabad. The other sponsors included Higher Education Commission of Pakistan, PTCL, National Telecommunication Corporation and Charlotte Research Institute. Among the gold and platinum sponsors included British Telecom (BT) and Etisalat (a telecommunication company headquartered in UAE). HONET 2007 was co-located with the International Conference on Innovations in Information Technology (Innovation 07) which is also an annual international conference organized by the United Arab Emirates University (UAEU) and shared some common sessions [17] .

The fifth international symposium was held at Penang, Malaysia in November 2008. It was jointly sponsored by UNC charlotte, Universiti Sains Malaysia [18] and NUST of Pakistan. It was co sponsored by : KICT, IIUM, Jalan Gombak, Kuala Lumpur (Malaysia), Higher Education Commission and PTCL R&D Fund (Pakistan). Technical sponsor were IEEE communication society. The thematic focus was high-speed internet, e-government, e-healthcare, network security and the enabling technologies.

The sixth international symposium was held at Alexandria, Egypt on December 28-30, 2009. It was jointly organized by UNC Charlotte, and Alexandria Higher Institute of Engineering and Technology (AIET) [19] and was hosted by Pharos University in Alexandria [20]. The local industry sponsors were JELECOM (Jelco) Egypt, and ALEXFERT (AF), Alexandria Egypt. It was also co-sponsored by the international alumni hosts, Universiti Sains Malaysia (USM) at Penang, Malaysia and NUST Islamabad, Pakistan. The event had a technical sponsorship of IEEE communication society. The thematic focus was Nanophotonics for high speed-internet for block components to e-science and e-healthcare applications, network security and enabling technologies.

The seventh symposium was held at the National Institute of Lasers Enhanced Sciences (NILES) Cairo University, Egypt on December 19-21, 2010. It was sponsored by UNC Charlotte and hosted by NILES at Cairo University, Giza [21]. It was also co-sponsored by the alumni hosts consisting of Alexandria Higher Institute of Engineering and Technology and Pharos University in Alexandria, Universiti Sains at Penang, Malaysia and NUST Islamabad, Pakistan. HONET 2010 thematic focus was "Laser enhanced sciences and engineering for green ICT." The invited speakers who attended the event included five delegates from US (two UNC Charlotte, one Ciena Corporation, one Defense photonics, one FIT Florida, one SUNY Utica and one from University of New Mexico, Albuquerque NM), two from Canada (university of Ottawa), two from Australia, one from UAE, one from Pakistan, one from Saudi Arabia, and five from the host country, Egypt. The contributed papers in HONET 2010 represent several countries including US, Canada, Australia,

Korea, Japan, Malaysia, India, Pakistan, Iran, Jordan, Saudi Arabia, Tunisia, and Egypt the host country.

The next international symposium the eighth HONET is scheduled to be held in the Royal Kingdom of Saudi Arabia on December 19-21, 2011 with the main theme of "Nanotechnology for ICT" along with the original scope of "optical internet and enabling technologies". The organizing and steering committees have plans to expand the scope and grow the upcoming event to the next level with its broader scope (short courses, workshops, in addition to the symposium).

4.0 Results and Conclusion

The organization of seven international symposia and associated workshops in five countries has covered the regions from North America, South Asia, Asia Pacific, Middle East and North Africa. It has emerged as a truly international forum sharing knowledge, sustainability and collaboration in line with NSF global vision and scope of international cooperation for scientific research and education. The international symposia and related workshops brought together leading USA, other participating, and host countries researchers working in the area of ICT with a focus on the optical communication to foster collaborative research and development, and educational interactions and joint future activities. Researchers from USA and host countries identified the area of mutual interest and formed focused research groups, which has lead visits from both sides at faculty and graduate students level. This in turn helped to foster improved business and technology interactions with US and various regions around the world that is of key importance to long-term US interests.

One of the overriding objectives is to generate intellectual capital by an increased level of research resulting in patents, reports, and publications in leading international journals and conferences such as IEEE, SPIE, OSA, and ACM. A book on "Nanotechnology for Telecommunications," [22] was co-edited by three of the HONET participants in which other participants authored chapters on various aspects of optical communications and enabling technologies. This book was published by CRC press, Taylor & Francis Group in June 2010.

The UNC Charlotte, USA, and the NUST have extended the partnership in the areas of Optical Communications and Optoelectronics, Engineering disciplines as well as in Bioinformatics, E-commerce and College of Business and Healthcare to name a few. NUST wants to establish various centers on the pattern of Charlotte Research Institute at UNC Charlotte, who is ready to share the experience and success.

The college of computing at Universiti Sains Malaysia and the national center for IPv6 (NAv6) in Penang Malaysia has sent their first visiting scholar and a formal request for support in their graduate programs. All this activity is in line with the visions of serving regional and national needs for educational and economic progress as well as global outreach for international collaboration and cooperation for world's peace and prosperity.

The US delegates from other universities including Tennessee Tech, SUNY Institute of Technology, Rochester Institute of Technology, Florida Atlantic University, UNM Albuquerque as well as the Industry such as EXFO Inc., MOVAZ(ADOVA), MCNC, Wave7 Optics, Ciena, Cisco etc; have established links and partnerships with NUST, COMSATs, and LUMS of

Pakistan and with other countries in the HONET perspective. These interactions and co operations extended to Higher Education Commission of Pakistan and telecommunication companies such as the PTCL and NTC.

Among various research groups established, the most notable are "Optical Internet", Grid-computing Networks, Network Security, and Enabling Technologies continue to build momentum and grow in scope and impact. Other includes Joint Proposals for 'Capacity-Building in Pakistan by Research and Development of test beds for Global Lambda Integrated Facility (GLIF) Nodes. Not all of such grant proposals were successful but it has generated the activity in the host countries and has brought the awareness and enthusiasm among the participants.

Not counting the other universities or industries interaction, seven graduate students (two females and five males) have joined Ph.D., programs in ECE, Optical Engineering, Computer Science and College of Business at UNC Charlotte. More students are expected to be enrolled in other programs at UNC Charlotte and other universities including NCSU, UNM, SUNYIT Utica, SUNY Oswego, SUNY Fredonia, Rochester Institute of Technology, Florida Atlantic University and their international counterparts. Similarly, USM Penang Malaysia, AIET Alexandria, Cairo University and other institutions have started their collaborative interaction with their counterparts in USA, Canada, Australia, and other developed countries.

From the US perspective these efforts will also help maintain national prominence in related fields and provide a larger avenue to share research results among US professionals from educational institutions and experts from commercial sector and their counterpart from the host countries and other participating nations from various parts of the world.

References and URLs

1. National Science Foundation Office of International Science and Engineering ((OISE) http://www.nsf.gov/od/oise/about.jsp
2. University of North Carolina, Charlotte, http://uncc.edu/
3. National University of Science and Technology, Pakistan, http://www.nust.edu.pk/
4. State University of New York Institute of Technology, Utica, www.sunyit.edu
5. University of Arid Agriculture http://www.uaar.edu.pk
6. http://honet.uncc.edu/archive/honet04/index.html
7. www.honetcon-nsf.uncc.edu and http://niit.edu.pk .
8. http://honet.uncc.edu/archive/honet05/index.htm
9. http://honet.uncc.edu/archive/honet06/index.htm
10. http://honet.uncc.edu/archive/honet07/index.htm
11. http://honet.uncc.edu/archive/honet08/index.htm
12. High-Capacity Optical Networks and Enabling Technologies (HONET), 2009, 6th International Symposium on 28-30 Dec. 2009 IEEE Xplore Digital Library. http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=5418379
13. http://honet.uncc.edu/index.htm
14. Charlotte Research Institute http://www.charlotteresearchinstitute.com/
15. Higher Education Commission, Pakistan http://www.hec.gov.pk/Pages/main.aspx

16. COMSTs Institute of Information Technology http://www.ciit.edu.pk/
17. United Arab Emirates University (UAEU) http://www.uaeu.ac.ae/
18. Universiti Sains Malaysia http://www.usm.my/
19. Alexandria Higher Institute of Engineering and Technology (AIE) http://www.ait.edu.eg/
20. Pharos University in Alexandria (PU) http://www.pua.edu.eg
21. National Institute of Lasers Enhanced Science, Cairo university http://niles.cu.edu.eg/ICLA_6.htm
22. Anwar, Raja, Qazi, and Ilyas, "Nanotechnology for Telecommunications," CRC Press, Taylor & Francis Group, 2010.

Acknowledgements

This paper is based upon work supported, in part, by the National Science Foundation under Grants #s 042438; 0535833; 0638542; 0734183; and 0849174.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Thanks are also due to others sponsoring agencies and institutions, especially IEEE Communication Society for technical sponsorships, HEC Pakistan, CRI UNC Charlotte, North Carolina, USA for their multiple financial sponsorships, and of course HONET's host partner institutions in various countries.