R&D Activities on Photonic Networks in Vietnam

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Posts and Telecommunications Institute of Technology (PTIT)
Vietnam
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1. R&D on Photonic Networks in Vietnam

The end-to-end view of network segments: the access network, the metro network, and the long-haul backbone network.
1. R&D on Photonic Networks in Vietnam

- **Photonic Network Providers**
  - Vietnam Posts and Telecommunications Group (VNPT)
  - Viettel
  - Hanoi Telecom
  - FPT Telecom

- **Technologies**
  - Backbone networks:
    - DWDM ring-based networks
    - IP (MPLS or SDH) over WDM
  - Metro Area Networks: Ethernet-based MAN
  - Access Networks: AON/PON-based FTTH networks
1. R&D on Photonic Networks in Vietnam

- Photonic Network Research Groups in VN
  - School of Information and Communication Technology - Hanoi University of Science and Technology
    - Research areas:
      - Design and Optimization for Optical Networks
    - Major publications
      - On the Optimization of Survivable Mesh Long-Reach Hybrid WDM-TDM PONs
      - A Novel Topology Aggregation Approach for Shared Protection in Multi-domain Networks
      - Multi-domain optical networks: issues and challenges - Recent progress in dynamic routing for shared protection in multi-domain networks
1. R&D on Photonic Networks in Vietnam

- **Photonic Network Research Groups in VN**
  - **School of Electronics and Telecommunications** - Hanoi University of Science and Technology
    - Research areas:
      - Photonic Crystal Fiber: Design, Fabrication, and Applications
      - Nonlinear Effect in Photonic Devices
  - **Faculty of Electrical and Electronics Engineering** - Ho Chi Minh city University of Technology
    - Research areas:
      - Microwave photonics
      - Fiber optics sensors
      - Passive optical networks
      - Visible light communications
2. Introduction to PTIT - Vietnam

- **Posts and Telecommunications Institute of Technology**
  - A former member of Vietnam Posts and Telecommunications Group (VNPT)
  - A new member of Ministry of Information and Communications (MIC), Vietnam
  - A leading university focusing on Research and Education in the field of ICT in Vietnam
  - Integrating Research – Education/Training – Manufacturing & Trading in the field of ICT.
2. Introduction to PTIT - Vietnam

- **Organization**

  - **Education**
    - Faculty of Information Technology
    - Faculty of Telecommunications: Photonic Division
    - Faculty of Electronic Engineering
    - Faculty of Information Security
    - Faculty of Multimedia Technology
    - ...

  - **Research**
    - Research Institute of Posts and Telecommunications (RIPT)
    - Institute of Information and Communication Technology CDiT
    - Economics Institute of Posts and Telecommunications (ERIPT)

- **Training Centers**
  - Posts and Telecommunications Training Center
3. R&D Activities

- **Photonic Network Research Group at PTIT**
  - **Members and Research Topics**
    - **Assoc. Prof. Ngoc T. DANG** (ngocdt@ptit.edu.vn)
      - System modeling, performance analysis and improvement methods for optical code-division multiple-access (OCDMA) systems; Free-space optical (FSO) communication systems; and Visible light communications.
    - Advanced optical technologies for 5G mobile networks
    - **Dr. Nhan D. NGUYEN** (nhannd@ptit.edu.vn)
      - Mode-locked laser; Advanced modulation schemes for optical communications; Optical soliton transmission techniques; Photonic signal processing.
    - **Dr. Chau H. LE** (lehaichau@gmail.com)
      - Optical system design and performance analysis; Optical networks architecture and control protocol; Advanced optical technologies and techniques for broadband access networks
3. R&D Activities

- **Optical CDMA Systems**

  Multiple Access Interference (MAI)

  Splitter Loss

  Receiver noise & Optical Beating Interference (OBI)

```
Binary data ➔ OCDMA encoder ➔ Combiner ➔ Optical fiber ➔ Splitter

OCDMA encoder ➔ Recovered data

Transmitter #1

OCDMA encoder ➔ Recovered data

Transmitter #K

OCDMA encoder ➔ Recovered data

Transmitter #K
```

- **Objectives**
  1. Performance evaluation of OCDMA systems under the effects of physical layer impairments
  2. Performance improvement methods for OCDMA systems
3. R&D Activities

Optical CDMA Systems

- Performance Analysis of MW–OCDMA Systems under the Effects of *Group Velocity Dispersion*
- Performance Analysis of MW–OCDMA Systems under the Effects of *Four-Wave Mixing*
- Performance Improvement of MW–OCDMA Systems Using *Optical Hard-Limiter*
- Performance Improvement of MW–OCDMA Systems Using *Multi-Code Modulation*
- Performance Improvement of MW–OCDMA Systems Using *Multi-Code Pulse-Position Modulation*

Assoc. Prof. Ngoc T. DANG (in collaboration with the University of Aizu, Japan)
3. R&D Activities

- **Free-Space Optical Commun. Systems**

![Diagram of FSO systems with physical layer impairments](Source: http://althosbooks.com/opcodi.html)

- **Objectives**
  1. Performance analysis of FSO systems under the effects of physical layer impairments
  2. Performance improvement methods for FSO systems
3. R&D Activities

Free-Space Optical Commun. Systems

- Performance Analysis of FSO and FSO/CDMA Systems under the Effects of *Pulse Broadening*
- Performance Improvement of FSO/CDMA Systems using *Forward Error Correction*
- Performance Improvement of FSO and FSO/CDMA Systems using *Advanced Modulation Schemes*
- Performance Improvement of FSO and FSO/CDMA Systems using *Relay Transmission*

Assoc. Prof. Ngoc T. DANG (in collaboration with the University of Aizu, Japan)
3. R&D Activities

Optical Soliton Trans. & Signal Processing

- Generation of Bound solitons in actively phase modulation mode–locked laser ring resonators
- Fast–processing statistical methods for measurement of BER in optical fiber communication systems
- Generation of high order multi–bound solitons and propagation in optical fibers
3. R&D Activities

**Optical Netw. Design & Performance Analysis**

- Impact of Electrical Grooming and Regeneration of Wavelength Paths in Creating Hierarchical Optical Path Networks
- Hybrid–Hierarchical Optical Path Network Design Algorithms Utilizing ILP Optimization
- Hierarchical Optical Path Network Design Algorithms Considering Waveband Add/Drop Ratio Constraint
- Performance evaluation of large-scale multi-stage hetero-granular optical cross-connects

Dr. Chau H. LE (in collaboration with the Nagoya University of Aizu, Japan)
4. International Collaboration

- **Performance Evaluation and Improvement Methods for Relay-Assisted Free-space Optical Communication Systems**
  - An on-going project funded by National Foundation for Science and Technology Development (NAFOSTED, Vietnam): grant no. 102.02-2013.02
  - Collaboration with Computer Communications Lab., Univ. of Aizu (JP)

![Figure 3. FSO access networks: (a) without relaying and (b) with relaying techniques](image)

Figure 3. FSO access networks: (a) without relaying and (b) with relaying techniques
4. International Collaboration

- Advanced Optical Technologies for 5G Backhaul Mobile Networks
  - Millimeter-wave Radio-over-Fiber
  - RoF/MMW
  - RoF/FSO
  - FSO/FSO
  - FSO/MMW
4. International Collaboration

- **Visible Light Communications (VLC)**
  - Performance improvement methods
  - Multiple access techniques for VLC
  - Cross-layer design and performance analysis
  - Applications of VLC

Conclusion

- **Research on Photonic Networks in Vietnam**
  - Mainly based on theoretical study and simulation
  - Lack of experiment systems
  - Research outcomes are academic publications

- **Expected International Collaboration in Photonic Networks**
  - Doing experiment
  - Standardization
  - Establishment of R&D platforms
Thank you for your attention!

Q & A
Major Publications


