

# Second Workshop on Optics and Computer Science WOCS

Pascal Berthomé  
LRI, Université de Paris-Sud  
Orsay, FRANCE  
email: [berthome@lri.fr](mailto:berthome@lri.fr)

Philippe Marchand  
University of California  
San Diego, USA  
email: [pmarchand@ucsd.edu](mailto:pmarchand@ucsd.edu)

1 April 1997 - Geneva, CH

This workshop is part of the 11th International Parallel Processing Symposium (IPPS) organized in Geneva, Switzerland on April 1-5 1997

The Workshop on Optics and Computer Science - WOCS - is the second in a series, started in Metz in december 1995.

## Scope of the Workshop

Advances in semiconductor technologies coupled with progress in parallel processing and multi-computing are placing stringent requirements on inter-system and intra-system communications. Demands for high density, high bandwidth, and low power interconnections are already present in a wide variety of computing and switching applications, including, for example, multiprocessing and parallel computing (simulations of real problems, monitoring of parallel programming, etc), and enhanced digital telecommunications services (broadcast TV, video on demand, video conferencing, wireless communication, etc.). Furthermore, with advances in silicon and Ga-As technologies, processor speed will soon reach the gigahertz (GHz) range. Thus, the communication technology is becoming and will remain a potential bottleneck in many systems. This dictates that significant progress needs to be made in the traditional metal-based interconnects, and/or that new interconnect technologies, such as optics, be introduced in these systems.

Optical means are now widely used in telecommunication networks and the evolution of optical and optoelectronic technologies tends to show that they could be successfully introduced in shorter distance interconnection systems such as parallel computers. These technologies offer a wide range of techniques that can be used in

interconnection systems. But introducing optics in interconnect systems also means that specific problems have yet to be solved while some unique features of the technology must be taken into account in order to design optimal systems. Such problems and features include device characteristics, network topologies, packaging issues, compatibility with silicon processors, system level modeling, ....

The purpose of this workshop is two-fold. First, we hope to provide a good opportunity for the optical, architecture and communication research communities to get together for a fruitful cross-fertilization and exchange of ideas. The goal is to bring the optical interconnects research into the mainstream research in parallel processing, while at the same time provide the parallel processing community with a more comprehensive understanding of the advantages and limitations of optics as applied to high-speed communications. In addition, we intend to assemble a group of major research contributors to the field of optical interconnects for assessing its current status, and identifying future directions. By its location, this workshop will provide the first real opportunity for European researchers to expose their result in this field.

Pascal Berthomé  
Philippe Marchand

## Organization

The workshop features invited speakers, several sessions of submitted papers, and a panel discussion.

The workshop is divided into four main sessions covering different aspects of the interaction between both communities. A first session presents theoretical aspects of the modeling of optically interconnected systems. A second session is devoted to protocol aspects induced by the use of the Wavelength Division Multiplexing technology in general network. The third session inspects fundamental reason of using optical devices instead of classical electronic ones. The fourth session presents uses of Free-Space interconnections in experimental systems. During these sessions, 12 regular papers and 3 invited papers have been presented. A special session of 7 posters has also been organized.

## Invited speakers

**T. Drabik**, Georgia Institute of Technology, Metz, France and Atlanta, USA. "*How can we make optical interconnects mundane?*"

**A. Ferreira**, LIP, Lyon, France "*Towards effective models for OPS-based lightwave networks*"

**S. Levitan**, University of Pittsburgh, Pittsburgh, USA *"Forging a computer aided design tool for digital optoelectronic systems"*

## **Steering Committee**

Timothy Drabik, Georgia Institute of Technology, Metz, France and Atlanta, USA  
Sadik C. Esener, University of California, San Diego, USA  
Afonso Ferreira, Laboratoire d'Informatique du Parallélisme, ENS Lyon, France

## **Program Committee**

Pascal Berthomé, LRI, Université de Paris Sud, France (Computer Science Chair)  
Philippe Marchand, University of California, San Diego, USA (Optics Chair)

Dominique Barth, LRI, Orsay, France  
Eric Belhaire, IEF, Orsay, France  
Jean-Claude Bermond, I3S, Nice-Sophia Antipolis, France  
Karl Heinz Brenner, Mannheim, Germany  
Jacek Chrostowski, NRC, Ottawa, Canada  
Marc Desmulliez, Herriot-Watt, Scotland  
Ashok V. Krishnamoorthy, Lucent Bell-Labs, USA  
Philippe Lalanne, IOTA, France  
Ahmed Louri, University of Arizona, USA  
Yao Li, NEC Research Institute, USA  
Nicolas Mauduit, France  
Frederick B. McCormick Jr., Call-Recall Inc., USA  
M. Ajmone Marsan, Torino, Italy  
Rami Melhem, University of Pittsburgh, USA  
Haldun Ozaktas, Bilkent University, Turkey  
Rama Mohan Paturi, UCSD, USA  
Larry Rudolph, MIT, USA.  
Assaf Schuster, Technion, Israel  
Ted Szymanski, McGill, Montreal, Canada  
Jun Tanida, Osaka University, Japan

## List of Referees

Each paper appearing in this CD-ROM proceeding was reviewed by at least three referees who judge the papers for originality, quality and consistency with the themes of the meeting. Due to the high level of submissions, seven papers have been presented in a poster session in addition to the twelve regular papers. Due to the high quality of the submissions, all the papers have in the proceeding the same number of pages.

We would like to give a special thanks to the referees of all the papers who did their work very efficiently and quickly.

Barth, Dominique	Beauquier, Bruno
Belhaire, Eric	Bermond, Jean-Claude
Berthomé, Pascal	Bianco, Andrea
Chrostowski, Jacek	Dabbous, Walid
Desmulliez, Marc	Fumagalli, Andrea
Krishnamoorthy, Ashok	Laforest, Christian
Lalanne, Philippe	Li, Yao
Louri, Ahmed	Marchand, Philippe
Marsan, Marco	Mauduit, Nicolas
McCormick, Rick	Melhem, Rami
Meo, Michela	Meyer auf der Heide, Friedhelm
Neri, Fabio	Ozaktas, Haldun
Paturi, Mohan	Rudolph, Larry
Scheideler, Christian	Schuster, Assaf
Szymanski, Ted	Tanida, Jun
Zissimopoulos, Vassilis	

# Workshop on Optics and Computer Science

## Full Papers

### **Optical Routing in Meshes using the Duplication Model**

Ben Asher (Haifa University, Israel)

---

### **Approximation Results for Wavelength Routing in Directed Tree**

Jansen (Universtaet Trier, Germany)

---

### **Comparison of the Communication Latency for an Optical Bus and for Several 2D Electronic Network Topologies**

Collet and Fesquet (LAAS, France)

<http://www.laas.fr>

---

### **High Bit Rate Interconnection Optical Bus for ATM Boards**

Present and Fayet (INT and PRISM, France)

---

### **On Inter-Cluster Communication in a Time-Deterministic WDM Star Network**

Jonsson (Halmstad University, Sweden) and Svensson (Chalmers University, Sweden)

<http://www.hh.se/cca>

---

### **Graph Problems Arising from Wavelength-Routing in All-Optical Networks**

Beauquier (I3S, France), Bermond (I3S, France), Gargano (Universita di Salerno, Italy), Hell (Simon Fraser University, Canada), Perennes (Delft, The Netherlands) and Vaccaro (Universita di Salerno, Italy)

<http://zenon.inria.fr/sloop/personnel/Bruno.Beauquier/me.html>

---

### **WDM and SDM in Future Optical Networks**

Kenter and Heemstra de Groot (University of Twente, The Netherlands)

<http://www.tios.cs.utwente.nl/~kenter/>

---

### **Adaptive and Global Routing for Multiplexed Optical Communication on Mesh and Torus Networks**

Chang and Melhem (Pittsburgh, USA)

<http://www.cs.pitt.edu/~melhem>

---

### **Making Virtual Memory Real: Integrating an Optical Memory into the Memory Hierarchy**

Chiarulli and Levitan (Pittsburgh, USA)

<http://cs.pitt.edu/~don>

---

### **Comparison of Fully Three-Dimensional Optical, Normally Conducting, and Superconducting Interconnections**

Ozaktas (Bilkent University, Turkey)

<http://www.ee.bilkent.edu.tr/~haldun>

---

---

**Free-space Optical Interconnects for Data Routing, Switching, and Processing**

McCallum, Guilfoyle, and Stone (OptiComp, USA)

<http://www.opticomp.com>

---

**A Token-based Media Access Protocol for Wavelength Division Multiplexed Optically Interconnected Multiprocessors**

Ha and Pinkston (University of Southern California, USA)

<http://www.usc.edu/dept/ceng/faculty.html/pinkston/SMART.html>

---

**Posters****Low-cost Guided Wave Interconnections Using Side-Coupling Polymer Optical Fibers**

Li and Wang (NEC Research Institute, USA)

---

**CMOS Photodiode Based on Vertical p-n-p Junctions**

Lalanne and Rodier, (IOTA, France)

---

**Folded Architecture for Modular All Optical Switch**

Cohen, Mendlovic, Leibner and Marom (Tel-Aviv University, Israel)

---

**An Optimal Dynamic Multicast Routing Algorithm for High-Speed LAN/MAN Interconnections**

Kang and El Zarki (University of Pennsylvania, USA)

---

**An Optical Thresholding Perceptron**

Saxena, Moerlandm Fiesler, Pourzand and Collings (IDIAP, Switzerland)

<http://www.idiap.ch/nn.html>

---

**Bounds on Optical Bandwidth Allocation on Directed Fiber Tree Topologies**

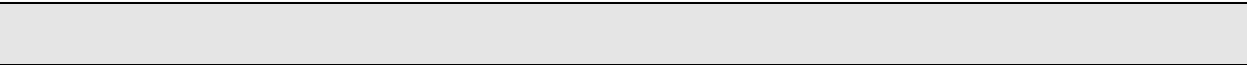
Caragiannis (University of Patras, Greece), Kaklamanis (University of Patras and Computer Technology Institute, Greece) and Persiano (Universita di Salerno, Italy)

---

**All-to-All Broadcast and Broadcast-and-Select WDM Networks with Tunable Devices of Limited Tuning Ranges**

Choi (George Washington University, USA), Choi (George Washington University, USA) and Ni (Michigan State University, USA)

---



## Advanced Program

**08:00 am** Introduction: P. Berthomé, LRI, Orsay, France and P. Marchand, UCSD, La Jolla, CA, USA

08:15–9:45 am

### **Session I: Optical Network: Algorithm, routing and modeling**

**Chair:** Assaf Schuster, Technion, Israel

**08:15 am** (Invited) Afonso Ferreira, LIP, Lyon, France "*Towards effective models for OPS-based lightwave networks*"

**08:45 am** Y. BenAsher, Haifa University, Haifa, Israel, "*Optical routing in meshes using the duplication model*"

**09:05 am** C. Chang and R. Melhem, University of Pittsburgh, Pittsburgh, PA, USA, "*Adaptive and Global Routing for Multiplexed Optical Communication on Mesh and Torus Networks*"

**09:25 am** D. Présent and C. Fayet, INT, Evry, France, "*High Bit rate Interconnection Optical Bus for ATM Boards*"

10:00 – 11:40 am

### **Session II: WDM Networks**

**Chair:** R. Melhem, University of Pittsburgh, Pittsburgh, USA

**10:00 am** H. Kenter and S. Heemstra de Groot, University of Twente, Enschede, The Netherlands, "*WDM and SDM in Future Optical Networks*"

**10:20 am** B. Beauquier<sup>1</sup>, J. C. Bermond<sup>1</sup>, L. Gargano<sup>2</sup>, P. Hell<sup>3</sup>, S. Perennes<sup>1</sup>, U. Vaccaro<sup>2</sup>, (1) SLOOP, CNRS/UNSA/INRIA, Sophia Antipolis, France, (2) Università di Salerno, Barossini, Italy, (3) Simon Fraser University, Burnaby, Canada, "*Graph Problems arising from Wavelength Routing in All Optical Networks*"

**10:40 am** K. Jansen, Universität Trier, Trier, Germany, "*Approximation Results for Wavelength Routing in Directed trees*"

**11:00 am** M. Jonsson and B. Svensson, Halmstad University, Halmstad, Sweden, "*On inter-cluster communication in a time-deterministic WDM star network*"

**11:20 am** J. Ha and T. Pinkston, University of Southern California, Los-Angeles, CA, USA, "*A Token-based Media Access Protocol for Wavelength Division Multiplexed Optically Interconnected Multiprocessors*"

11:40 – 12:30 am

**Session III: Poster Session**

**Presentation:** P. Berthomé, Orsay

**11:40 am**

- Y. Li and T. Wang, NEC Research Institute, Princeton, NJ, USA, "*Low-cost Guided Wave Interconnections Using Side-Coupling Polymer Optical Fibers*"
- P. Lalanne and J. C. Rodier, IOTA, CNRS, Orsay, France, "*CMOS photodiodes based on vertical p-n-p junctions*"
- N. Cohen, D. Mendlovic, B. Leibner, and E. Marom, Tel Aviv university, Tel Aviv, Israel, "*Folded architecture for modular all-optical switch*"
- M. Kang and M. El Zarki, University of Pennsylvania, Philadelphia, PA, USA, "*An Optimal Dynamic Multicast Routing Algorithm for High-Speed LAN/MAN Interconnections*"
- I. Saxena, P. Moerland, E. Fiesler, A. Pourzand, and N. Collings, IDIAP, Martigny, Switzerland, "*An Optical Thresholding Perceptron*"
- I. Caragiannis<sup>1</sup>, C. Kaklamanis<sup>2</sup>, and P. Persianno<sup>3</sup>, (1) University of Patras, Rio, Greece, (2) Computer Technology Institute, Patra, Greece, (3) Universita de Salerno, Baronissi, Italy, "*Bounds on Optical Bandwidth Allocation on Directed Fiber Tree Topologies*"
- Hongsik Choi<sup>1</sup>, Hyeong-Ah Choi<sup>1</sup>, and L. Ni<sup>2</sup>, (1) George Washington university, Washington, DC, USA, (2) Michigan State University, East Lansing, MI, USA, "*All-to-All Broadcast in Broadcast-and-Select Networks with Tunable Devices of Limited Tuning Ranges*"

02:00 – 02:40 pm

**Session IV: "Technology Comparisons: Optics and Electronics**

**Chair:** Yao Li, NEC Research Center, Princeton, USA

**02:00 pm** J. Collet and L. Fresquet, LAAS, CNRS, Toulouse, France, "*Comparison of the Communication Latency for an Optical bus and for several 2D electronic network topologies*"



**02:20 pm** H. Ozatkas, Bilkent University, Ankara, Turkey, "*Comparison of Fully Three-Dimensional Optical, Normally Conducting, and Superconducting Interconnections*"

02:40 – 03:50 pm

**Session V: Free Space Optics**

**Chair:** Jacek Chrostowski, NRC, Canada

**02:40 pm** (Invited) Tim Drabik, Georgia Tech. Lorraine, Metz, France, "*How can we make optical interconnects mundane?*"

**03:10 pm** D. McCallum, P. Guilfoyle, and R. Stone, OptiComp, Zephyr Cove, NV, Usa, "*Free-space optical interconnects for data routing, switching, and processing*"

**03:30 pm** D. Chiarulli and S. Levitan, University of Pittsburgh, Pittsburgh, PA, USA, "*Making Virtual Memory Real: Integrating an Optical Memory into the Memory Hierarchy*"

**03:50 pm** (Invited) S. Levitan, University of Pittsburgh, Pittsburgh, PA, USA, "*Forging a computer aided design tool for digital optoelectronic systems*"

04:30 – 05:30 pm

**Session VI: Panel Discussion**

**Moderator:** Pascal Berthomé, LRI, Orsay, France

**05:30 pm** Wrap-up