

## Editor's Note

"Entering a new era from lasercomm research and development to commercialization" was the subtitle of this year's International Conference on Space Optical Systems and Applications held in Kobe, Japan. This nicely reflects the spirit we experience at the moment in the field of Optical Wireless Communications. The creativity, experience and heart's blood of past years' research and development efforts eventually find their way to serve society. We see this in the recent technology demonstrations, growing start-ups and increasing industrial interest. In that sense, I wish fun in reading the new OPTICWISE newsletter.

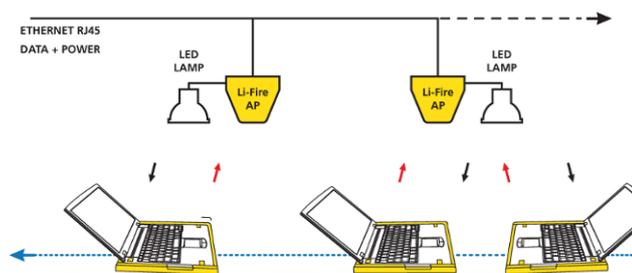
*Florian Moll*  
 Editor of the Newsletter

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## OPTICWISE Highlights

Optical Wireless Communications (OWC) become more and more mature as a whole range of recent demonstrations with bread board models and system prototypes have demonstrated. This accounts short and long range communications as well as indoor and outdoor, static and dynamic scenarios. One example comes from pureLiFi, a spin-off company of the University of Edinburgh co-founded by the OPTICWISE Management Committee (MC) member, Prof. Harald Haas. As illustrated in the figure, PureLiFi is developing a high speed bidirectional wireless network based on visible light communications. The modem under development will be attached to a standard light fitting and enable wireless connection through LEDs. Latest news reported an 1 Gbit/s communication demonstration over a link distance of 10 m using light waves from micro LEDs with even less than 0.5 W power.



Concept of pureLiFi technology. Source: pureLiFi

On the research side, a world record was recently achieved at the Aveiro University, Portugal, where a 1.6 Tbit/s OWC link was demonstrated over 80 m between two buildings on the campus. The experiment was carried out in a collaborative effort between OPTICWISE MC Members Giorgio M. T. Beleffi and Antonio L. J. Teixeira. In their record breaking experimental set-up, they exploited polarization and wavelength multiplexing using 16 channels, operating each at 100 Gbit/s. Transmission over 80 m free-space between two buildings and 40 km were demonstrated and measured in terms of bit-error rate. The results were published in SPIE Optical Engineering.

Another remarkable achievement comes from German Aerospace Center (DLR) which is represented by the MC member Florian Moll in OPTICWISE. In collaboration with companies Airbus Defence & Space and ViaLight Communications, the fastest flying laser link system to date was demonstrated by installing a laser communication terminal onboard a Tornado jetfighter and testing the downlink to a ground station. Image data were transferred to the DLR Transportable Optical Ground Station with a 1.25 Gbit/s link over a distance of 50 km. In this experiment, a novel method of precise beam steering developed by DLR was deployed in the airborne terminal: a free-space pointing assembly with an azimuth and elevation motorized glass prism.



Tornado jet fighter during downlink demonstration, zoom to glass dome and pointing unit during inspection. Source: Airbus DS (left)/ViaLight Communications (lower right).

## Meetings and Workshops

The Action's **5th Management Committee (MC) meeting** was held at Northumbria University in Newcastle upon Tyne, UK on October 21-23, 2013. During the event, eight scientific and technical input documents were presented and discussed in the working groups. The content covered a wide range of topics: Performance evaluation of relay-assisted free-space optical (FSO) links, MIMO FSO system design and analysis, effect of fog on FSO link performance, design of cellular backhaul topology using the FSO technology, underwater optical wireless communication among others. More information on the content can be found on the Action website.

Invited speaker Prof. Mitsuji Matsumoto from Waseda University, Japan gave a talk on the Challenges of Visible Light Communications. Amongst other, he reported on the activities of the Visible Light Communications Consortium (VLCC) in Japan. He also now became an international partner of the Action after MC approval. Another invited speaker was Nikola Serafomovski from PureLiFi, UK, who talked about the commercialisation opportunities of visible light communication. In addition to his company, he informed about new start-ups in the field like Bytelight (USA), and OLEDCOMM (France), which impressively showed that the transition of the technology from research and development to commercialization is ongoing. He also made a demonstration using his company's VLC prototype and was able to successfully transmit high definition video between two computers in non-line-of-sight conditions.

During the MC meeting, it was agreed that the next MC Meeting will be held in Graz, Austria co-located with ICTON 2014. Already during NOC/ICTON 2013, Optical Wireless was represented by three sessions and could welcome around 100 participants. The 7th MC Meeting + 3rd Annual Workshop will be held in Portugal, co-located with Networks 2014 in Funchal, Portugal.

The **2nd International Workshop on Optical Wireless Communications (IWOW)** was also held in Newcastle on October 21, 2013. More than 35 works were presented, 75 % from Europe, 20 % from Asia and 5% from USA.



*Active session during 2nd International Workshop on OWC at Northumbria University, Newcastle.*

Invited talk from Prof Thomas D.C. Little, Boston University, USA focused on VLC and smart illumination while the other invited speaker Prof Chao Lu from The Hong Kong Polytechnic University addressed the role of advanced digital signal processing techniques in long reach fiber optical communications.



*Presentation and demonstration of artificial turbulence generator during training school on OWC.*

In parallel to the MC meeting and the IWOW workshop, early stage researchers (ESR) from OPTICWISE partners, a total of 15 attendees, joined the 2nd Training School on OWC. This training school addressed a wide range of OWC topics including channel impairments and characterization of indoor and outdoor OWC links. In addition to a number of lectures, the attendees had more than 10 hours of hands-on experience using the state-of-the-art facilities of Prof Fary Ghassemlooy's research lab at Northumbria University.

## 3<sup>rd</sup> Training School

The 3rd Training School on Optical Wireless Communications was held at the University of Aveiro in Portugal on April 27 - May 3, 2014. The main aims of this school were: 1) To introduce topics to those who have just moved into the topics of OWC; 2) To enhance practical skills in OWC; and 3) To improve and enhance knowledge in OWC.



*Training school lab session at University of Aveiro, Portugal.*

The training school was designed to address the needs of students and researchers with different proficiency levels, from MsC to PhDs and RAs, with specific interests in OWCs. The scope of this training school tackled both; new researchers entering into the fields of OWC and more experienced researchers searching to find specialized skills in advanced topics on OWC.

The training school included theoretical and practical sessions targeting a number of concepts including: Fundamental Topics on Optics; Optoelectronic Devices and Circuit Design Concepts; Modulation and Equalization; Visible Light Communication Systems; Free Space Optical Communications and Advanced Topics on Communication Theory. The program of the school consisted of 14 theoretical sessions and 10 hands-on experience sessions able to complement some aspects discussed during the theoretical sessions. In terms of timing balance between theoretical and practical sessions, the program achieved a balance with 50% of the total time for practical sessions and 50% for theoretical sessions, with a total of 46 working hours spread over the entire week.



Group photo of training school teachers and students at University of Aveiro, Portugal.

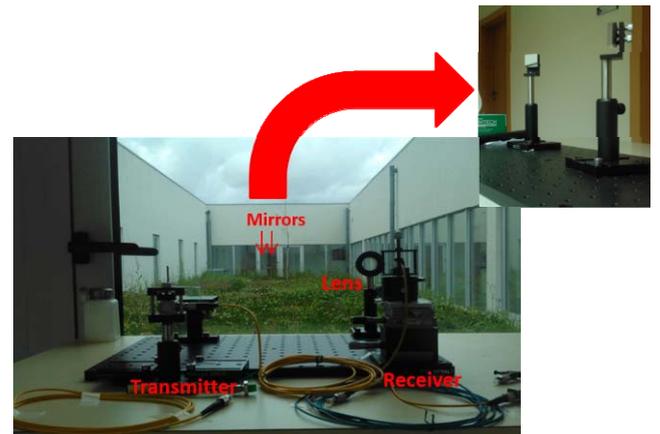
Most of the sessions took place on the classrooms and laboratories of the University of Aveiro, with the participations of the Physics Department and the Electronics Telecommunications and Informatics Department. Support for advanced topics on FSO experimental aspects was provided by the Optics Group laboratories at Instituto de Telecomunicações. Most of the sessions were conducted by the local university staff. Invited lecturers from other institutions, both at national and international levels further supported the theoretical sessions. Students feedback on the training school particularly acknowledged the enriching hands-on environment, the variety of themes and the knowledge sharing.



Teachers and students in the lab during OPTICWISE training school at University of Aveiro, Portugal.

## News from the Working Groups

The scientists of the Departamento de Electrónica e Telecomunicações were very active in the field of demonstrations. Under the lead of Prof. Antonio L. J. Teixeira, Vice-Chair of the **SIG TESEO (Special Interest Group Techno-Economics, Industrial Standards and Future Trends in OWC)**, an experiment has been conducted that demonstrated a hybrid fiber-free space passive optical network (PON) that enables high spectral density, aggregated capacity and total throughput exploiting ultra-dense wavelength-division-multiplexing (UDWDM) of baseband and radio-over-fiber (RoF) channels. In addition, for the first time, a bi-directional advanced modulation formats PON based on hybrid optical distribution network (fiber plus an outdoor passive head free space optics) was successfully demonstrated with reduced penalty. Hybrid splitting based on beam splitters was also demonstrated showing a path towards FSO distribution in temporary campaigns or controlled environments. A shifted time and wavelength division multiplexing PON (TWDM-PON) signal was inserted to study the impacts on the system and its required guard bands as shown in the figure below.



Setup of free-space optical communication testbed at University of Aveiro, Portugal.

**WG4 (Advanced Photonic Components)** participants have devoted large efforts in design and development of highly sensitive optical receiver with and without optical and electrical amplifiers, also including investigation of noise and distortion. Furthermore, a feed-forward linearized optical transmitter was studied and realized. Investigation of polymer micro-mechanical components, remote sensor and plasmonics supports was carried out to understand how device trade-offs contribute to system performance. In general, test of optoelectronic components and fabrication of optoelectronic devices are the main issues of the group. An essential task is design and development of various subsystem/system test-beds. Also an imaging system demonstrator was presented by WG4 participants.

## Member Profiles



**Zabih (Fary) Ghassemlooy**, *Action Vice Chair and Chair of WG2*, received BSc (Hons) degree in Electrical and Electronics Engineering from the Manchester Metropolitan University in 1981, and MSc and PhD from UMIST in 1984 and 1987, respectively. In 2004, he joined the University of Northumbria at Newcastle (UNN) as an Associate Dean (AD) for Research in the School of Computing, Engineering and Information Sciences. 2012-2014 he was AD for research and innovation, Faculty of Engineering, at UNN, UK. He heads the Northumbria Communications Research Laboratories within the Faculty. His research interests are in optical wireless communications, free space optics, visible light communications.



**Yahya Baykal**, *Chair of Special Interest Group on Underwater Communications*, received his BSc and MSc degrees from the Middle East Technical University (METU), Ankara, Turkey, in 1974 and 1977, respectively, and his PhD degree from Northwestern University, Evanston, Illinois in 1982. He was an Assistant Professor in the Electronic Engineering Departments of METU and Hacettepe University and the General Manager with the İltektelekomünikasyon (İskratel) Company. He is currently working as the Vice Rector and Professor of Electronic and Communication Engineering Department in Çankaya University, Ankara, Turkey. His main research areas cover atmospheric turbulence and



**Luis Nero Alves**, *Chair of Special Interest Group on Visible Light Communications*, was born in 1972 at Porto, Portugal. He graduated in 1996 and received his MSc degree in 2000, both in Electronics and Telecommunication Engineering from the University of Aveiro. In 2008, he obtained the PhD degree in Electrical Engineering from the University of Aveiro. Since 2008, he is the lead researcher at the Integrated Circuits Group from the Instituto de Telecomunicações – Aveiro. His current research interests are focused on optical wireless communication systems using the visible light spectrum, e.g. for networking support applications in public lighting infrastructures.

## Upcoming Events

- IEEE Global Communications Conference (GLOBECOM), 8-12 December, 2014, Austin, USA.
- 5th IEEE Workshop on Optical Wireless Communications (OWC'14), 8 December, 2014, Austin, USA.
- SPIE LASER, Free-Space Laser Communication and Atmospheric Propagation XXVII, 8-9 February, 2015, San Francisco, USA.
- 3<sup>rd</sup> International Conference on Photonics, Optics and Laser Technology (PHOTOPTICS), 13-15 March, 2015 Berlin, Germany.
- The Optical Fiber Communication Conference (OFC), 22-26 March, 2015, Los Angeles, USA.
- SPIE Defense + Security, Atmospheric Propagation XII, 20-24 April, 2015, Baltimore, USA.
- Conference on Lasers & Electro-optics (CLEO), 10-15 May, 2015, San Jose, USA.
- European Conference on Optical Communications (ECOC), 27-30 September, 2015, Valencia, Spain.
- IEEE Global Communications Conference (GLOBECOM), 6-10 December, 2015, San Diego, USA.

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<http://opticwise.uop.gr/>

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