

Working Group 2, Milestone 2.1

System Design for VLC Short-range IoT and for Multi-user Scenarios

Report edited by Giulio Cossu (Scuola Superiore Sant'Anna, Pisa, Italy), Xiaodan Pang (KTH Royal Institute of Technology, Sweden) and Nobby Stevens (KU Leuven, Belgium).

June 2022



This project has received funding from the European Cooperation in Science and Technology (COST) organization under project no CA19111.

1 Introduction

In the NEWFOCUS working group 2, the optical wireless range was defined in the order of magnitude of meters. Consequently, the large majority of the work can be found in the realm of indoor environments. In the first year and a half of this project, multiple input documents created by the members of this action and publications acknowledging NEWFOCUS can be classified under the “System Design for VLC Short-range IoT and for Multi-user Scenarios” umbrella.

Below, we have created an overview of the input documents and publications that fill within the

- a. System Design for VLC Short-range IoT
- b. System Design for Multi-user Scenarios

classification.

2 System Design for VLC Short-range IoT

2.1 Input documents

- *Optimized Analog Multi-Band Carrierless Amplitude and Phase Modulation for Visible Light Communication-Based Internet of Things Systems*, by Luís Rodrigues, Mónica Figueiredo, Luís Nero Alves; Department of Electronics, Telecommunications and Informatics, University of Aveiro, Portugal; School of Technology and Management, Polytechnic of Leiria, Portugal; Instituto de Telecomunicações, Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, Portugal.
- *Optical wireless audio headset for communication in an aircraft cockpit*, by P. Combeau, A. Julien-Vergonjanne, S. Sahuguède, L. Aveneau, and H. Boeglen; XLIM Laboratory, UMR CNRS 7252, University of Poitiers, France; XLIM Laboratory, UMR CNRS 7252, University of Limoges, France.
- *Indoor monitoring system based on ARQ signaling generated by a Visible Light Communication link* by Joan Bas, Jose Antonio Ortega, Marti Busquets and Alexis Dowhuszko, Centre Tecnologic de Telecomunicacions de Catalunya (CTTC/CERCA), Castelldefels, Spain; Universitat Politècnica de Catalunya (UPC), 08034 Barcelona, Spain; Department of Communications and Networking, Aalto University, Espoo, Finland.
- *Two-Tier Multi-Rate Slotted ALOHA for OWC/RF-Based IoT Networks* by Milica Petkovic¹, Dejan Vukobratovic¹, Andrea Munari, Federico Clazzer¹ University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia; Institute of Communications and Navigation of the German Aerospace Center (DLR), Wessling, Germany.
- Amel Chehbani, Amina Boussebt, Stéphanie Sahuguède, Anne Julien-Vergonjanne, and Pierre Combeau, “RF-Free infant ECG monitoring: Performance and signal quality assessment” University of Limoges & University of Poitiers.
- Tijana Devaja, Milica Petkovic, Francisco J. Escribano, Cedomir Stefanovic, Dejan Vukobratovic, “Slotted Aloha with Capture for OWC-based IoT: Design and Analysis in Finite Block-Length Regime”, University of Novi Sad & ²Universidad de Alcalá & Aalborg University.
- High-power VLC for Industry 4.0, by Sergio Rodríguez Coronel, Máximo Morales Céspedes, Juan Carlos Torres Zafra, Ana García Armada Universidad Carlos III de Madrid, 28911 Leganés, Spain.

2.2 Publications

- J. Bas, J.-A. Ortega, M. Busquets and A. Dowhuszko, “Indoor monitoring system based on ARQ signaling generated by a Visible Light Communication link”, in Proc. IEEE Global Commun.

Conf. pp. 1-6, Dec. 2020.

- M. Petkovic, T. Devaja, D. Vukobratovic, F. J. Escribano and Č. Stefanović, "Reliability Analysis of Slotted Aloha with Capture for an OWC-based IoT system," 2021 17th International Symposium on Wireless Communication Systems (ISWCS), 2021, pp. 1-6.
- Rodrigues, L.; Figueiredo, M.; Alves, L.N. "Optimized Analog Multi-Band Carrierless Amplitude and Phase Modulation for Visible Light Communication-Based Internet of Things Systems". *Sensors* 2021, 21, 2537. <https://doi.org/10.3390/s21072537>

3 System Design for Multi-User Scenarios

3.1 Input documents

- *Benefits of MIMO Mode Switching, Angular Diversity and Multiuser Multiplexing for LiFi*, by S. M. Kouhini, P. Hellwig, D. Schultz, R. Freund, V. Jungnickel; Fraunhofer Heinrich Hertz Institute, Einsteinufer 37, 10587 Berlin, Germany.
- *Optical-CDMA for Uplink Transmission in Medical Extra-Wireless Body Area Networks* Jahid Hasan¹, Ali Khalighi¹, Bastien Béchadergue; Aix-Marseille University, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France; Oldecomm SAS, Vélizy-Villacoublay, France.
- Mohsen Abedi, Alexis Dowhuszko, and Risto Wichman, "Visible Light Communications: A Novel Indoor Network Planning Approach".

3.2 Publications

- N. Su, E. Panayirci, M. Koca and H. Haas, "Transmit Precoding for Physical Layer Security of MIMO-NOMA-Based Visible Light Communications," 2021 17th International Symposium on Wireless Communication Systems (ISWCS), Berlin, Germany, 2021, pp. 1-6, doi: 10.1109/ISWCS49558.2021.9562248.
- S. R. Teli, P. Chvojka, S. Vitek, S. Zvanovec, R. Perez-Jimenez and Z. Ghassemlooy, "A SIMO Hybrid Visible-Light Communication System for Optical IoT", in *IEEE Internet of Things Journal*, vol. 9, no. 5, pp. 3548-3558, 1 March, 2022, doi: 10.1109/JIOT.2021.3098181.
- Younus, O.I.; Hassan, N.B.; Ghassemlooy, Z.; Zvanovec, S.; Alves, L.N.; Le-Minh, H. "The Utilization of Artificial Neural Network Equalizer in Optical Camera Communications". *Sensors* 2021, 21, 2826. <https://doi.org/10.3390/s21082826>