



## ICT PH.D. PROGRAM AT DIET

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# Short course on Optical Wireless Communications for outdoor, indoor, and underwater applications

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<b>Lecture Room</b>	<b>2<sup>nd</sup> floor (n. 206) at DIET, Via Eudossiana 18, 00184 Rome (Italy)</b>		
<b>Dates</b>	<b>Tuesday</b>	<b>12 January 2016</b>	<b>h. 9-12</b>
	<b>Wednesday</b>	<b>13 January 2016</b>	<b>h. 9-12</b>
	<b>Thursday</b>	<b>14 January 2016</b>	<b>h. 9-12</b>

**Lecture contents.** Optical wireless communications have recently received particular attention in both academia and industry due to their potential in providing very high-rate data transmission in various application scenarios. This presentation provides an overview on OWC systems in three main application areas, that is, outdoor, indoor, and underwater contexts. As concerns outdoor applications, we review the most important limitations affecting the performance of free-space optical (FSO) links in practice. Focusing on terrestrial FSO systems, we consider the effects of background radiations and atmospheric turbulence and fog on the system performance after a brief description of the receiver electronics and photo-detection parts. We also study the solutions to mitigate these adverse channel effects. In particular, concerning atmospheric turbulence, we review the solutions of time and space diversity to reduce the fading effect at the receiver. More specifically, we describe MIMO FSO structures and the appropriate signaling schemes for them. Concerning indoor applications, we will particularly focus on the emerging field of visible-light communications (VLC). Here, the main limitation on the data rate arises from the limited modulation bandwidth of the commercially available white LEDs, which is typically in the range of several MHz. To deal with this problem, we present several proposed transmission schemes based on optical orthogonal-frequency-division-multiplexing (O-OFDM) and pulse amplitude modulation or carrier-less amplitude and phase modulation with frequency-domain equalization. On the other hand, in the underwater context, the major challenges on the communication link include high beam attenuation by the aquatic channel, especially in high turbidity waters, as well as link alignment issues. We present the main considerations on the impact of the underwater channel and the transmission schemes allowing high rate data transmission in this context. We also discuss the sensitivity to link misalignments in practical situations. Lastly, within these contexts, we address the remaining challenges and the future research directions for improving the link performance and reliability, while talking about the current research activities in Institut Fresnel, Marseille. An introductory part will be presented for each application context in order to give appropriate background to the audience before dealing with the more theoretical concepts.



Dr. Ali Khalighi received his PhD degree in Telecommunications from the Institut National Polytechnique de Grenoble, Grenoble, France, in 2002. From 2002 to 2005, he was with GIPSA-lab, Télécom Paris-Tech (ENST), and IETR-lab, as a post-doctoral research fellow. He joined École Centrale Marseille and Institut Fresnel in 2005, where he currently holds an Associate Professor position. He also received his HDR (Accreditation for Research Supervision) degree from Aix-Marseille University in 2014. His main research areas of interest include signal processing for wireless communication systems with an emphasis on the physical layer aspects of free-space, underwater, and indoor visible-light optical communications. So far he has co-authored more than 70 book chapters and journal and conference papers on these topics. He has served as the Technical Program Committee of more than 15 international conferences and workshops in the communications area, and was the TPC co-chair of the International Workshop on Optical Wireless communications (IWOW) 2015. Also, he served as the

Vice Chair of Working Group 2 of the FP7 IC1101 COST Action on optical wireless communications. Dr. Khalighi is the recipient of the Scientific Excellence Award from the French Ministry of Research and Higher Education for the periods of 2009–2017.