Combinations Scenarios of Optical and RF-Communication Networks for Different High Data Rate Multimedia Applications and Innovations in Autonomous Driving

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Abstract: In this contribution Combinations of Optical- and RF-Wave Propagation are illustrated for different scenarios. The considerations include Optical Wireless Communication (OWC, well known as Free Space Optics (FSO)) as hybrid transmission methods with telecommunication technologies (like WLAN, RF- and satellite communications) and also Sensing Technologies (like LiDAR and radar combinations). The contribution deals with possible fields of applications for optical wireless in conjunction with automated driving. The scope considers requirements (including infrastructure and regulations), differences of Optical and RF-Wave Propagation and promising combinations of optical techniques with conventional wireless technologies. This paper should also provide inputs to define new ideas and aspects for the future research focus within Europe.

Optical wireless has a huge potential to cover the expected high data rate demands in relation to automated driving. A welcome side effect is the relief of the crowded RF bands respectively the support to fulfil the bandwidth demands with a combination of these technologies. It turned out that hybrid systems are currently the most promising approach as each technology has its own culprits and the combination provides the advantages without the disadvantages. In future it would not be possible to process and transmit the amount of data (as example Live/HD maps) in real-time even with the future 5G mobile networks, without using optical wave propagation. Also the visible light communication (VLC) offers a well suited concept of optical communications, but research has to be done to reach a mature stage. So far VLC (as Broadcast technology) can be perfectly adapted to transfer a high amount of information and data to the users and clients. As it is likely that the headlamps and taillights of vehicles will not disappear in the next time, they could also be used for communication purposes as well as serving exact position data in locations, where no satellite position system is in reach (e.g. tunnels, narrow house-canyons in cities).

Additional LiDAR is an important technology for automated vehicles. Laser rays are used to draw a precise picture of the surroundings. The combination of LiDAR, Radar and cameras represents the current state-of-the-art system. To realise the broad use throughout industry, the costs need to be reduced. Optical solutions are not only designed to communicate outwards, they can also be implemented inside the vehicle. We should consider that a reduction of vehicle weight and the complete lack of electromagnetic disturbances are interesting properties for cars and traffic. It is easy possible to increase the security of tramway systems and train controlling with LiDAR. The track is defined and other track or road users could be detected in an earlier stage.

All those examples demonstrate optical wireless as a necessity for automated driving, but not all systems are suitable for mass markets yet, and further research and has to be done to fulfil all requirements. As mentioned the applications could be extended to trains, ships, aeroplanes etc. Like presented so often in the past Hybrid communication systems allow worldwide access to the Internet or other networks by combining satellite communications, FSO, Wireless LAN, Local Multipoint Distribution System (LMDS) and DVB-T (terrestrial digital video broadcast). Current and future applications of OWC and hybrid solutions (including deep space missions) in combination with 5G networks will be supplemented now by combining Optical- and RF-waves also for sensing and detecting targets, obstacles and neighbour-systems for autonomous driving systems (for cars, ships and planes).