Threat of Low-Cost Jammers: The Effects on Visible Light Communication Systems

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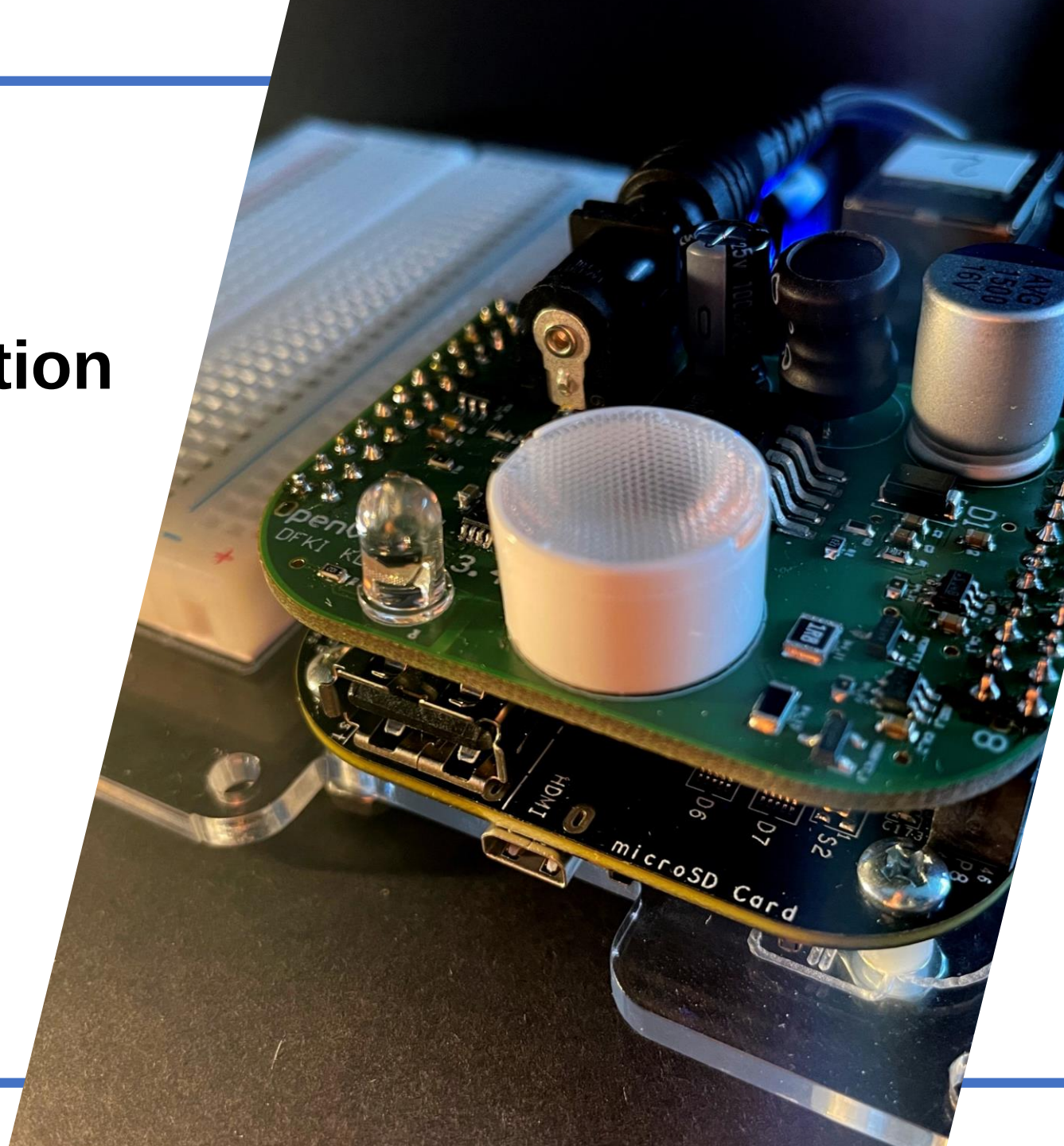
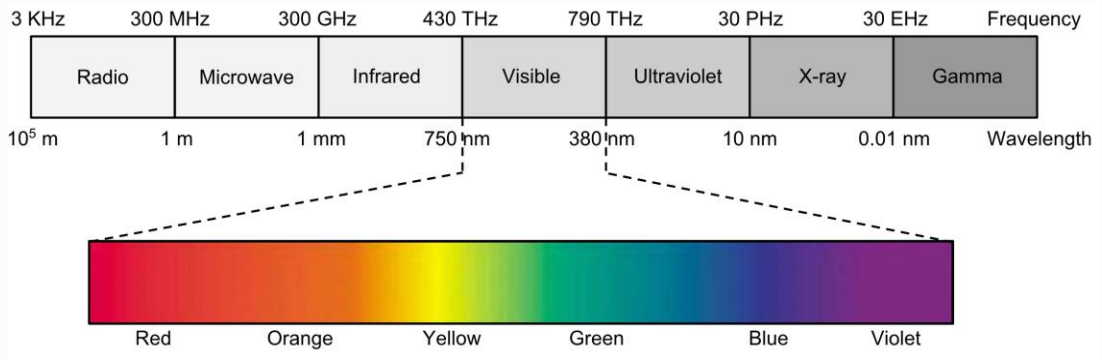


What is VLC?

Visible Light Communication (VLC) → Visible light spectrum to transmit data



Electromagnetic Spectrum [1]

[1] P. H. Pathak, X. Feng, P. Hu and P. Mohapatra, "Visible Light Communication, Networking, and Sensing: A Survey, Potential and Challenges," in IEEE Communications Surveys & Tutorials, vol. 17, no. 4, pp. 2047-2077, Fourthquarter 2015, doi: 10.1109/COMST.2015.2476474.

Motivation - Advantages of VLC

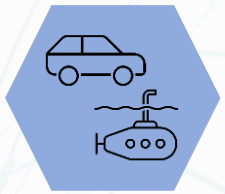
Growing number of devices with limited Radio Frequency (RF) spectrum
→ Through VLC extended spectrum

LEDs: cheap and already used for lighting
→ Easy implementation

No interference problems
→ Advantage for airplanes or hospitals

Security aspect
→ Attacker can't detect through walls

Potential application
→ Vehicular and under-water communication



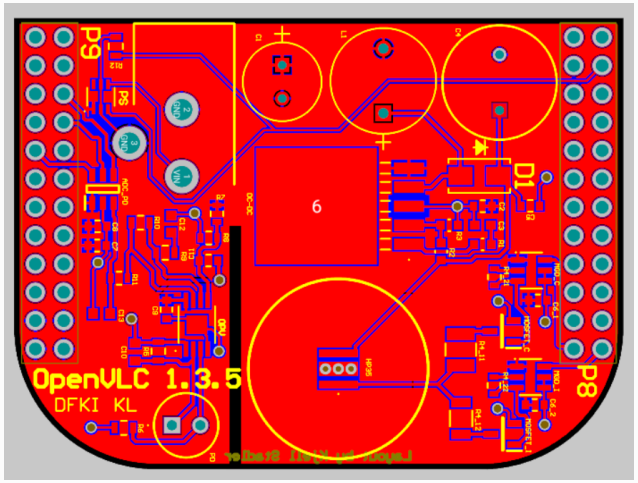
Examination of Various VLC Platforms

Platform Name	Author	Year	Hardware	Maximal Data Rate	Corresponding Range
iDropper	*Dietz et al.*	2003	MCU	250 bps	≈ 10 cm
Shine	*Klaver et al.*	2015	Arduino	1 kbps	1 m
modBulb	*Hewage et al.*	2016	FPGA/MCU	1 Mbps	1 m
enLighting	*Schmid et al.*	2016	Arduino + Atheros	600 bps	5 m
DarkLight	*Tian et al.*	2016	FPGA	1.6 kbps	1.3 m
PurpleVLC	*Yin et al.*	2018	BBB	100 kbps	6 m
OpenVLC	*Galisteo et al.*	2019	BBB + Cape	400 kbps	3.5 m
SmartVLC	*Wu et al.*	2020	BBB	100 kbps	3.6 m

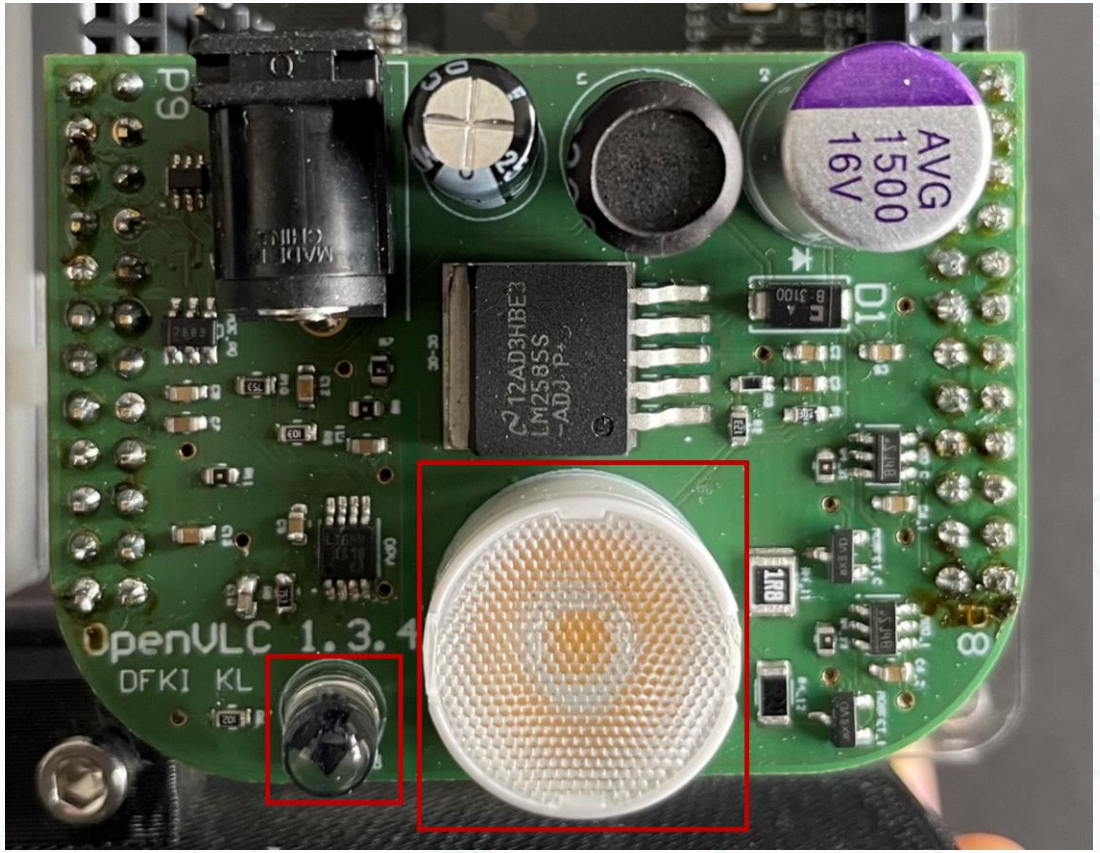
PCB Development & System Adjustments

Hardware-adapted OpenVLC system:

- Frequency range: (380-780) nm
- Clock frequency: 1 MHz



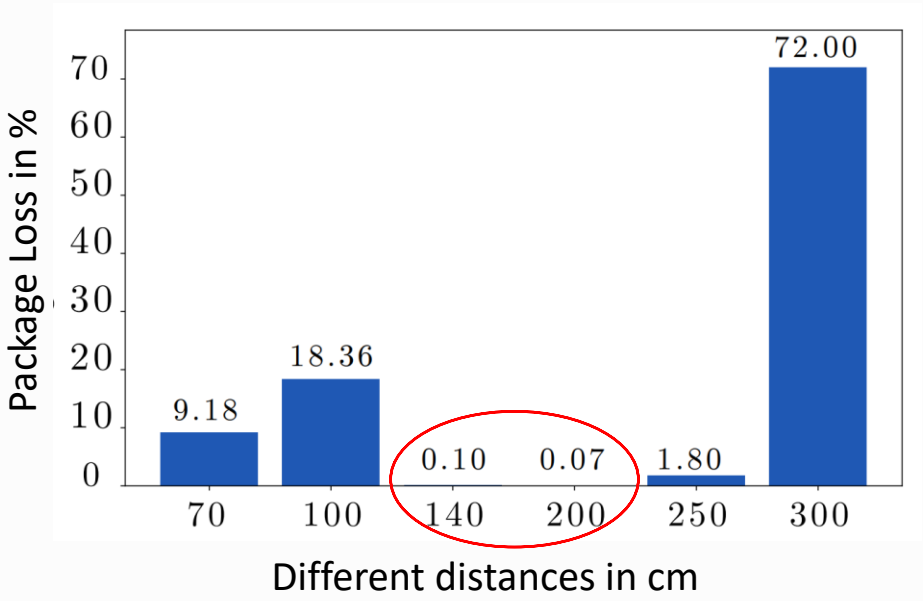
PCB



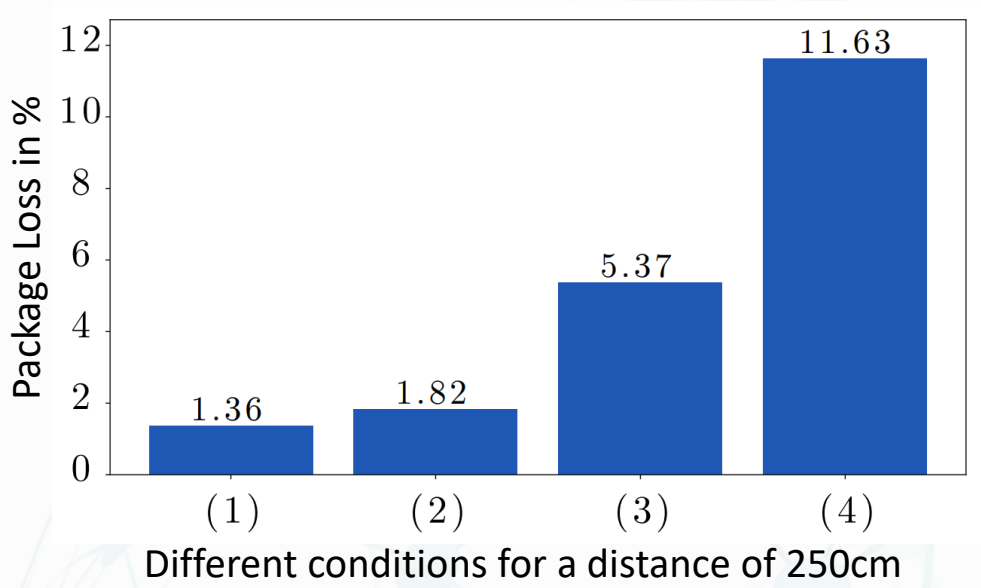
Photodiode LED

System Evaluation

Evaluation of system capabilities:
Suitable transmission distance

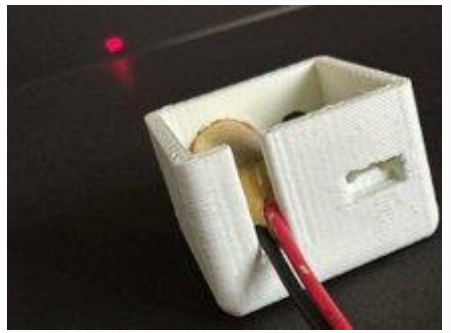


Investigation of light effects by daylight and artificial light



(1) without daylight (dl) and artificial light (al),
(2) with (dl) and without (al),
(3) without (dl) and with (al),
(4) with (dl) and (al)

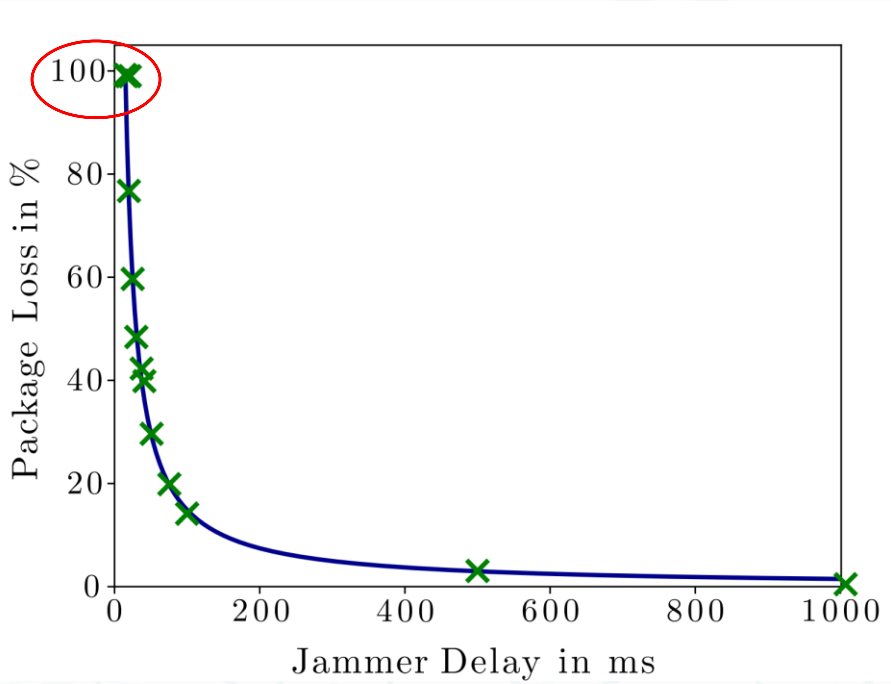
Testing of Jamming



Laser diode for experimental setup

- Jamming approach: Till denial of service
- Jammer: Low-cost laser diode (650 nm, various attack frequencies)

Jamming Duration in [ms]	Package Loss in [%]
10	100
14	100
15	99.22
20	76.73
25	59.67
30	48.41
35	42.61
40	40.01
50	29.79
75	19.94
100	14.15
500	3.04
1000	1.47
on	0.04
off	0.05



Package Loss in percent at different jammer delays (x). Also, approximated function f(x) = 1488/x

Future Approaches

Use of different jammer forms (random or passive)

Diffuse jamming attacks (mirrors, glass,…)

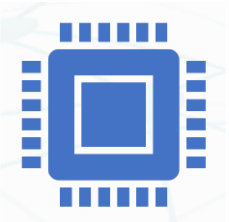
Indirect eavesdropping

Conclusion

System adjustments and examination of external influences

Investigation of influences due to a low-cost jammer

Entire transmission could be interrupted with a low-cost jammer



Highlighting the importance of improved security concepts and smart algorithms, esp. of jamming with VLC

THANK YOU

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