# Using Visible Light as a Truly Green Way of Communication

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## Introduction

- The exponential growth of Internet of Things (IoT) devices will result in high demand for wireless traffic and energy consumption.
- High energy efficient wireless communication systems are critical to achieving United Nations (UN) sustainability development goals (SDGs) and the requirements of the next generation (6G) wireless networks.
- Traditional radio frequency (RF) communication systems are unable to provide the increasing demand for high-data-rate IoT devices.
- Visible light communication (VLC) utilizes the visible spectrum for data transmission and offers a colossal 400 THz bandwidth, which solves the RF spectrum scarcity and congestion issues.
- VLC systems have many unique advantages, including safety, health, Quality of Service (QoS) and security, augmentation of existing technologies, and green technology.
- VLC potentially will play a significant role in the development of 6G technology while satisfying UN SDGs.

## VLC System Overview

- In typical VLC systems, off-the-shelf light emitting diodes (LEDs) and photo-detectors (PDs) are used as transmitters and receivers, respectively.
- Intensity modulation (IM) process allows LEDs to send information by varying the light intensity at a very high speed.
- direct detection (DD) process at the receiver detects information by generating an electrical current proportional to the variation in the received optical power.

## Contributions

Problem Statement: Despite a huge unlicensed bandwidth in VLC, the modulation bandwidth of commercially available LEDs is limited [1].

Challenge: Designing spectral-efficient coded modulation systems is a challenging task.

- VLC has a unipolar signal for intensity modulation and direct detection (IM/DD).
- In general, the distribution of the input symbols is not the capacity-achieving one. So, it causes shaping gap (difference between the transmission rate and Shannon's limit).
- The transmission rate and channel coding rate should be adapted according to the channel condition.

Possible Solution: probabilistic shaping (PS) can enhance spectral efficiency (SE) and reduce the shaping gap by optimizing the probabilities of input symbols.

- PS for coherent modulation is not directly applicable to VLC.
- For VLC with IM/DD, the optical signal is unipolar and has a non-symmetric optimal probability mass function (PMF).
- To enhance SE, novel adaptive coded forward error correction (FEC) based color-shift keying (CSK) modulation scheme with PS is proposed.

## Numerical Results

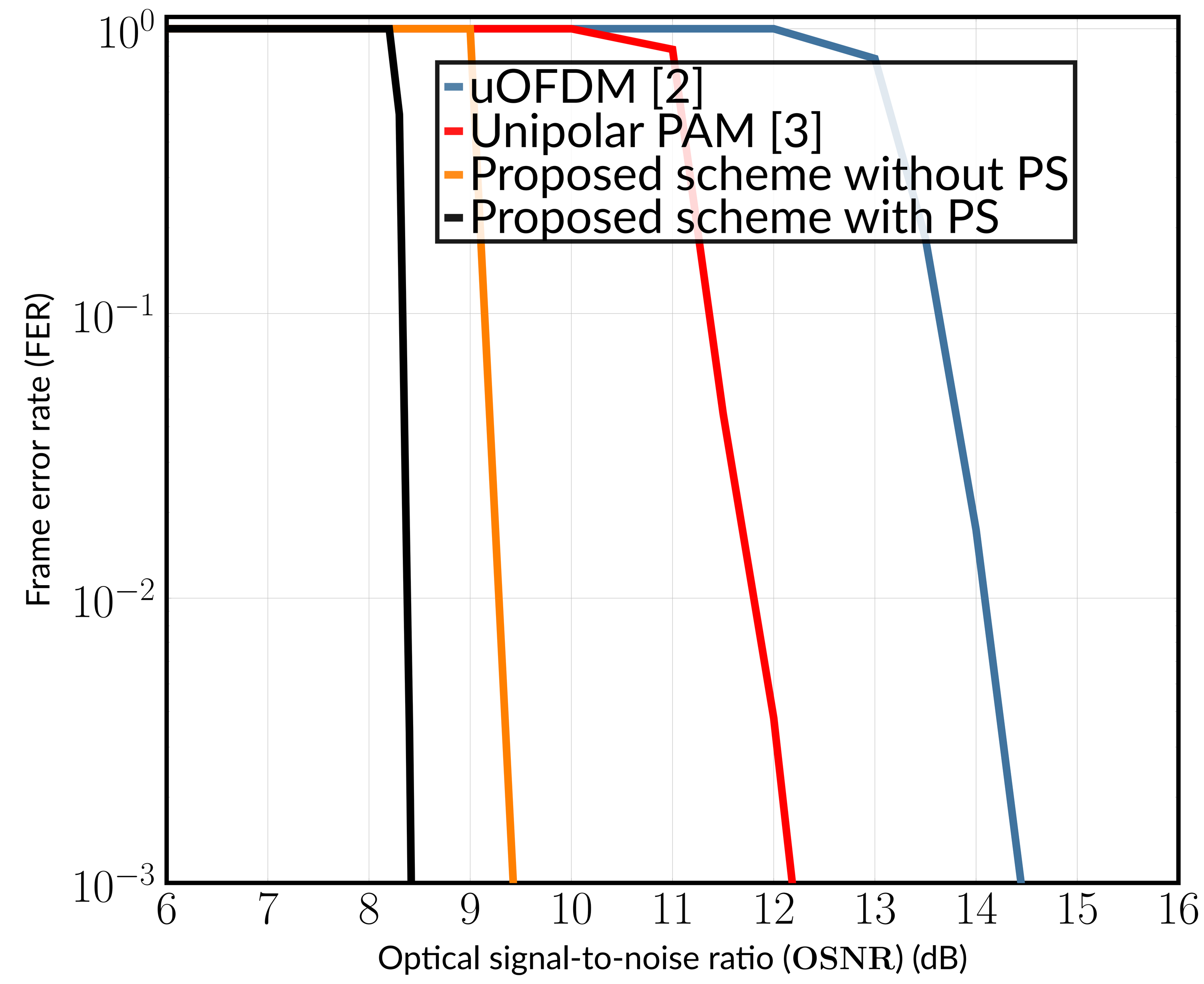


Figure 2. Comparison of different schemes in terms of FER for normalized data rate, $\mathrm{R} = 2$ b/cu/sc.

## Applications

Our proposed scheme can be useful in the next few years in several research areas:

- Li-Fi : the networked, mobile, high-speed VLC solution for wireless communication.
- Vehicle Visible Light Communication (V2LC), capable of collecting and sending information collected by the different sensors coupled in the vehicles and in surroundings.
- To perform a high precision positioning using VLC, a receiver must pick up the signals from the LEDs in a room and calculate the distance from them, using various algorithms to establish the exact position of the receiver.

## Conclusion

- VLC is a promising solution for next-generation wireless networks that can satisfy the requirements of 6G wireless networks and UN SDGs.
- VLC can complement RF communication systems and offer an extra data layer with a higher rate.
- VLC is a green and energy-efficient technology that combines illumination and data transmission functions.

## References

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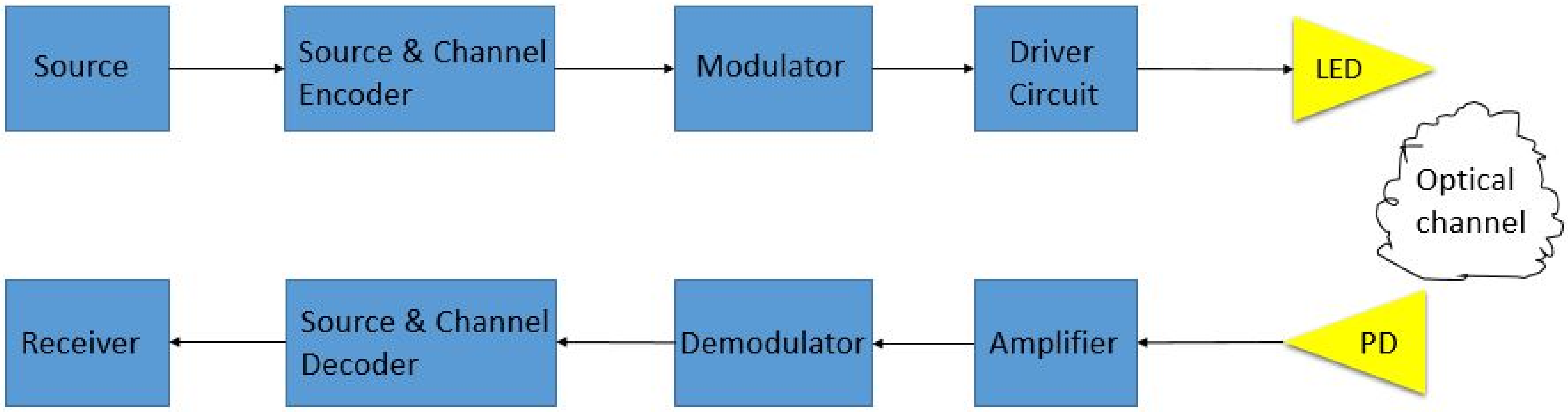


Figure 1. Typical VLC system model..