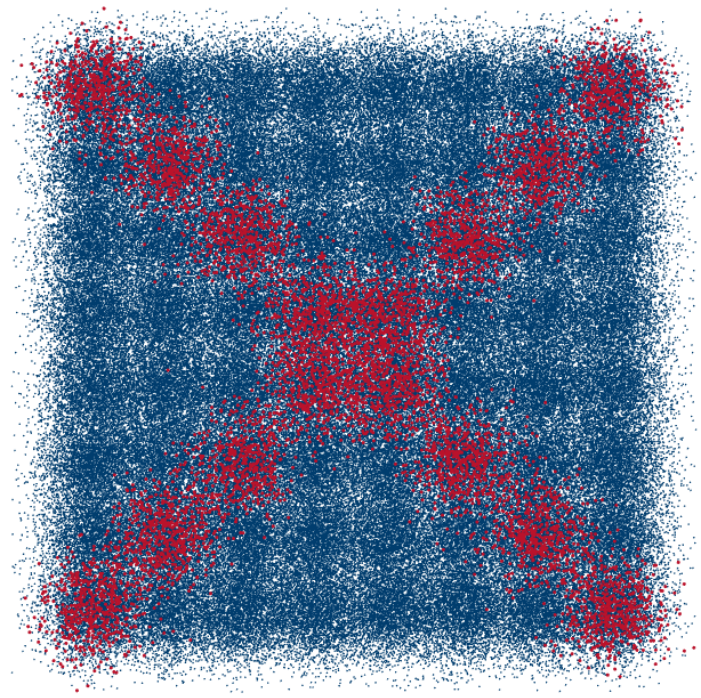


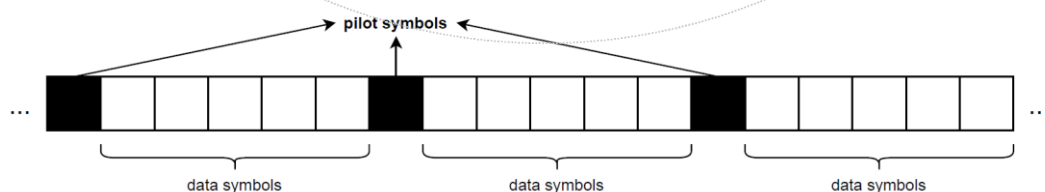
Method to perform modulation over pilot symbols in communications systems employing quadrature amplitude modulation (QAM). It allows to either increase the delivered bit-rate of the transmission system while keeping the same operating bandwidth and/or reduce the required signal-to-noise ratio (SNR) for error-free operation. It does not incur performance penalty or added computational complexity.



Tech offer | Increasing the information capacity of optical communications through embedded data modulation over pilot symbols

In modern coherent optical communication systems employing quadrature amplitude modulation (QAM), the use of pilot symbols is very common to aid on the estimation and compensation of carrier-phase noise. These pilot symbols are composed of QAM symbols with pre-defined amplitude and phase, which are known *a priori* both by the transmitter and receiver. Pilot symbols are time-multiplexed with regular data symbols (payload), typically in a regularly distributed fashion.

In order to circumvent this loss of information rate imposed by the use of pre-defined pilot symbols, we propose the use of embedded data modulation, in which the amplitude (and possibly also the phase) of the pilot symbols can be modulated, while keeping their underlying properties. This allows to increase the information rate of the transmission system without incurring into additional complexity and/or performance penalty.



APPLICATIONS

OPTICAL FIBER LINKS

HIGH-CAPACITY (<100 GBPS) COHERENT
TRANSCEIVERS

ANY QAM-BASED TRANSMISSION
SYSTEMS EMPLOYING PILOT SYMBOLS
(RF, WIRELESS, OPTICAL)

BENEFITS

INCREASED TRANSMITTER INFORMATION RATE which can be utilized to improve the performance of the transmission system in various ways:

- **DIRECT INCREASE OF BIT-RATE** for the same symbol-rate, modulation format, coding-rate and pilot-rate of the transmission rate
- **IMPROVEMENT OF REQUIRED SNR** for operation, while keeping the same net bit-rate

INTELLECTUAL PROPERTY

Provisional patent application filed in Portugal
(priority date: 24/05/2021)

INVENTORS

Researchers from:

- Instituto de Telecomunicações (Portugal)
- Universidade de Aveiro (Portugal)

SCIENTIFIC PUBLICATIONS

F. P. Guiomar, B. M. Oliveira, M. S. Neves, M. A. Fernandes, and P. P. Monteiro, "[Squeezing Out the Achievable Information Rate From Coherent QAM Systems Through Amplitude Modulation of CPE-Pilots](#)", in *Proc. Optical Fiber Conference (OFC)*, paper F4D.4, Fully-Virtual Event, March 2021.

DEVELOPMENT STAGE

TRL 6
The prototype system was tested in intended environment, with performance close to expected.

COMMERCIAL OFFERING

- Licensing or assignment agreement
- Testing of new applications
- Joint further developments

KEYWORDS

OPTICAL NETWORKS
DIGITAL SIGNAL PROCESSING
PILOT SYMBOLS
QUADRATURE AND AMPLITUDE MODULATION (QAM)

TARGET MARKET

Instituto de Telecomunicações seeks manufacturers of telecommunications equipment, producing coherent optical transceivers.

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