XI Jornada de **Jóvenes Investigadores**

16 de junio de 2022

Instituto Universitario de Investigación en Ingeniería de Aragón
Universidad Zaragoza

Evaluation of Radio over Plastic Optical Fiber Communications

Muhammad Waseem[1,2], Alicia López[1], Pedro Luis Carro[2], María Ángeles Losada[1]

GTF Grupo de Tecnologías Fotónicas

1: Grupo de Tecnologías Fotónicas (GTF)
2: Grupo Communication Networks and Information Technologies (CeNIT)
Instituto de Investigación en Ingeniería de Aragón (I3A), Universidad de Zaragoza
Mariano Esquillor s/n, 50018, Zaragoza, Spain. Tel. +34-641956724, e-mail: 806405@unizar.es

CeNIT Communication Networks and Information Technologies

In this work, we have experimentally evaluated the performance of a Radio over Plastic Optical Fiber (RoPOF) communications link by simultaneously transmitting Long-Term Evolution (LTE) and Narrow-Band Internet of Things (NB-IoT) signals over 75-meters of PMMA large-core Graded-Index POF (GI-POF).

Overview

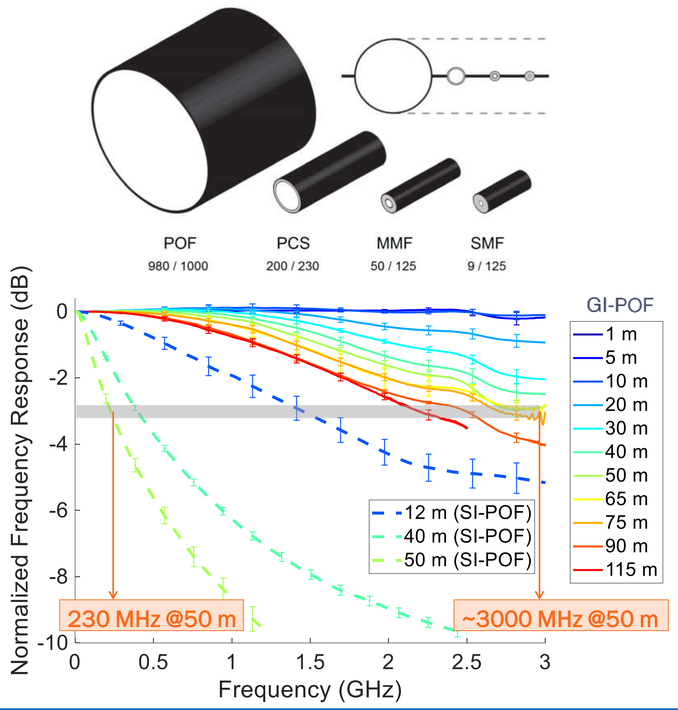
- Network **connectivity demands**
- **Short-range** communication networks
- Distributed Antenna Systems (DAS)
- **Convergence of radio and fiber optic technologies**
  - Optics: high capacity and low attenuation
  - Radio/Wireless: ubiquity
- Characteristics of POF over Glass Optical Fiber
  - Ruggedness
  - Installation and Maintenance Cost
  - Power Consumption
  - Safety
  - Do-it-yourself

Types of plastic optical fibers

Standard POF (980 / 1000)
- PMMA core
- ~0.2 dB/m @650 nm
- >150 MHz·km (GI-POF)

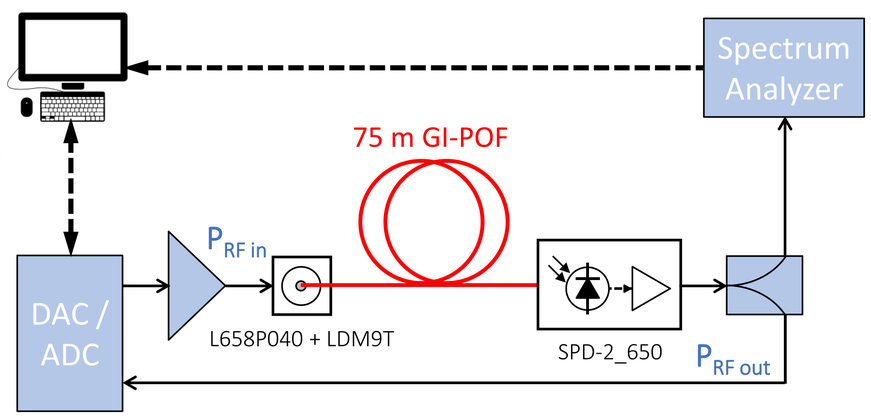
PF-POF (50–120 / 2000)
- Perfluorinated polymer
- ~0.06 dB/m @850 nm
- >300 MHz·km

PCS (200–1500 / 500–2000)
- Plastic clad / silica core
- ~0.015 dB/m @850 nm
- 20 – 9 MHz·km (200 – 600 µm)



Experimental Setup

- MATLAB LTE Toolbox
- DAC/ADC: Zed Board (Xilinx Zynq-7000)
- Laser Diode L658P040
  - Wavelength 658 nm
  - Nominal power 40 mW
- 75-meter Graded-Index POF
- Receiver SPD-2-650

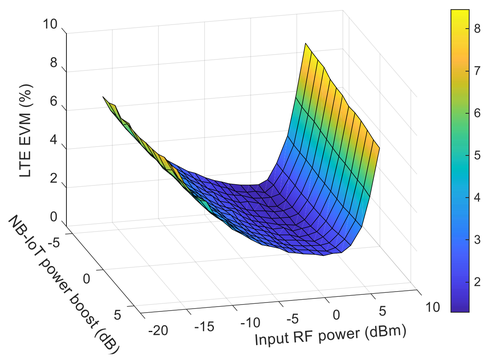


Transmission paramaters

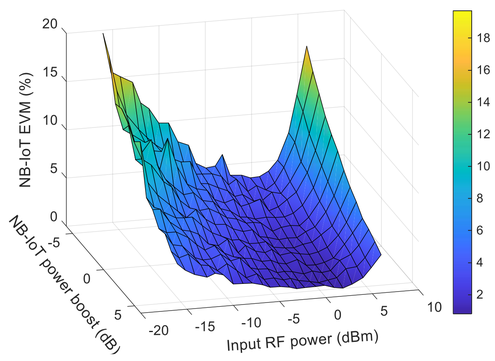
Carrier frequency	**800 MHz**
LTE bandwidth	**10 MHz**
Input RF power ($P_{RF\ in}$)	**-16 dBm – +6 dBm**
NB-IoT operation mode	**Guardband**
NB-IoT PRB	**50 / 51**
NB-IoT power boost	**-6 dB – +6 dB**

Results

Transmission performance: EVM



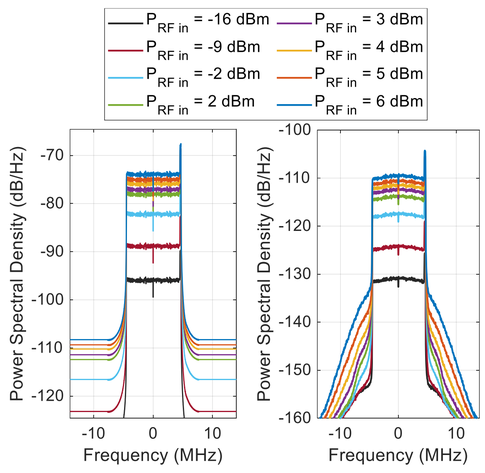
10-MHz LTE @800 MHz



Guardband NB-IoT @PRB 50

- Low SNR @ low input RF power
- Non-linearities @ high input RF power
- NB-IoT power boost has little impact over LTE EVM
- EVM are below quality thresholds for most input RF powers:
  - 8% for LTE
  - 17.5% for NB-IoT

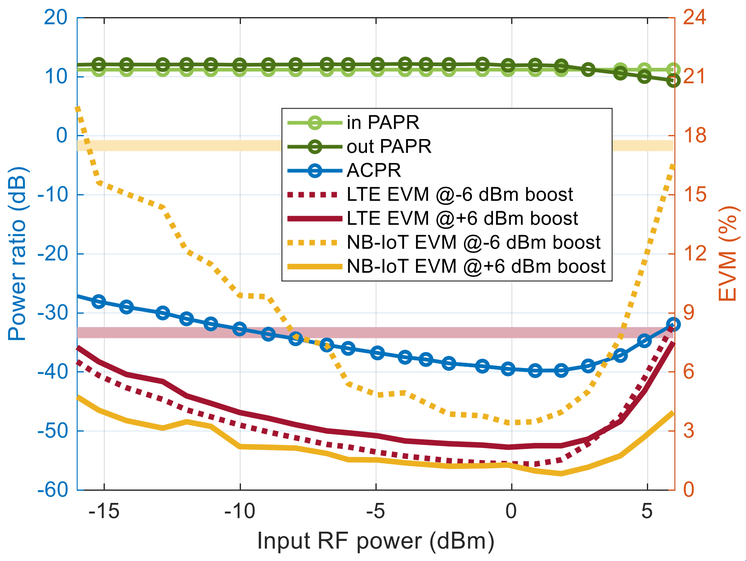
Non-linearities metrics: PSD, PAPR, ACPR



Input PSDs | Output PSDs

- Output PAPR slightly decreases from 2 dBm consequently with ACPR and EVM increase

- Power leakage to adjacent channels due to non-linear behavior of the devices
- ACPR has tolerable values, below –33 dB for input RF power values higher than -10 dBm



Conclusions

The combined transmission of NB-IoT and LTE over the POF meets the standard quality for both services, for a wide range of input RF powers.

A high power boost to the NB-IoT signal results in a better transmission performance over a wider range of input powers, with hardly any impact over the LTE signal.

Non-linear effects, determined by the values of PAPR and ACPR, do not severely affect LTE transmission except at the highest analysed input RF powers.

The reported results demonstrate the feasibility of RoPOF transmission over PMMA large-core GI-POF for future short-range networks.

Acknowledgments

This research was funded by the Spanish Ministry of Science and Innovation (MICINN/FEDER), grant numbers RTI2018-095684-B-I00 and RTI2018 094669 B-C33, and by the Aragón Government (DGA), under grant numbers T20-20R and T31-20R.