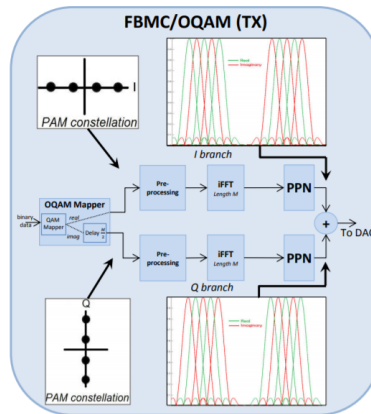


Deep learning for FBMC/OQAM systems to reduce PAPR and save power

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Filtered multicarrier systems such as Filter-bank multi-carriers (FBMC) [1] or Filtered OFDM (F-OFDM) [2] are promising technologies to improve future Internet-of-thing networks. These modulation techniques enable to support asynchronous communications [3] where the transmitters and the receivers don't need to be perfectly synchronized to a common and precise time-base to transmit data. Therefore, communication protocols can be simplified which, in turn, reduces the signalization overhead and saves power.

However, these modulations suffer from non-linearity issues of the power amplifier due to their high Peak-to-Average Power Ratio (PAPR) [4]. Their spectral shapes are distorted by the non-linearity, causing spectral regrowth [5] and interference, and therefore lose all their competitive advantages. One straightforward solution is to ensure that the average transmit power is far below the input backoff of the power amplifier so that the peak power of the signal stay within its linearity zone. However, this requires over-dimensioned and power-consuming amplifiers. Another approach is to use pre-distorsion techniques [6] at transmitter side and interference cancellation techniques at the receiver. However, these techniques can be complex to implement and may require an accurate knowledge of the power amplifier model that may evolve with the time and the environmental conditions.

Recently, Deep Learning (DL) techniques have attracted a lot of interest in telecommunication [7] due to their abilities to efficiently provide solutions to complex non-linear problems that typical processing techniques have difficulties to deal with. Power amplifier non-linearity distortions fall into these difficult problems. Therefore, we propose to use deep learning techniques to deal with the spectral regrowth (transmitter side) and interference (receiver side) issues caused by the power amplifier on the filtered multicarrier signal. One of the challenge is to design a deep neural network (DNN) architecture with low complexity at transmitter side which is efficient enough to combat spectral regrowth. At the receiver side, there is no complexity constraints other than being realistically implementable on hardware, and have to deal with remaining interference.

Currently, a pre-distorsion algorithm based on a DNN has been proposed in [8] and applied on FBMC in [9], which demonstrates the efficiency of the approach. However, this DNN-based technique greatly increases the RF design complexity. In fact, an additional analog-to-digital converter is needed since the DNN uses the

HPA output as feedback information to digitally remove the distorted component of the signal. In [7], it has been shown that a DNN used as a detection at the OFDM receiver can greatly improve the receiver BER performance when facing interference due to clipping when reducing the PAPR. However, such observation have not been confirmed for filtered waveforms, and no DNN was employed at the transmitter side to further improve the performance. Therefore, there is a lot of room for improvements.

The objective of the PhD thesis is to propose **a novel DNN-based technique that can efficiently reduce the PAPR and combat spectral regrowth of transmitted FBMC/OQAM symbols with low computational complexity**. A dedicated post-processing block can be proposed at the receiver side to deal with potential residual interference. A successful candidate should have knowledge about the following fields:

1. Wireless telecommunication in general, particularly signal modulation and demodulation techniques.
2. OFDM transmitter and receiver techniques, including channel equalization and estimation.
3. Deep neural networks in general.
4. Programming in MATLAB, Python and/or C++.
5. Some experience in at least one deep learning framework such as Pytorch, TensorFlow, Keras...

To apply for this Ph.D. position, please send an email to **both** Francois Leduc-Primeau (francois.leduc-primeau@polymtl.ca) and Jeremy Nadal (jeremy.nadal@polymtl.ca) with your curriculum vitae and university transcripts as attachments. Selected candidates will be contacted to schedule an interview, and asked to solve an assignment. This assignment serves as a base to evaluate the candidate's knowledge. It is expected that the candidate completes the assignment and sends the responses 1 or 2 days before the interview. During the interview, some questions will be asked about the assignment.

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