GPU-based Predistortion for Massive MIMO Arrays in 5G and Beyond

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Digital Predistortion (DPD) Overview

Digital predistortion (DPD) creates an inverse nonlinearity to linearize power amplifier (PA) output.

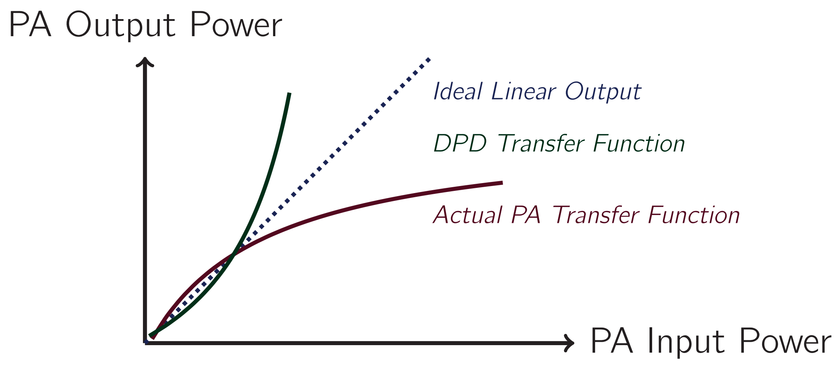
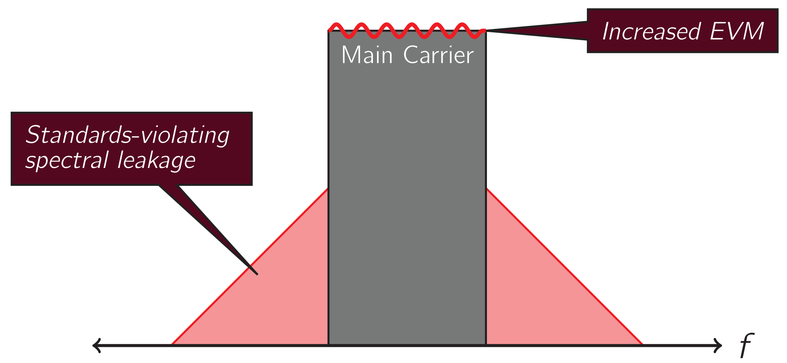


Figure: Example AM/AM Curve for a PA.

Without DPD, nonlinearities in the PA create spectral regrowth around a carrier which could violate 3GPP spectral emission masks and degrade EVM as shown below:

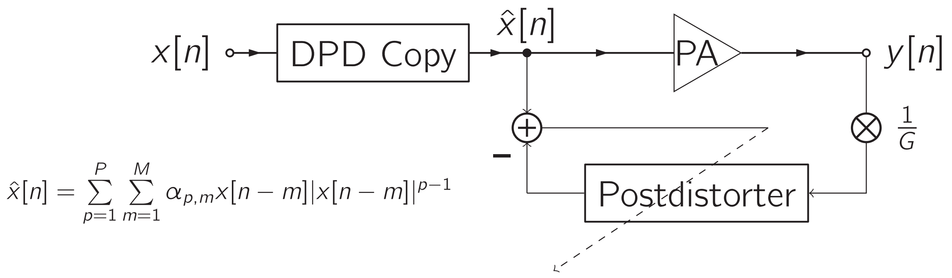


Challenges:

- High PAPR and wide bandwidths in 5G NR.
- PAs are most efficient near saturation.
- **Large number of antennas in 5G and beyond.**

Single Antenna DPD: Memory Polynomials with ILA

The indirect learning architecture (ILA) shown below is often used to train DPDs in single-antenna systems. Memory polynomials are often used as the post/predistroter to model any nonlinearities and memory effects.



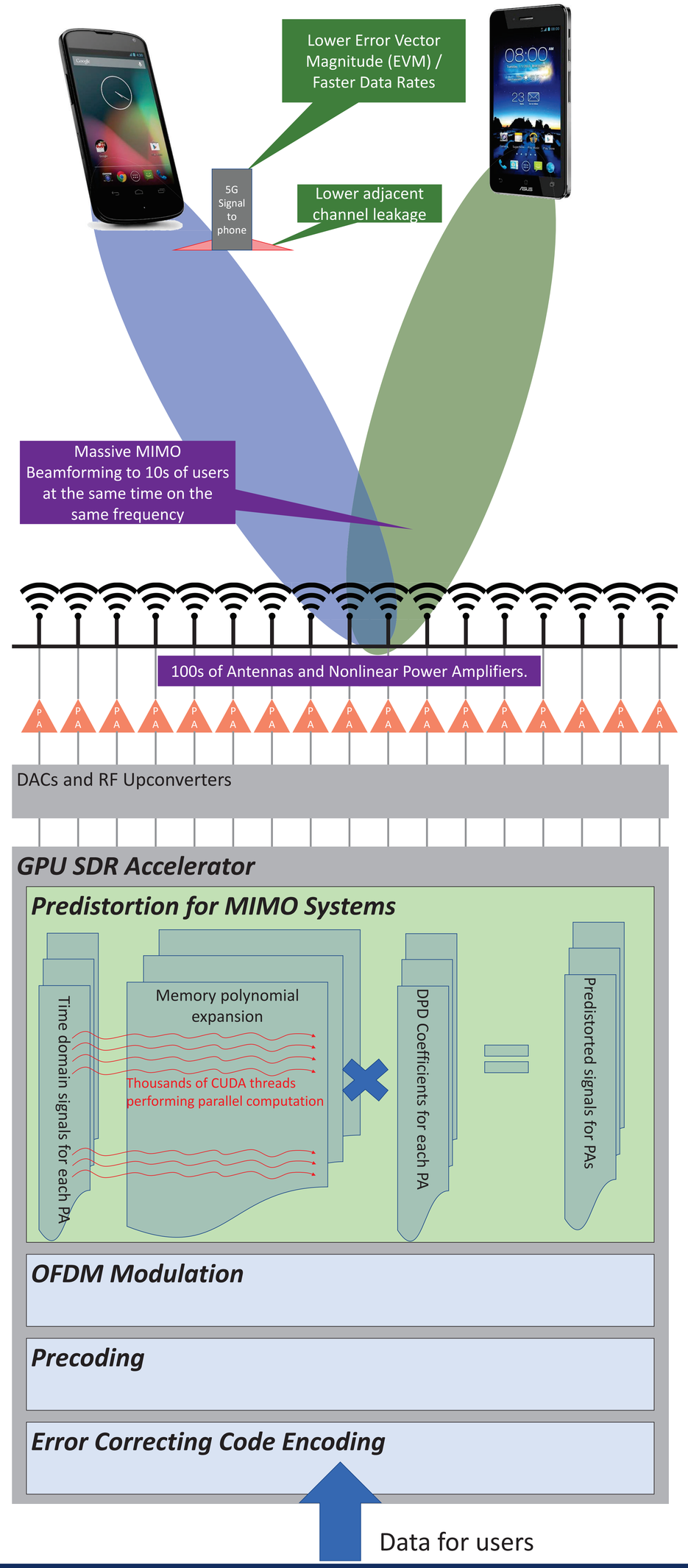
This Work: GPU-Based DPD Solution

Parallel processing on GPU for many antennas

- GPUs have thousands of cores
- Single instruction multiple thread programming fits for doing DPD for many antennas

Massive MIMO for 5G and Our GPU Predistortion Solution

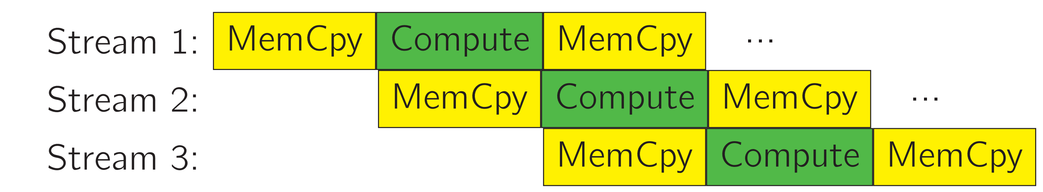
GPUs offer flexible, high-performance platform for computing DPD and other massive MIMO baseband tasks.



Optimizations for the GPU

To further improve the GPU performance, we implement the following optimizations:

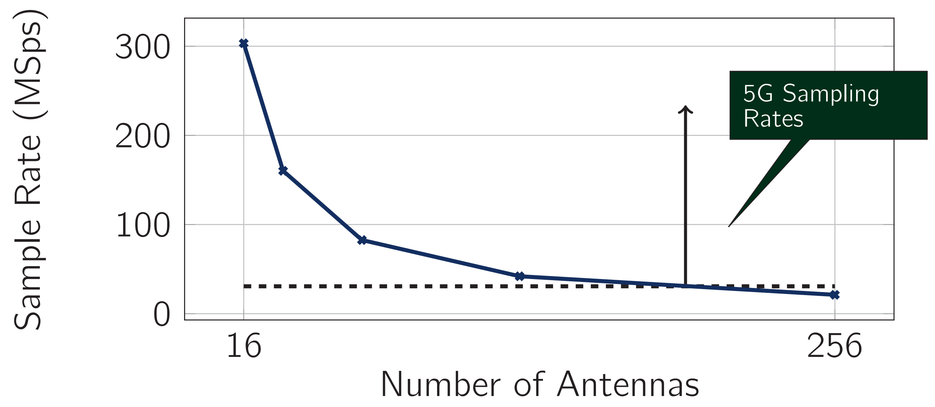
- Multiple GPU Streams
  - Reduces latency
  - Overlaps memory transfers to-and-from device with computation on the device.



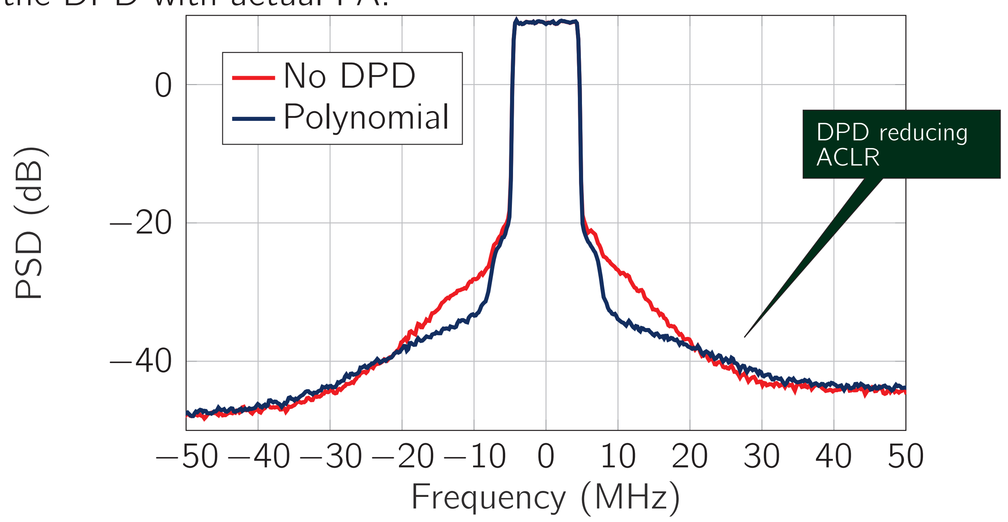
- Reduced Precision
  - 16 bit half data types to cut memory transfers in half.
- Efficient storage of PA DPD coefficients
  - Utilizing the GPU's constant memory for rapid access to coefficients

Results

Able to predistort at 5G sample rates for more than 128 antennas. This can correspond to high data-rate signals for up to 16 users.



Linearization is able to suppress the adjacent channel when testing the DPD with actual PA.



Conclusions Currently, there are few DPD for MIMO systems in the literature. We present a GPU-based solution and show that the parallelism in GPUs help to meet the predistortion challenges for massive MIMO systems in 5G.

Future Work:

- Add in antenna crosstalk compensation.
- Integrate with other MIMO baseband tasks.