F1: Beamforming Techniques and RF Transceiver Design

Vector Modulation Techniques and Interference Nulling

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Will Future Phased-Array Systems be Fully Digital

- As with most things, the answer is YES and NO
- Commercial low-GHz systems
  - Up to 40 MHz
  - 9-10 bit Sigma-Delta ADC’s are compact and power efficient (< 30 mW)
  - ADC power goes up rapidly if more bits and more BW is required → perhaps in military systems
  - Spatial multiplexing → fully digital required
- Moore’s law alone not sufficient. Digital ASIC implementations of MIMO have relied on architectural improvements
  - Examples → FFT engines for OFDM, MIMO decoders
Mm-wave beamformers

- Millimeter-wave systems
  - Phased-array necessary since LOS channel
  - Not known if spatial multiplexing similar to low-GHz systems is possible
  - Channel BW ~ 2GHz, ADC 4-6 bits @ 3-5 GS/s
    - Lots of activity in this speed-resolution space
    - Moore’s law directly aids ADC design in this space
  - Researchers are trying to increase data rate by simply adding channel BW
  - ADC’s will probably keep up
  - But digital power dissipation may prove prohibitive
  - Mixed-signal equalizer-demodulators attractive
UWB beamformers for pulsed-signals

- Attractive for imaging radar (e.g., GPR)
  - Need true-time delay for fixed beamformers
  - Need transversal filters for adaptive or frequency-shaping
  - Simple modulations
  - Analog/RF domain solutions are available for true-time delay
  - Back-end very simple (squaring + integration energy detection)
  - Equivalent time sampling may be possible if “image” does not change quickly → cuts ADC sampling rate but need very wide front-end BW