



A Survey of Millimeter Wave RF Design Approaches for 5G Cellular Communications

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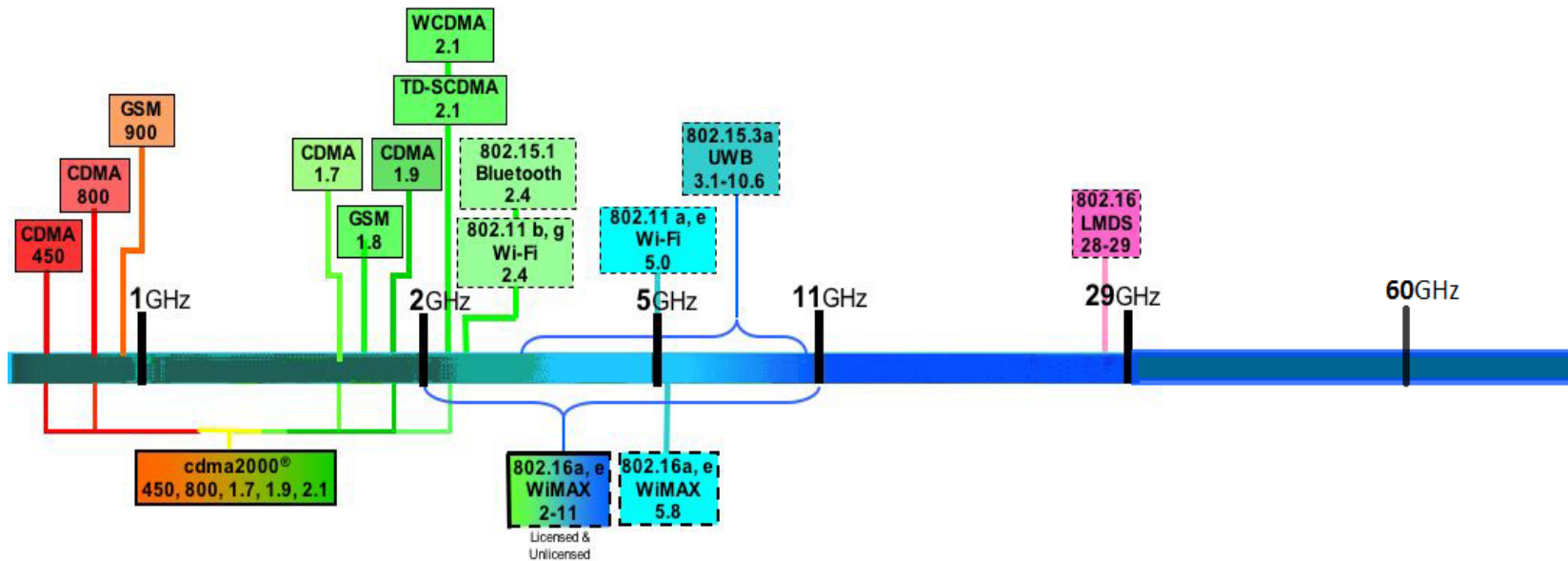
Jeffery H. Reed

Outline

- Introduction
- Classical Design
- Current State of **Art**
- **PA Trend**
- Simulation
- Conclusion

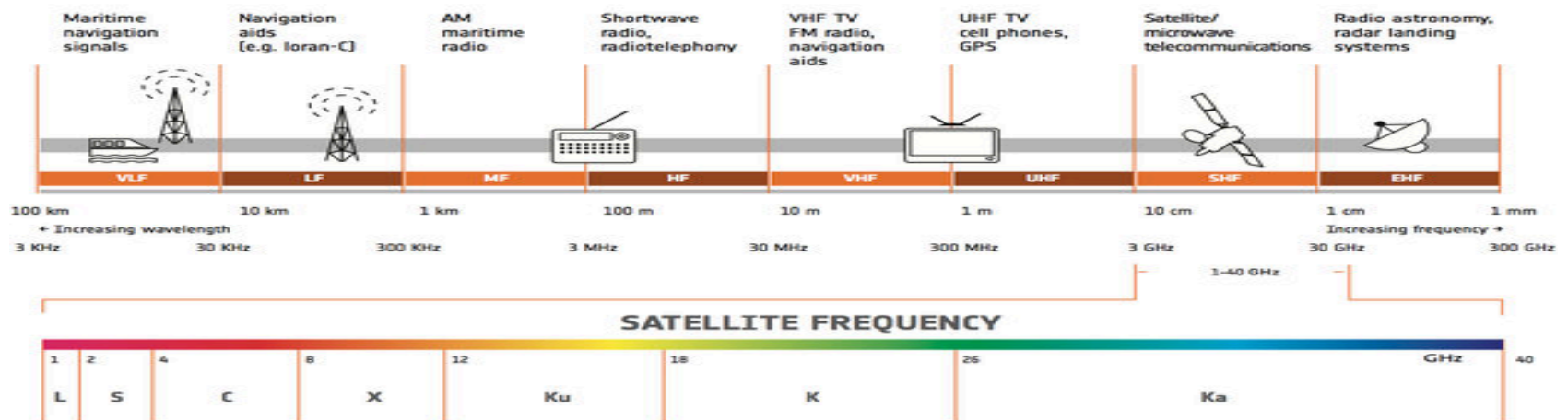
Introduction

- 5G
 - Why mmWave?



Introduction

- Current mmWave application
 - Meteorological satellite
 - Airport security scanner



Introduction

- Objective
 - Existing mmWave RF design
 - Advantages/disadvantages of employing existing cellular RF design for 5G

Classical Design

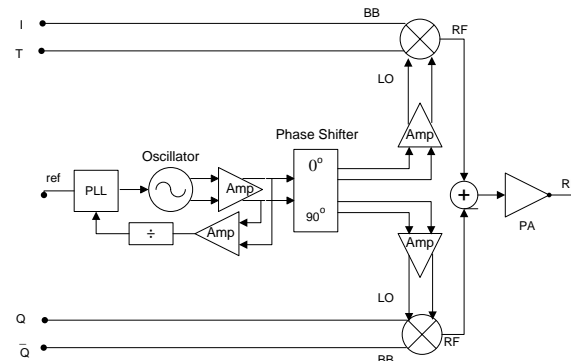
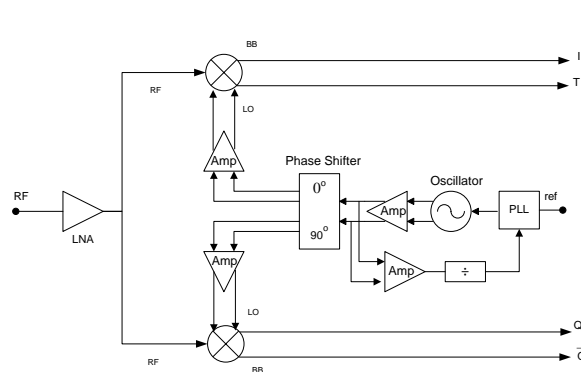
- Transmitter
 - Impulse Radio transmitter
 - Direct conversion transmitter
 - Two step transmitter

Classical Design

- Receiver
 - Non-coherent receiver
 - Coherent impulse radio receiver
 - Super heterodyne receiver
 - Direct conversion receiver
 - Image rejection receiver

Current State of Art

- Adopted direct conversion



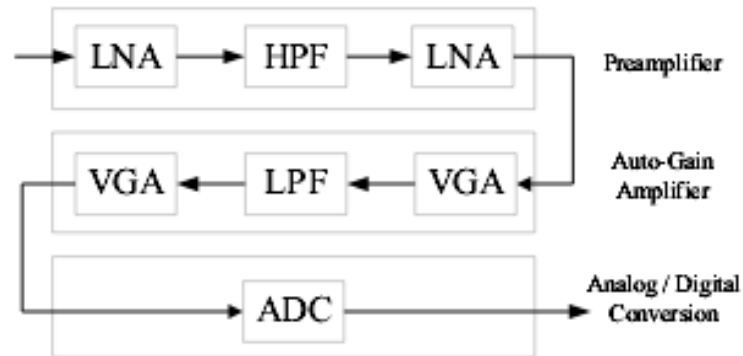
- Multipoint circuit

- Block Diagram Courtesy: M.M. Kraemer, "Design of a low-power 60 GHz transceiver front-end and behavioral modeling and implementation of its key building

block in 65 nm CMOS", University of Toulouse, January 2011

Current State of Art

- Linear frequency-modulated continuous wave (LFMCW) radar system

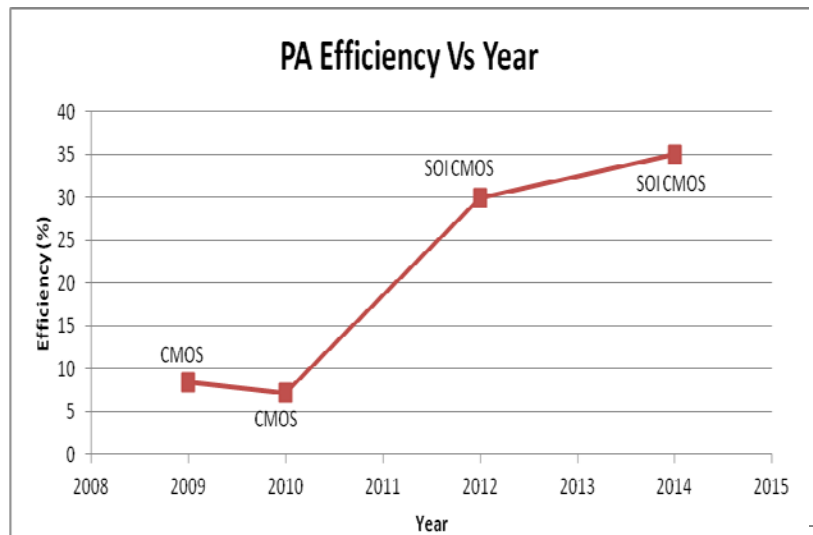
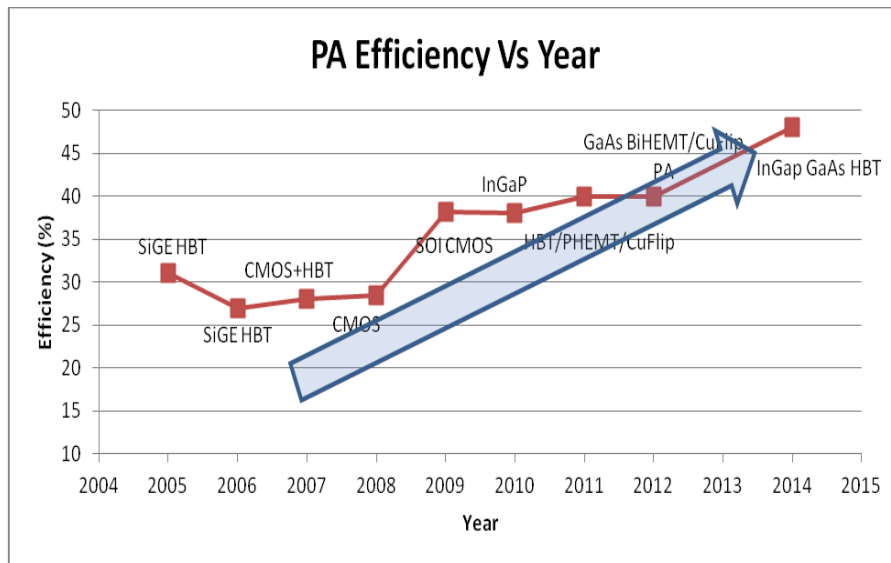


- Direct conversion
- Sub-harmonic down conversion

• Block Diagram Courtesy: Y. Bao, et.al; "Intermediate Frequency Circuit Design for a 60 GHz LFMCW Radar," Proc. ICMMT 2010

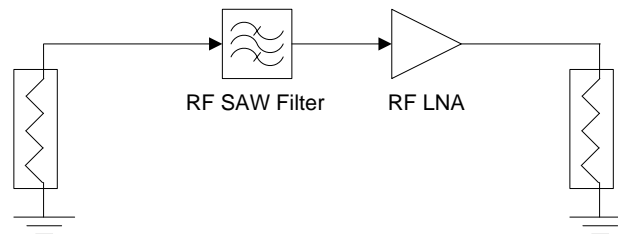
Power Amplifier (PA) Trend

- PA efficiency decreases as the RF Frequency increases.
- PA efficiency tends to increase as the technology grows over years.

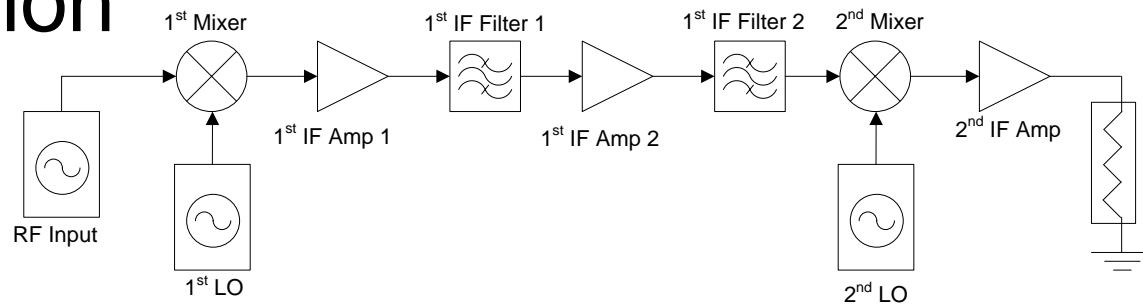


Simulation

- Superhetrodyne receiver architecture
- RF Section

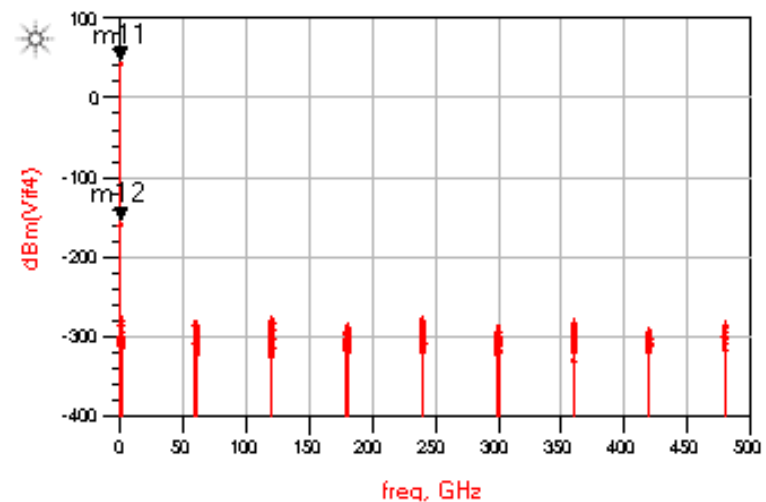
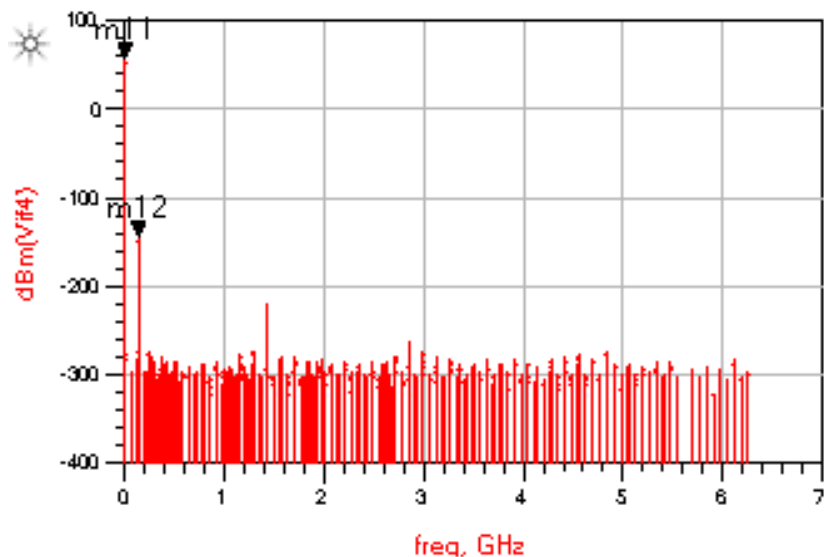


- IF Section



Simulation - Results

- 2nd IF Amplifier output at 700 MHz and 60 GHz



Conclusion

- Different architecture leads to different issues
 - Power amplifier efficiency
 - Image Rejection
 - Phase Noise



Questions