



mmWave Challenges for HW & Signal Processing

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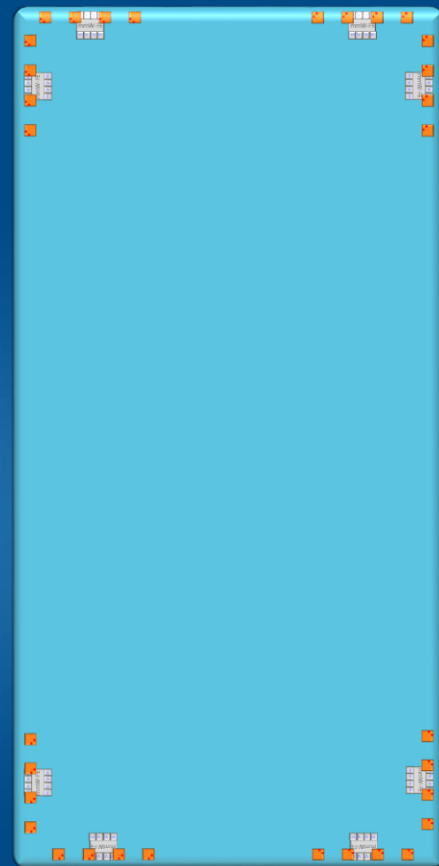
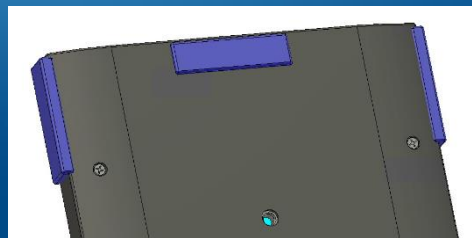
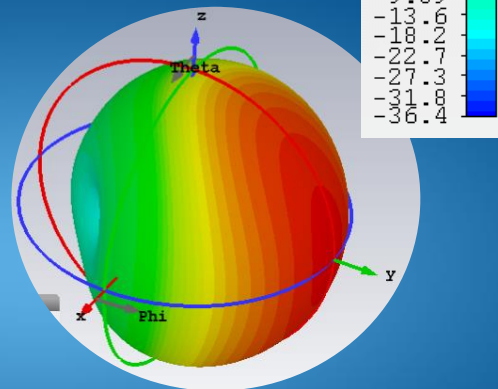


mmWave in a Mobile Form Factor

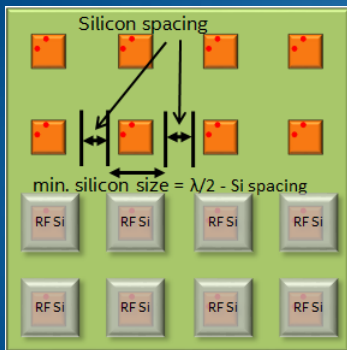
Fitting mmWave into a mobile device is challenging given limited space

Broadside arrays may not face in needed direction; requiring multiple arrays.

- Combination of edge facing and broadside arrays? How many?
- Optimum tradeoff for # elements vs Tx power per element?
- Does fewer elements help for beam acquisition? Does it hurt system performance due to interference?

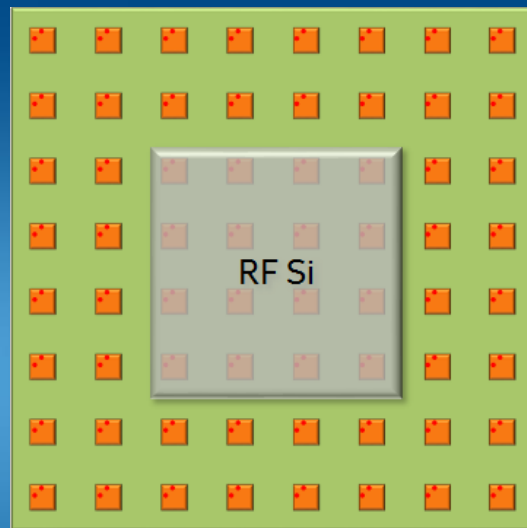


mmWave Silicon Partitioning – Antenna Array



One die per antenna element

- Optimal routing length/loss
- Very small and many die
- Many signals for RF phase control



One die per antenna array

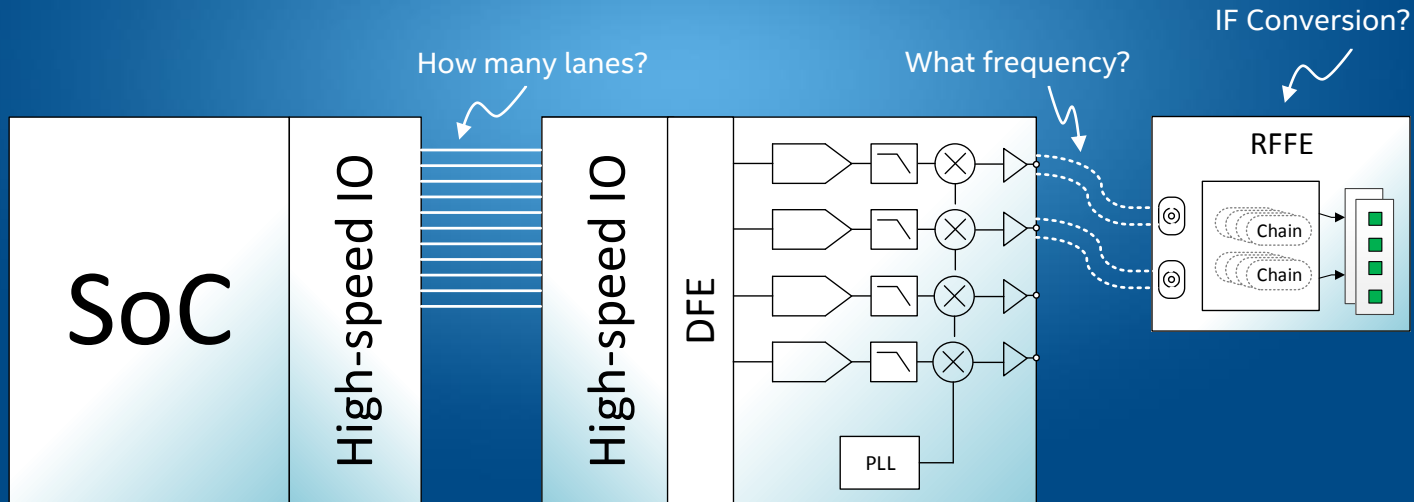
- Varying antenna feed lengths (delay and loss)
- Long feeds = large loss
- Thermal density challenges

mmWave Silicon Partitioning – Bits to Antenna

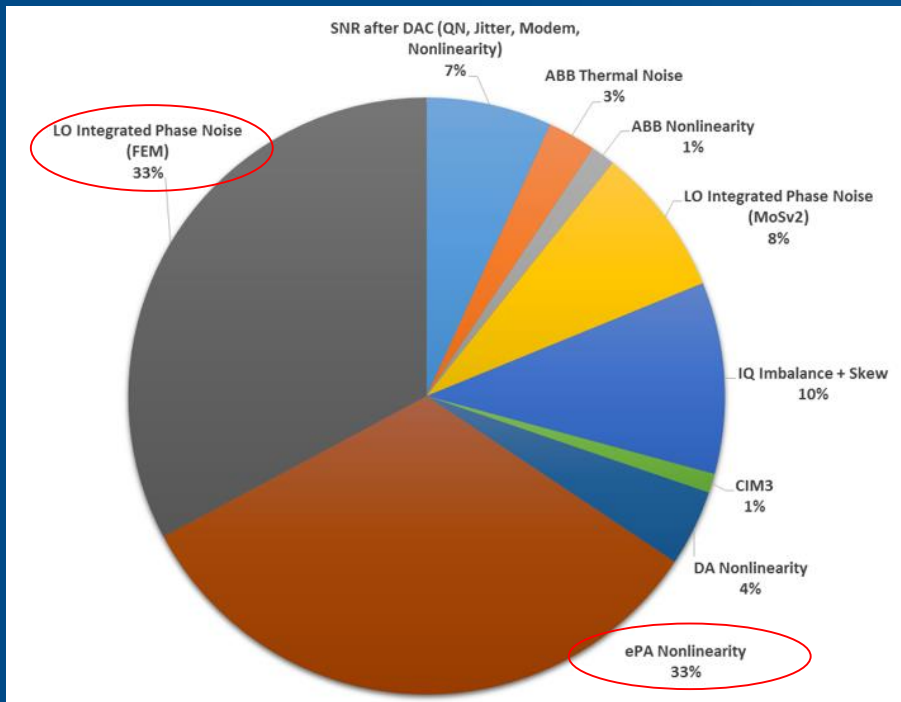
Form factor will dictate placement → up to 30cm routing for mobile devices

High frequencies = high insertion loss

What is the best silicon partitioning?



mmWave EVM Limitations

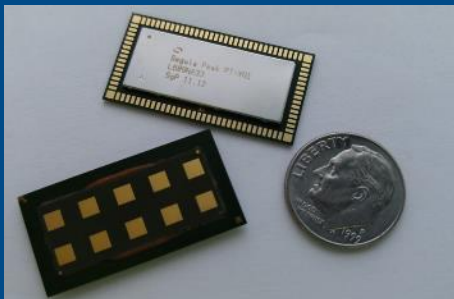


EVM Contributors (%) for mmWave system Tx

Integrated Phase Noise and PA nonlinearity are dominant EVM contributors

- DPD potential solution for PA efficiency vs linearity?
 - How to handle multiple PA's with single correction (analog beamforming)?
- Opportunities for phase noise cancellation?

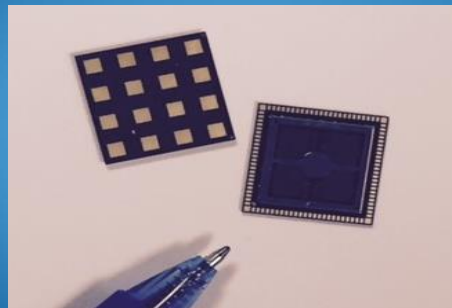
mmWave Device Examples



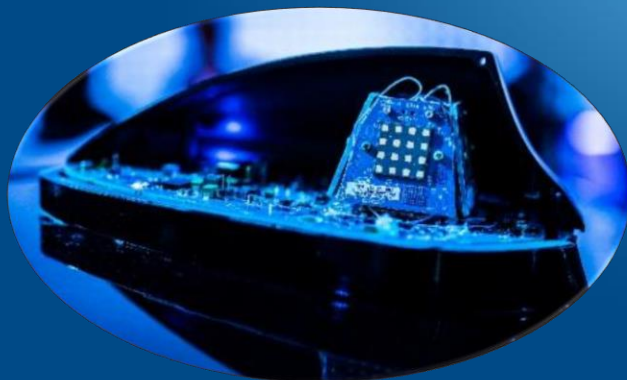
2x4 Dual-Pol. Array



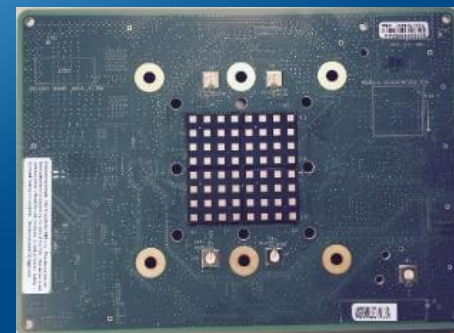
CPE



4x4 Dual-Pol. Array



Automotive



8x8 Dual-Pol. Array

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