A Modular Array Architecture for Millimeter Wave Massive MIMO Uplink

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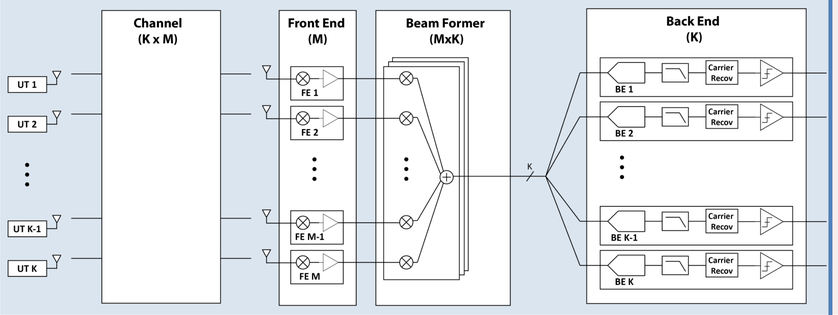
BWRC

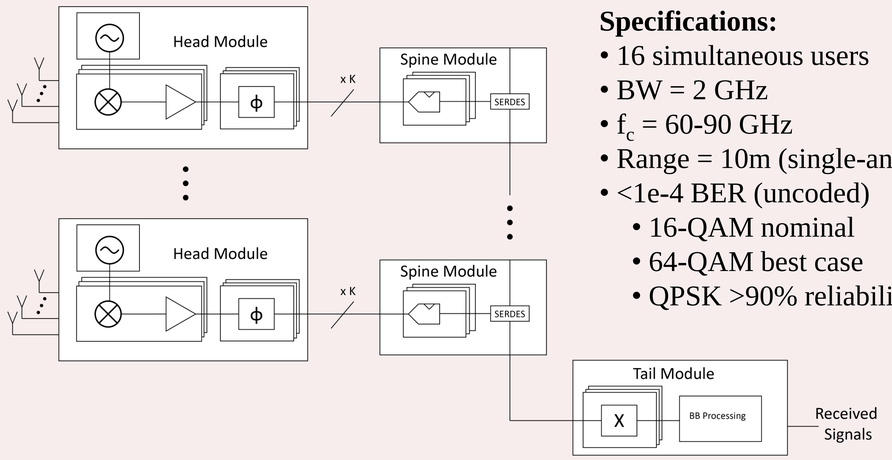
Motivation

Massive MIMO combines spatial multiplexing with phased arrays

- Multi-user operation (high capacity)
- Closed-loop channel estimation (no calibration)



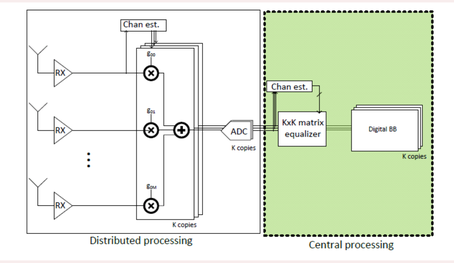
System Architecture and Specifications



Specifications:

- 16 simultaneous users
- BW = 2 GHz
- f_c = 60-90 GHz
- Range = 10m (single-antenna user)
- <1e-4 BER (uncoded)
  - 16-QAM nominal
  - 64-QAM best case
  - QPSK >90% reliability

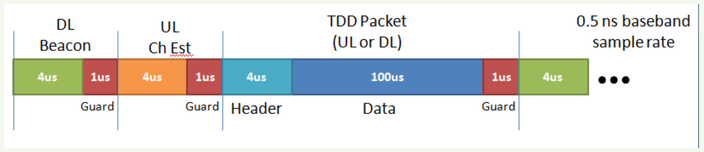
Hybrid BF architecture reduces implementation complexity

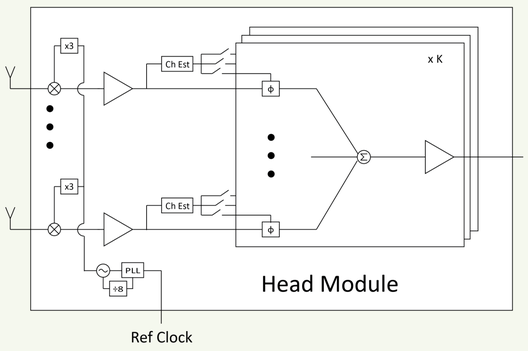


- Distributed channel est.
- Better design/assembly partitioning

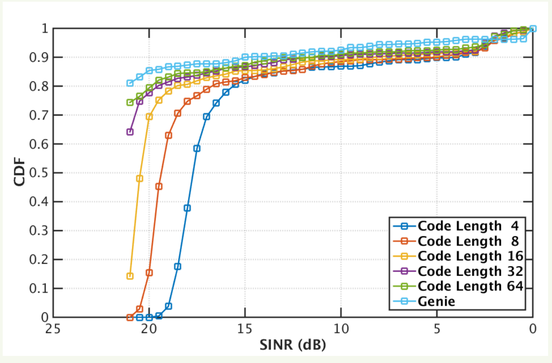
Head Module: mmW FE + Analog BF

TDD Frame Structure:



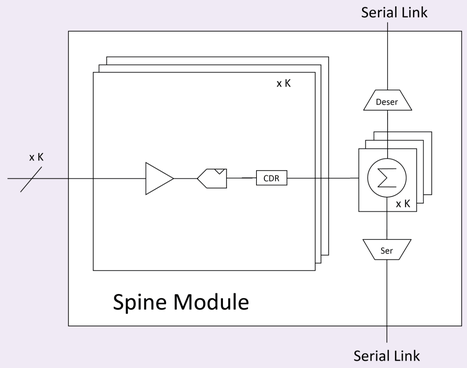


- 16 channel mixer first receiver
- Energy efficient LO architecture
- BB analog phase shifters
- Analog channel estimation

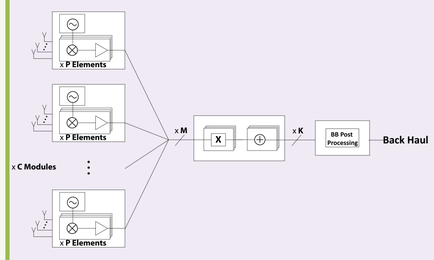


Coding gain enables per-element channel estimation with sufficient fidelity

Spine Module: Distributed combining

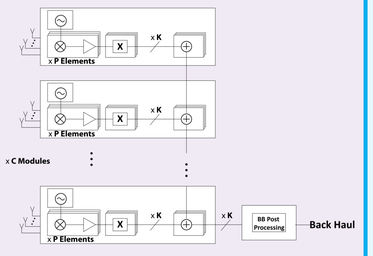


- Sub-array gain enables:
  - distributed timing recovery
  - reduced dynamic range for ADC
- Distributed summation leads to highly scalable arch.



Centralized combining:

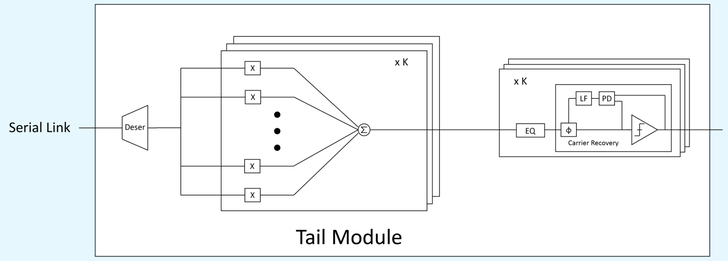
- Highest datarate scales with number of front ends



Distributed combining:

- Highest datarate scales with number of users

Tail Module: Zero-forcing + BB



- KxK ZF stage reduces computational complexity for same performance
- Per-user back-end uses conventional design

Hybrid BF achieves full performance of ZF with reduced complexity