# Journal Watch
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# Two-Dimensional AoD and AoA Acquisition for Wideband Millimeter-Wave Systems with Dual-Polarized MIMO

## Goal

- Two-dimensional AoD and AoA estimation techniques for wideband mmWave MIMO systems with dual polarized antennas

## Contributions

- Wideband angle estimation using multiple RF chains with dual polarized UPA
- Differential feedback for auxiliary beam pair design - To reduce the information feedback for AoD acquisition at the BS

**System Model:** Received signal in the $k^{th}$ subcarrier:

$$\mathbf{y}[k] = \mathbf{W}_{\mathrm{BB}}^{*}[k]\mathbf{W}_{\mathrm{RF}}^{*}\mathbf{H}[k]\mathbf{F}_{\mathrm{RF}}\mathbf{F}_{\mathrm{BB}}[k]\mathbf{s}[k] + \mathbf{W}_{\mathrm{BB}}^{*}[k]\mathbf{W}_{\mathrm{RF}}^{*}\mathbf{n}[k]$$

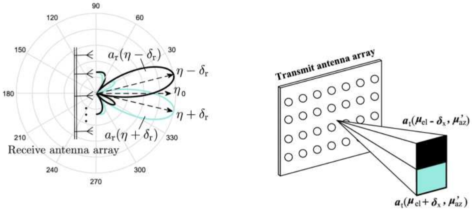
Dual Polarized Channel Model:

$$\mathbf{H}[k] = \sum_{r=1}^{N_{\mathrm{r}}} \rho_{\tau_r}[k]\left(\mathbf{X}_{\chi} \odot \left(\begin{bmatrix} g_r^{\mathrm{vv}} & g_r^{\mathrm{vh}} \\ g_r^{\mathrm{hv}} & g_r^{\mathrm{hh}} \end{bmatrix} \otimes \left(\mathbf{a}_{\mathrm{r}}(\psi_r)\mathbf{a}_{\mathrm{t}}^{*}(\theta_r, \phi_r)\right)\right)\right)\mathbf{R}_{\varsigma}$$

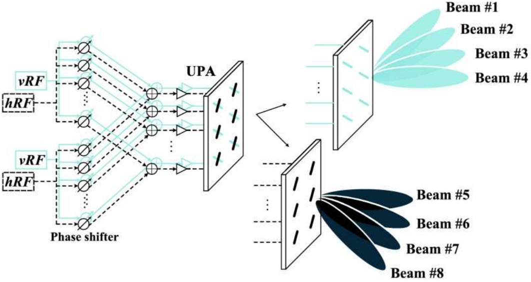
where

$$\mathbf{X}_{\chi} = \sqrt{\frac{1}{1+\chi}}\begin{bmatrix} 1 & \sqrt{\chi} \\ \sqrt{\chi} & 1 \end{bmatrix} \otimes \mathbf{1}_{\frac{M_{\mathrm{tot}}}{2} \times \frac{N_{\mathrm{tot}}}{2}},$$

Auxiliary Beam Pair enabled Two-Dimensional Angle Estimation:




(a) (b)



# Performance Analysis of a 5G Energy-Constrained Downlink Relaying Network with Non-Orthogonal Multiple Access

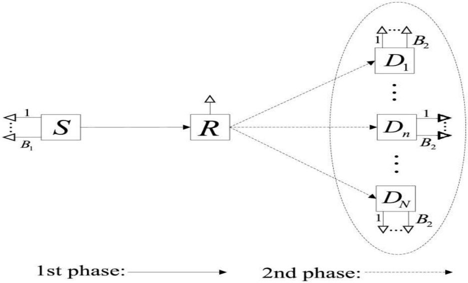
Goal

- Outage probability and ergodic rate analysis of a5G energy constrained network, where NOMA scheme is used for multiple users

Contributions

- Closed form expressions for the outage probability
- Lower bound of the outage probability
- Outage probability in the igh SINR regime
- Upper bound of the ergodic rate and analysis in the high SINR regime

System Model:



## System Model:

- Base station (BS) with multiple antennas, one relay node with single antenna and $N$ destination nodes with multiple antennas each
- Nakagami m-fading considered for all the channels
- First phase:
  - BS sends the superimposed signal to the relay node using transmit antenna selection (TAS) scheme
  - Imperfect CSI at the receiver

$$y_R = f\sqrt{P_1}\sum_{n=1}^{N} a_n x_n + v_1,$$

- Second Phase:
  1. Energy harvesting: Part of the power in the received signal used for energy harvesting
  2. Signal amplified by a factor of $G$ which depends of the transmit power
  3. Transmit to the destination
  4. MRC at the receiver using imperfect CSI and detection using successive interference cancellation
- Outage probability and ergodic rate analysis
- Verification of the theoretical results with simulations

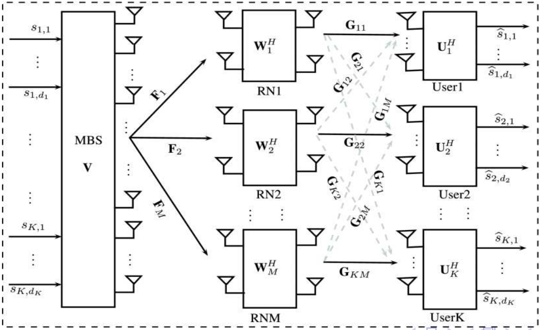
## Goal

- Interference alignment schemes for a MU half duplex AF-MIMO relay system

## Contributions

- Hybrid approach based on ZF and MMSE optimization criteria to deal with interference under perfect and imperfect CSI
- SNR gain of about 4 dB in comparison to a ZF approach
- Edge node SINR improvement by around 5 dB

## System Model:



- Estimated data streams at the $k$-th user

$$\widehat{\mathbf{s}}_k = \underbrace{\mathbf{U}_k^H \mathbf{H}_k \mathbf{V}_k \mathbf{s}_k}_{\text{Desired signal}} + \underbrace{\sum_{l=1, l \neq k} \mathbf{U}_k^H \mathbf{H}_k \mathbf{V}_l \mathbf{s}_l}_{\text{Interfering signals}} + \underbrace{\sum_{m=1}^{M} \mathbf{U}_k^H \mathbf{G}_{km} \mathbf{W}_m \mathbf{n}_m + \mathbf{U}_k^H \boldsymbol{\nu}_k}_{\text{Noise}} .$$

- Design precoder $\mathbf{V}_k$, combiner $\mathbf{U}_k$ to satisfy:

$$\sum_{l=1, l \neq k}^{K} \mathbf{U}_k^H \mathbf{H}_k \mathbf{V}_l = 0, \quad \forall l, k \text{ and } l \neq k, \tag{1}$$

$$\text{rank}\left(\mathbf{U}_k^H \mathbf{H}_k \mathbf{V}_k\right) = d_k, \quad \forall k. \tag{2}$$

- In addition to making interference leakage zero (good at high SNR), MSE is also minimized for improving the performance at low to moderate SNRs
  - Iterative algorithm
  - Relay matrix designed using ZF
  - Precoding and post processing filters designed by minimizing the MSE at each Rx (Alternating minimization)
  - For imperfect CSI case, expected values of the interference leakage and MMSE are minimized

# Other Interesting Papers

1. Achieving Near MAP Performance With an Excited Markov Chain Monte Carlo MIMO Detector
2. On the Performance of Millimeter Wave-Based RF-FSO Multi-Hop and Mesh Networks
3. Coverage Analysis of Multi-Stream MIMO HetNets With MRC Receivers
4. Aligning Power in Multiple Domains for Pilot Decontamination in Massive MIMO
5. Dynamic Cross-Layer Beamforming in Hybrid Powered Communication Systems With Harvest-Use-Trade Strategy
6. On Reusing Pilots Among Interfering Cells in Massive MIMO
7. Millimeter Wave Receiver Efficiency: A Comprehensive Comparison of Beamforming Schemes With Low Resolution ADCs