UNIVERSAL MIMO JAMMER MITIGATION VIA SECRET TEMPORAL SUBSPACE EMBEDDINGS

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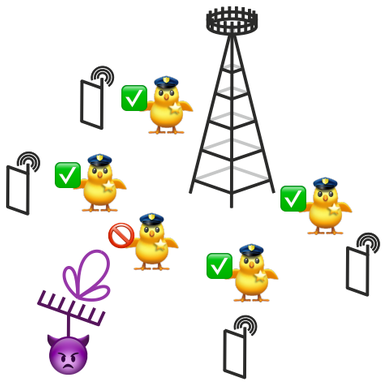
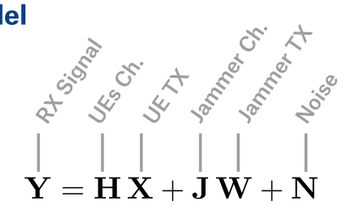
Jammers must be mitigated!

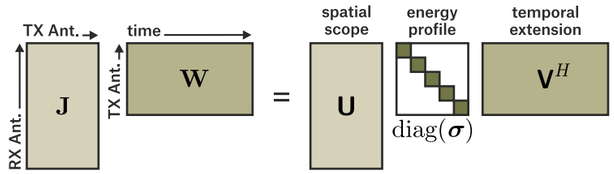


- MIMO enables jammer mitigation through spatial filtering
- Our method makes hard-to-mitigate **dynamic** jammers **static**

MU-MIMO model



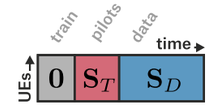
- The jammer interference can be characterized with a thin SVD



- For a **barrage jammer**, **V** is uniformly distributed

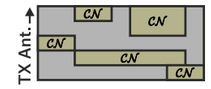
Existing approaches fail against dynamic jammers

- The jammer's spatial signature is often estimated with a **training period** where the UEs do not transmit, $\mathbf{X} = [\mathbf{0}, \mathbf{S}_T, \mathbf{S}_D]$

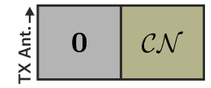


- This works against **barrage jammers**

- But it fails against **dynamic jammers**



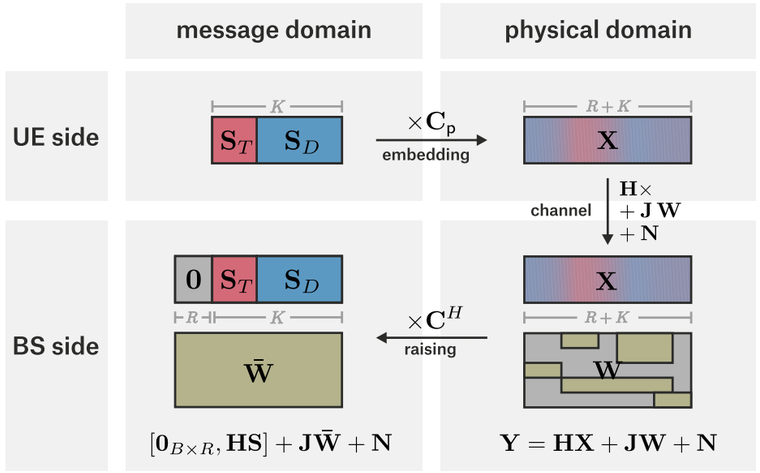
- And it fails against **data jammers**



Universal jammer mitigation with MASH

- The UEs and the BS construct a Haar distributed matrix $\mathbf{C} = f(\clubsuit) \in \mathbb{C}^{(R+K)\times(R+K)}$ based on a shared secret ♣
- $\mathbf{C}$ is split horizontally into $\mathbf{C}_\mathsf{o} \in \mathbb{C}^{R\times(R+K)}$ and $\mathbf{C}_\mathsf{p} \in \mathbb{C}^{K\times(R+K)}$
- The UEs **embed** a length-K signal $\mathbf{S} = [\mathbf{S}_T, \mathbf{S}_D]$ in the row-space of $\mathbf{C}_\mathsf{p}$ by transmitting $\mathbf{X} = \mathbf{S}\mathbf{C}_\mathsf{p}$
- The BS **raises** the signals by multiplying $\mathbf{Y}$ with $\mathbf{C}^H$

$$\mathbf{Y}\mathbf{C}^H = \mathbf{H}\mathbf{S}\mathbf{C}_\mathsf{p}\mathbf{C}^H + \mathbf{J}\underbrace{\mathbf{W}\mathbf{C}^H}_{\triangleq\bar{\mathbf{W}}} + \underbrace{\mathbf{N}\mathbf{C}^H}_{\triangleq\bar{\mathbf{N}}}$$
$$= [\mathbf{0}_{B\times R}, \mathbf{H}\mathbf{S}] + \mathbf{J}\bar{\mathbf{W}} + \bar{\mathbf{N}},$$



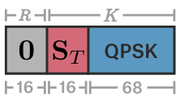
MASH transforms all jammers into barrage jammers:

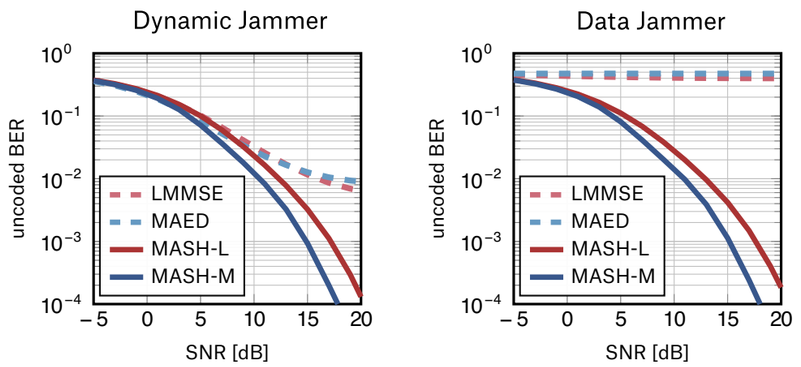
Theorem: Consider the jammer interference $\mathbf{J}\mathbf{W}$ with spatial scope **U**, temporal extension **V**, and energy profile $\boldsymbol{\sigma}$. Then the *raised* interference $\mathbf{J}\bar{\mathbf{W}}$ has identical spatial scope and energy profile, but its temporal extension $\bar{\mathbf{V}}$ is uniformly distributed.

- Variant I (**MASH-L**): Combine MASH with an LMMSE filter for linear jammer mitigation
- Variant II (**MASH-M**): Combine MASH with the nonlinear mitigation method MAED from [3]

Simulation results

- We compare **MASH-L** and **MASH-M** against their non-MASH counterparts **LMMSE** and **MAED**
- 3GPP 38.901 UMa channels, 64 BS antennas, 16 UEs, 10-antenna jammer, and the frame parameters are:





Key takeaways

- MASH makes hard-to-mitigate dynamic jammers static
- MASH is the **first method** to mitigate **all** jammers
- MASH works with linear and nonlinear mitigation methods

References

[1] Do, *"Jamming-resistant receivers for the massive MIMO uplink,"* 2018
[2] Hoang, *"Suppression of multiple spatially correlated jammers,"* 2021
[3] Marti, *"Mitigating smart jammers in multi-user MIMO,"* 2023

Link to the Paper