

## Introduction

Channel state information (CSI) is crucial for FDD MIMO systems.

We focus on task-oriented (semantic) compression:

- **Task:** MIMO precoding
- **Goal:** minimal CSI feedback overhead with maximal achievable rate

## System Model

- MIMO system: one BS with  $N_t$  antennas,  $K$  single-antennas users
- Downlink signal with linear **precoding**:  $\mathbf{x} = \sum_{k=1}^K \mathbf{v}_k s_k = \mathbf{V}\mathbf{s}$
- Received signal at  $k$ -th user:  $y_k = \mathbf{h}_k^H \mathbf{v}_k s_k + \sum_{j \neq k} \mathbf{h}_k^H \mathbf{v}_j s_j + z_k$
- **Metric:** sum of achievable rates

$$R = \sum_{k=1}^K R_k = \sum_{k=1}^K \log_2 \left( 1 + \frac{|\mathbf{h}_k^H \mathbf{v}_k|^2}{\sum_{j \neq k} |\mathbf{h}_k^H \mathbf{v}_j|^2 + \sigma^2} \right) \quad (1)$$

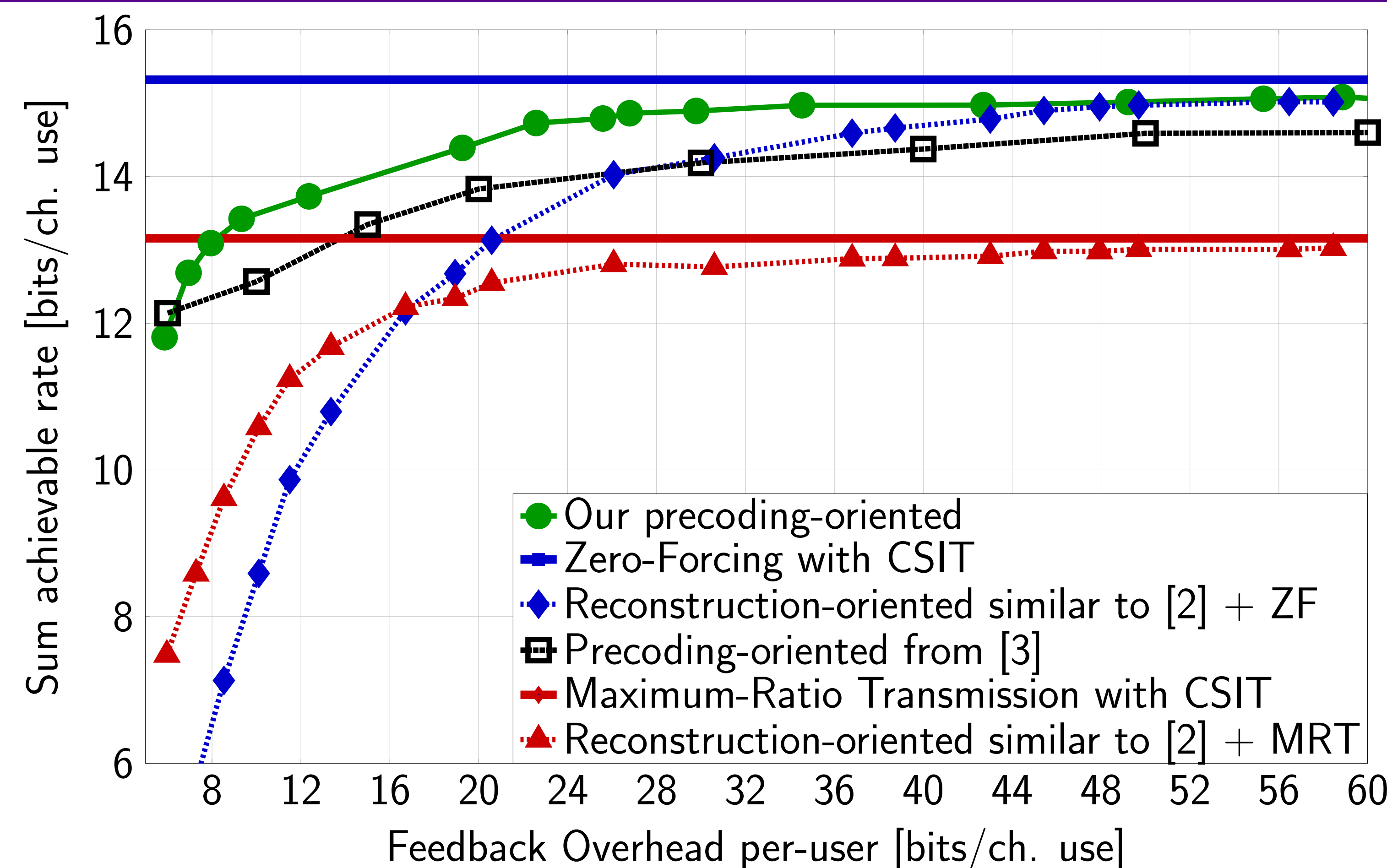
## Optimization

Loss function including three possible metrics:

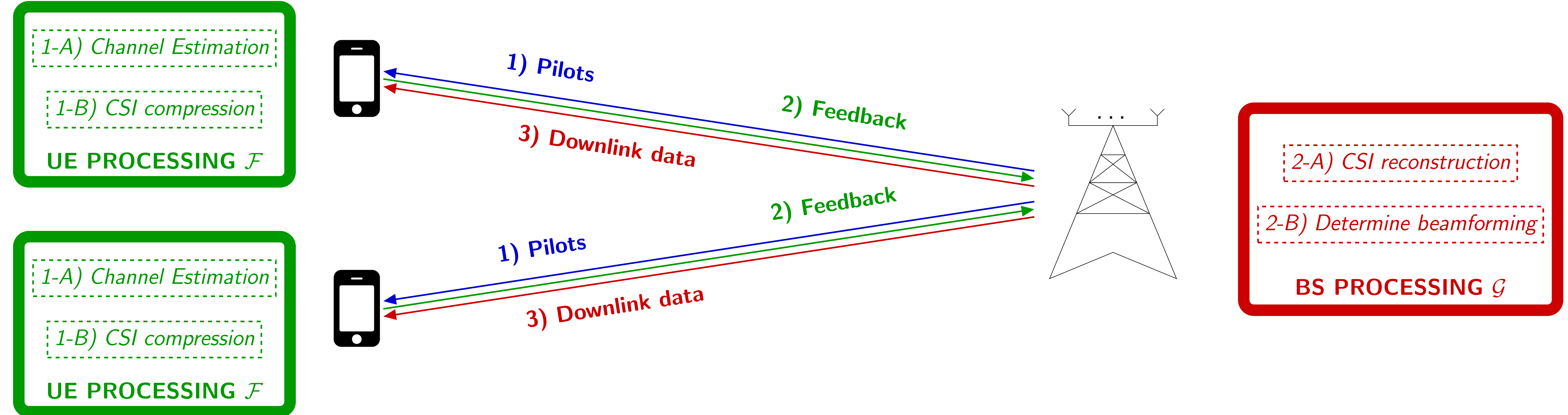
$$\mathcal{L}(\theta, \phi, \psi) = \mathcal{O} - \lambda \mathcal{R} + \gamma \mathcal{D}, \quad (2)$$

- Feedback overhead  $\mathcal{O}$ : entropy (feedback rate/overhead) of the pseudo-quantized features  $\tilde{\mathbf{t}}_k = \mathbf{t}_k + \text{quantiz.noise}$  as in [1].
- Performance  $\mathcal{R}$ : achievable rates with precoding  $\mathbf{V}$  according to (1).
- Distortion  $\mathcal{D}$ : reconstruction loss when estimating channels  $\hat{\mathbf{H}}$  (e.g., MSE).
- $\lambda$  and  $\gamma$  determine the tradeoff between the three components.
- Precoding-oriented corresponds to  $\{\lambda > 0, \gamma = 0\}$ .

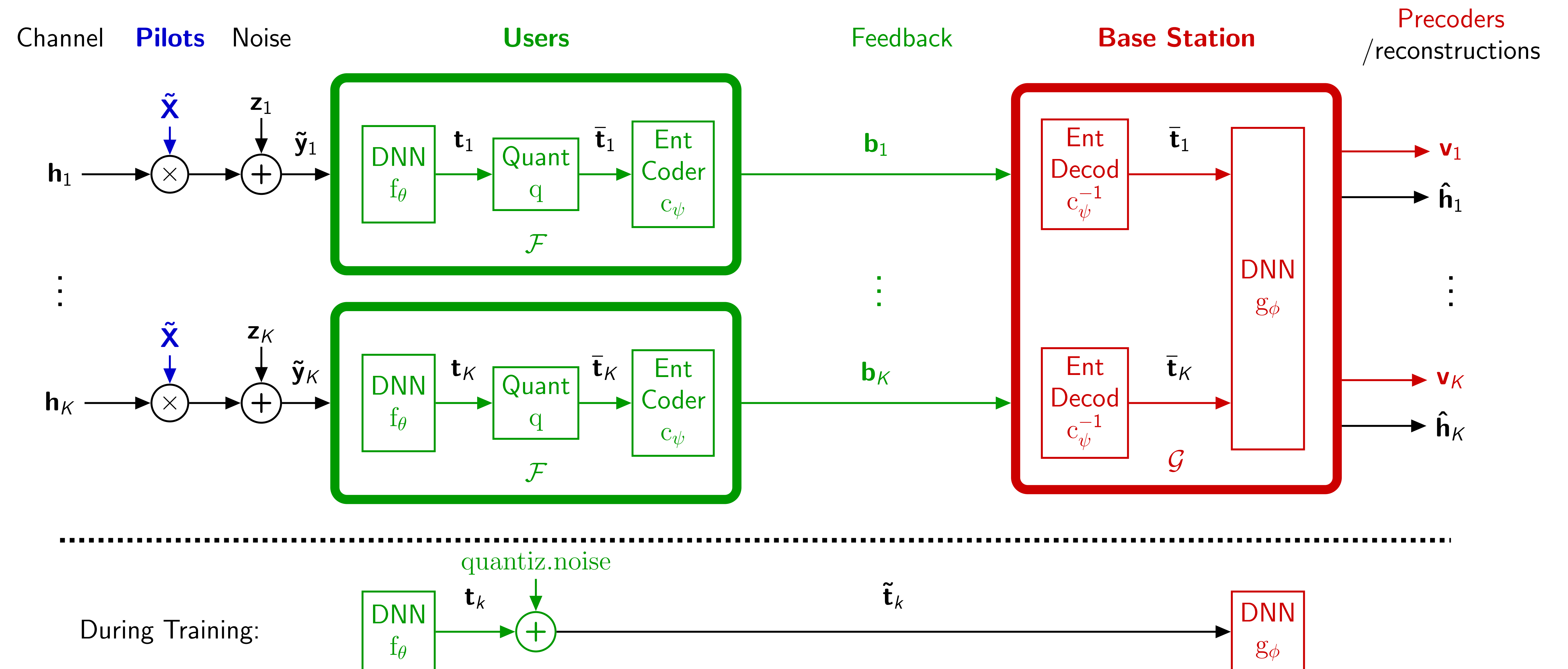
## Results: Feedback Overhead vs Users' Performance



## Conventional vs Semantic CSI



## Proposed CSI Feedback Architecture



## References

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- [2] M. B. Mashhadi, Q. Yang, and D. Gündüz, "Distributed deep convolutional compression for massive MIMO CSI feedback," *IEEE Transactions on Wireless Communications*, vol. 20, no. 4, pp. 2621–2633, 2021.
- [3] F. Sohrabi, K. M. Attiah, and W. Yu, "Deep learning for distributed channel feedback and multiuser precoding in FDD massive MIMO," *IEEE Transactions on Wireless Communications*, vol. 20, no. 7, pp. 4044–4057, 2021.
- [4] F. Carpi, S. Venkatesan, J. Du, H. Viswanathan, S. Garg, and E. Erkip, "Precoding-oriented massive MIMO CSI feedback design," in *(to appear) ICC 2023 - IEEE International Conference on Communications*, May 2023.

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