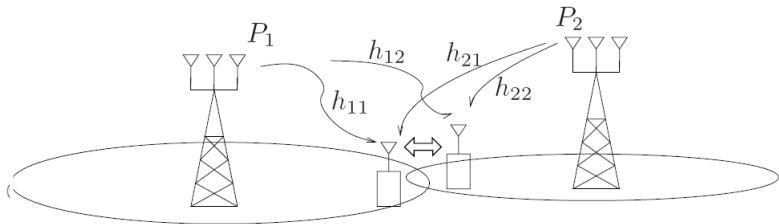


# Two-User Gaussian Interference Channel with Receiver Cooperation

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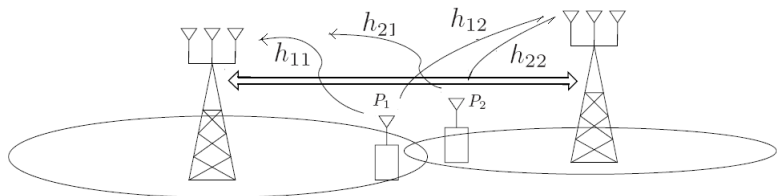
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## Motivation : Mobile Users at the Cell Edge



- Two users at the edge of their respective (adjacent) cells are close enough geographically to establish an independent communication link
- Can relay links be used for interference mitigation?

## Motivation : Multicell Processing



- Base stations that are connected via ideal backhaul links co-operate to mitigate intercell interference in the uplink
- Studied by Simeone *et al.* [3] using a 1-D cellular model with relay

## Two-User Gaussian Interference Channel with Relay Links

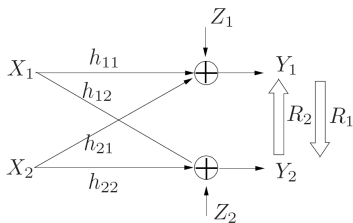


Figure: Gaussian interference channel with relay links

- Coding Strategies:
  - Han-Kobayashi common-private information splitting techniques for the interference channel
  - Decode-and-Forward or Quantize-and-Forward for the relay channel

## Related Work

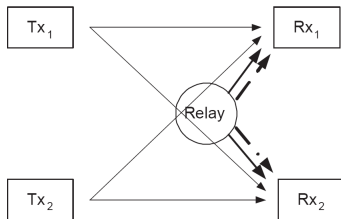
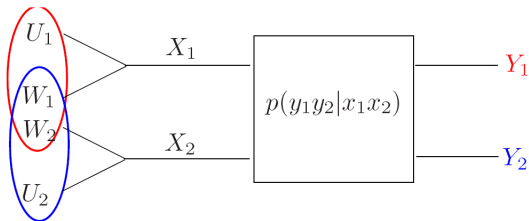


Figure: Interference channel with a relay

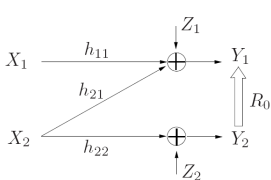
- Dabora *et al.* [4] study interference channels with relays
- Relay Strategies
  - Decode-and-Forward or Quantize-and-Forward to relay the intended signal
  - Interference Forwarding to relay the interfering signal

## Interference Channel : Han-Kobayashi scheme

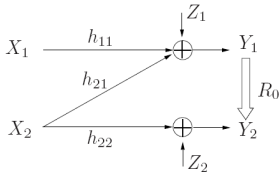


- Key idea : Partial interference subtraction
- Etkin, Tse and Wang recently showed that the Han-Kobayashi rate-region is within one bit of the capacity region

## Two simple models



(a) Type-I channel

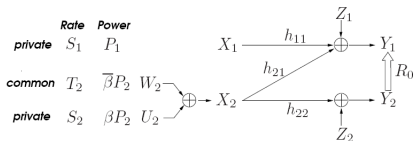


(b) Type-II channel

Figure: Gaussian Z-interference channel with a relay link

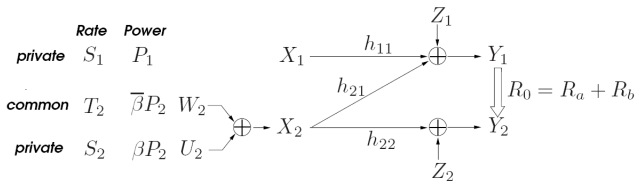
- One-sided interference channel with a relay link : studied by Yu and Zhou

## Type-I channel



- How can  $Y_2$  help  $Y_1$ ? Forward the interference to allow subtraction...
- Achievable rate region is based on the intersection of two multiple access regions:  $C_1 : (X_1, W_2) \rightarrow Y_2$  with  $R_0$ , and  $C_2 : (W_2, U_2) \rightarrow Y_2$ .
- Relay strategy : bin-and-forward

## Type-II channel



- How can  $Y_1$  help  $Y_2$ ?
- Decode and forward  $W_2$  using  $R_b$
- Quantize and forward  $h_{21}U_2 + Z_1$  using  $R_a$

## Current Work

Objective : To derive a one-bit result for the two-user Gaussian relay-interference channel

- Investigate combinations of the Han-Kobayashi common-private information splitting technique and various relaying strategies, to derive achievable rate-regions in different regimes for the general Gaussian interference channel with a relay link.
  - Starting point : Unidirectional links. The general setting can be viewed as a combination of the two types of Z-relay-interference channels, wherein a receiver may describe both common messages using bin indices, and describe the other user's private message using a quantize-and-forward strategy.
  - Investigate conferencing strategies

## Current Work

Objective : To derive a one-bit result for the Gaussian relay-interference channel

- Derive outer bounds for the capacity region of the two-user Gaussian interference channel with a relay link.
  - Traditional ideas : cut-set bound, asymptotic sum-capacity bound, extremal entropy bounds etc.
  - New ideas : genie-aided channels

## References

1. W. Yu and L. Zhou, "Gaussian Z-Interference Channel with a Relay Link : Achievability Region and Asymptotic Sum Capacity," submitted to *IEEE Transactions on Information Theory*, Sept. 2008.
2. R. Etkin, D. Tse and H. Wang, "Gaussian Interference Channel Capacity to Within One Bit," *IEEE Transactions on Information Theory*, Dec. 2008.
3. O. Simeone, O. Somekh, H. V. Poor and S. Shamai, "Local Base Station Cooperation Via Finite-Capacity Links for the Uplink of Linear Cellular Networks ," *IEEE Transactions on Information Theory*, Vol.55, No.1, Jan. 2009.
4. R. Dabora, I. Maric and A. Goldsmith, " Relay Strategies for Interference-Forwarding," 2008 IEEE Information Theory Workshop, Porto, Portugal, May 2008.