Bi-directional half duplex relaying protocols

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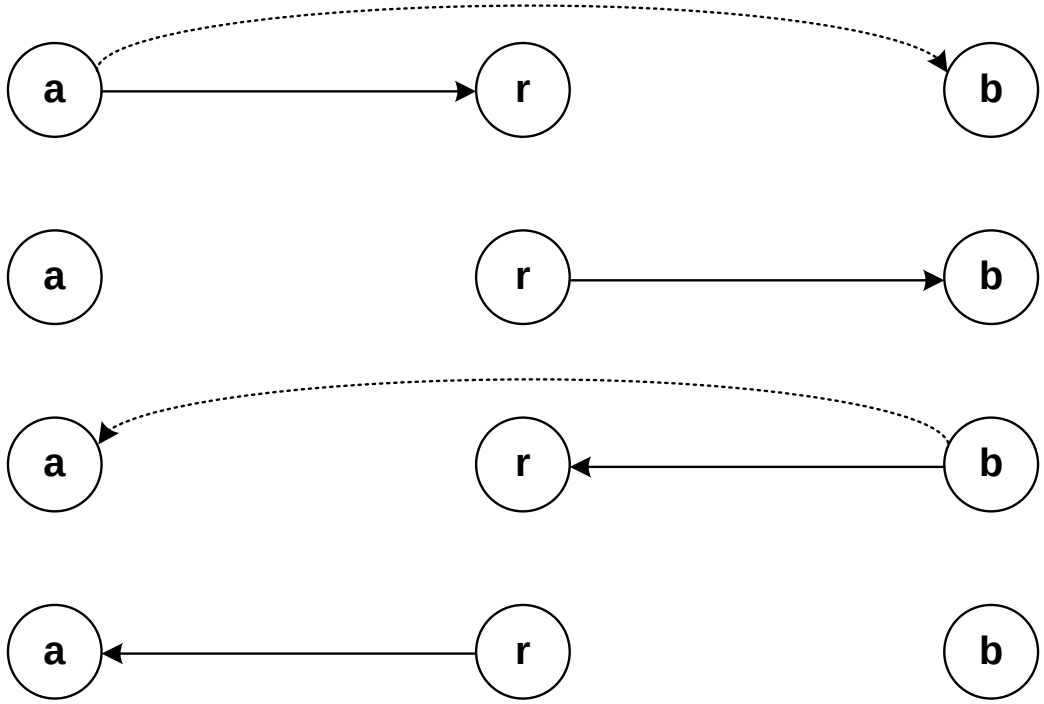
Introduction

- Bi-directional relaying communication

  -Two terminal nodes exchange messages over a ***shared half-duplex and memoryless*** channel with the help of a relay.



[Naïve four phase bi-directional cooperation]

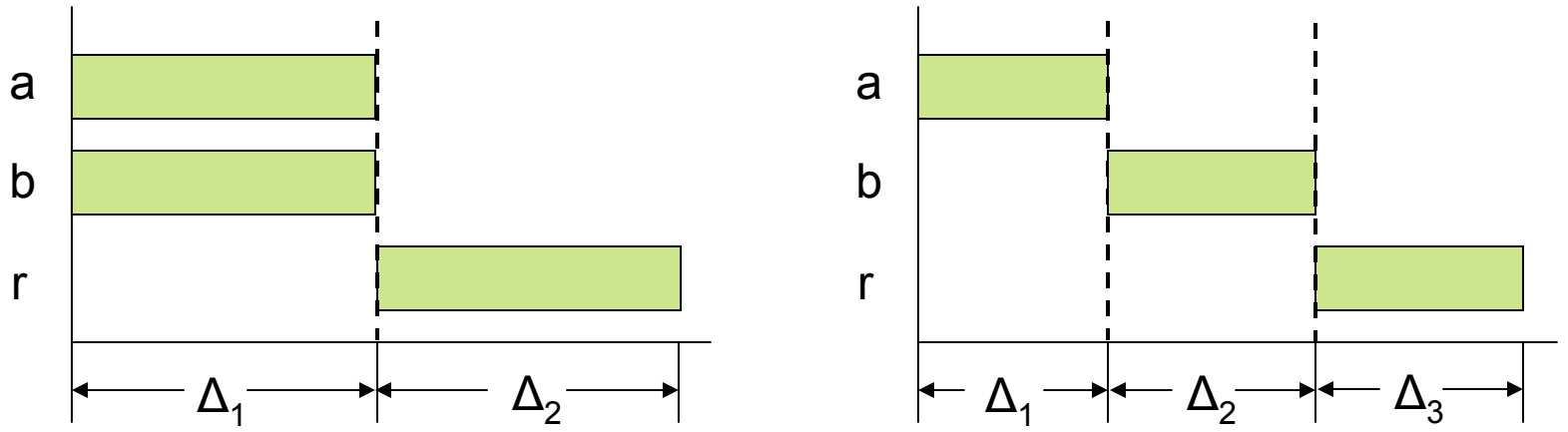
Introduction

- Comparison between four relaying schemes

Relaying	Complexity	Noise at relay	Relay needs
AF	very low	Carried plus noise at rx	Nothing
DF	high	Perfectly eliminated	full codebooks
CF	low	Carried plus distortion	$p(y_r)$
Mixed	moderate	Partially carried	one codebook, $p(y_r)$

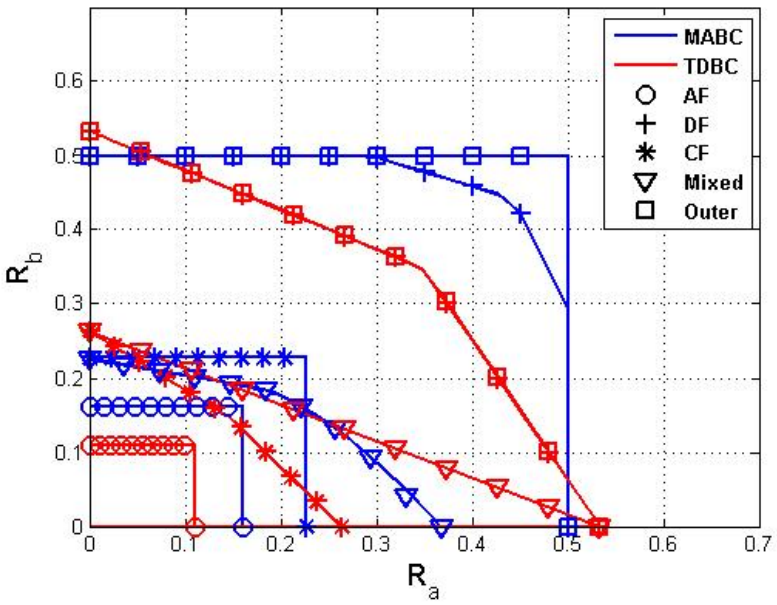
Single relay channel

- Protocols
  a) Multiple Access Broadcast (MABC)
  b) Time Division Broadcast (TDBC)

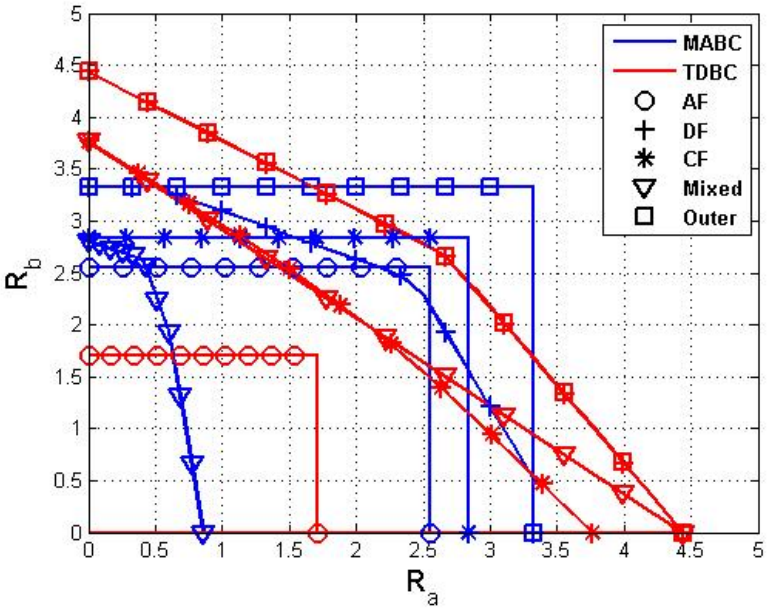


Single relay channel : $(h_{ar},h_{br},h_{ab}) = (1,1,0.3)$

0 dB



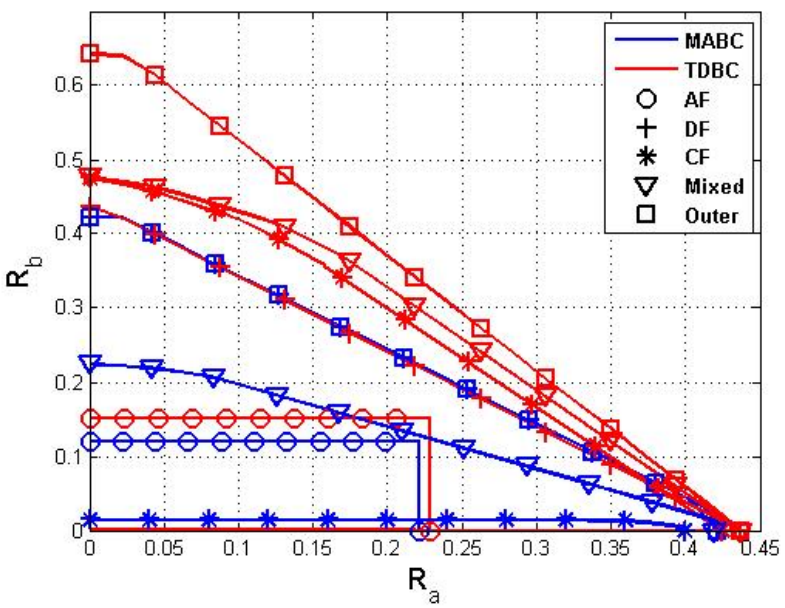
20 dB



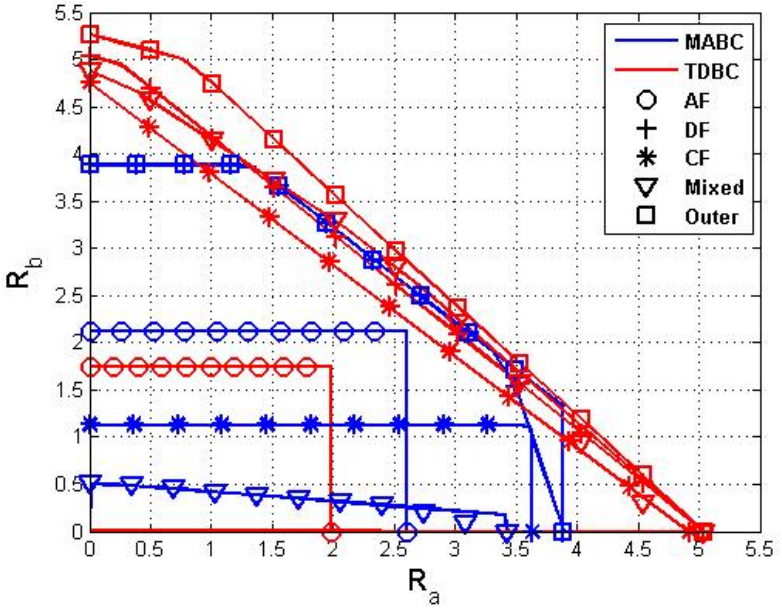
- In low SNR regime : DF MABC
- In high SNR regime : DF TDBC

Single relay channel : $(h_{ar},h_{br},h_{ab}) = (20,0.6,0.5)$

0 dB



20 dB



- In low SNR regime : Mixed TDBC
- In high SNR regime : DF TDBC or Mixed TDBC

Multiple relay channel

- ***(m,t) Multiple Hop Multiple Relay* (MHMR) protocol**

  m is the number of relays and **t** is the number of hops.

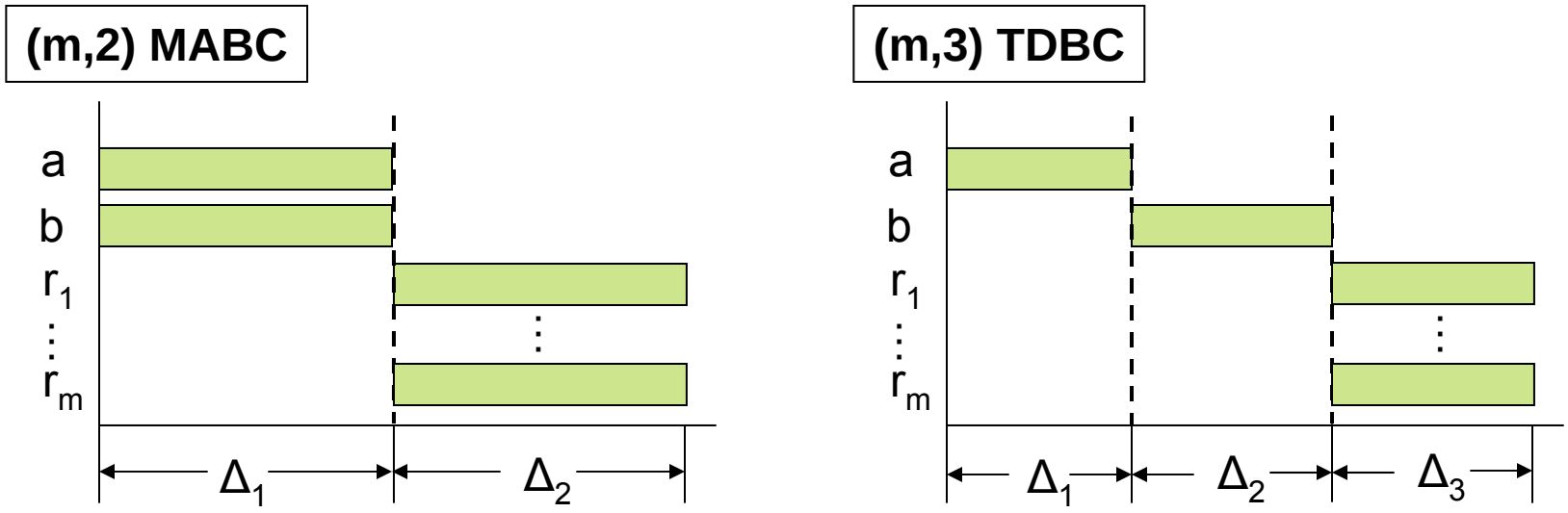
  - (m,2) MABC and (m,3) TDBC protocols

  Two protocols are the simplest cases of the (m,t) MHMR protocol directly extended from the single relay protocols.

  - (m,m+2) MHMR protocol

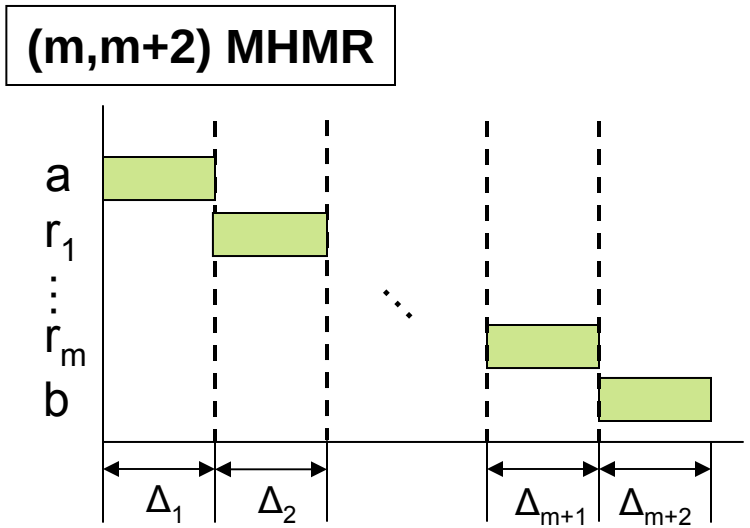
  Every intermediate hop has one relay in the (m,m+2) MHMR protocol. The total number of transmissions is reduced to m+2 and this is optimum since every node transmits at least once.

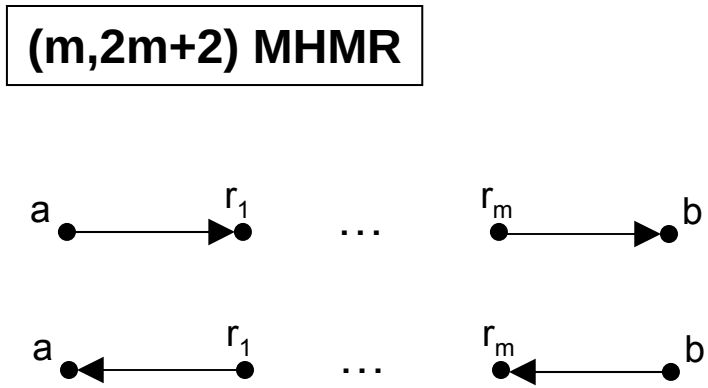
Multiple relay channel



- If r_i decodes w_a and w_b : $x_{r_i}(w_a,w_b)$
- If r_i decodes w_a only : $x_{r_i}(w_a)$
- If r_i decodes w_b only : $x_{r_i}(w_b)$
- Otherwise, r_i is silent.

Multiple relay channel

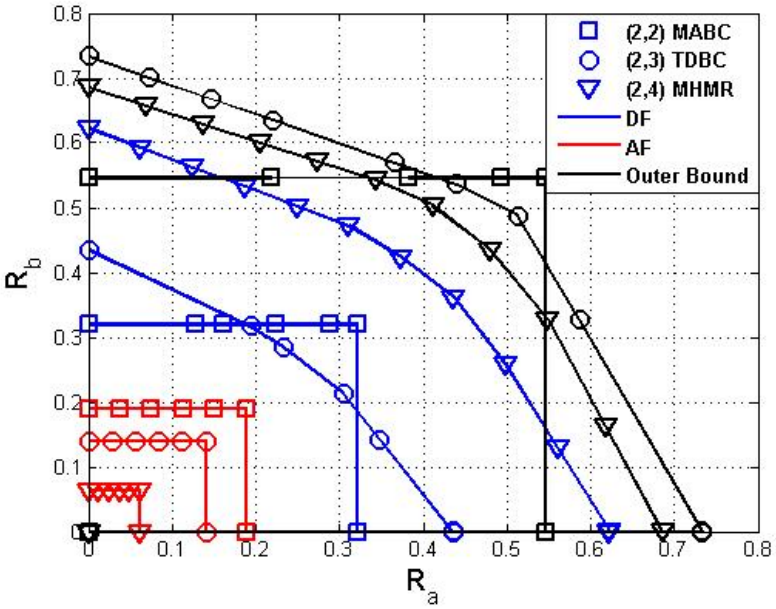




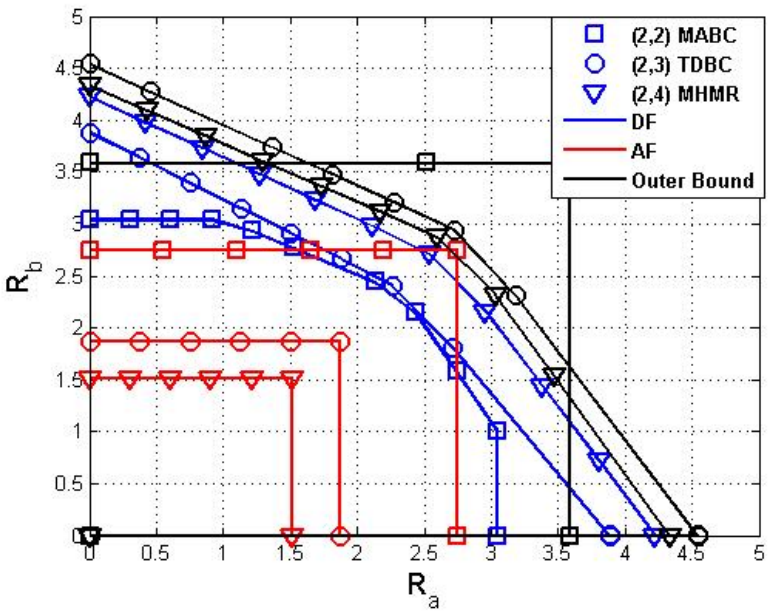
- Optimum serialized relaying protocol in terms of the number of hops

Multiple relay channel

0 dB



20 dB



- In low SNR : (2,4) DF MHMR
- In high SNR : (2,4) DF MHMR or (2,2) AF MABC

Conclusion

- We determine theoretical upper and lower bounds for various half-duplex bidirectional relaying protocols.

- We compare the relative performances of the proposed protocols in the Gaussian noise channel.

Publications

[Journal]

[1] **Sang Joon Kim**, Patrick Mitran, Vahid Tarokh, **"Performance Bounds for Bi-Directional Coded Cooperation Protocols",** IEEE Tran. Info. Theory, vol. 54, no. 11, pp. 5235-5241, Nov. 2008.

[2] **Sang Joon Kim**, Natasha Devroye, Patrick Mitran, Vahid Tarokh, **"Achievable rate regions for bi-directional relaying"**, Submitted to IEEE Tran. Info. Theory.

[3] **Sang Joon Kim**, Natasha Devroye, Vahid Tarokh, **"Bi-directional half-duplex protocols with multiple relays"**, Submitted to IEEE Tran. Info. Theory.

[Conference]

[1] **Sang Joon Kim**, Natasha Devroye, Vahid Tarokh, **"A class of Bi-directional multi-relay protocols",** in Proc. IEEE ISIT, 2009.

[2] **Sang Joon Kim**, Natasha Devroye, Patrick Mitran, Vahid Tarokh, **"Comparison of bi-directional relaying protocols",** in Proc. IEEE Sarnoff Sym., 2008.

[3] **Sang Joon Kim**, Patrick Mitran, Christina John, Reza Ghanadan, Vahid Tarokh, **"Coded Bi-directional Relaying in Combat Scenarios",** Milcom, Orlando, October 2007

[4] **Sang Joon Kim**, Patrick Mitran, Vahid Tarokh, **"Performance Bounds for Bi-Directional Coded Cooperation Protocols",** in Proc. IEEE ICDCS Conf., Toronto, Canada, June 2007