Scheduling for Amplify-and-Forward Cooperative Networks

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Presented by L. K. Chien

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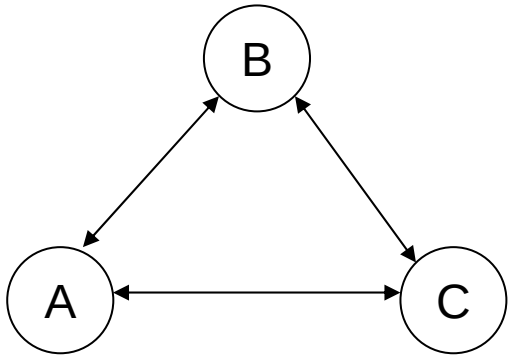
Outline

- Introduction
- System model
- Features of scheduling algorithm
- One source and select relay
- Three sources and select source
- Simulation
- Conclusion

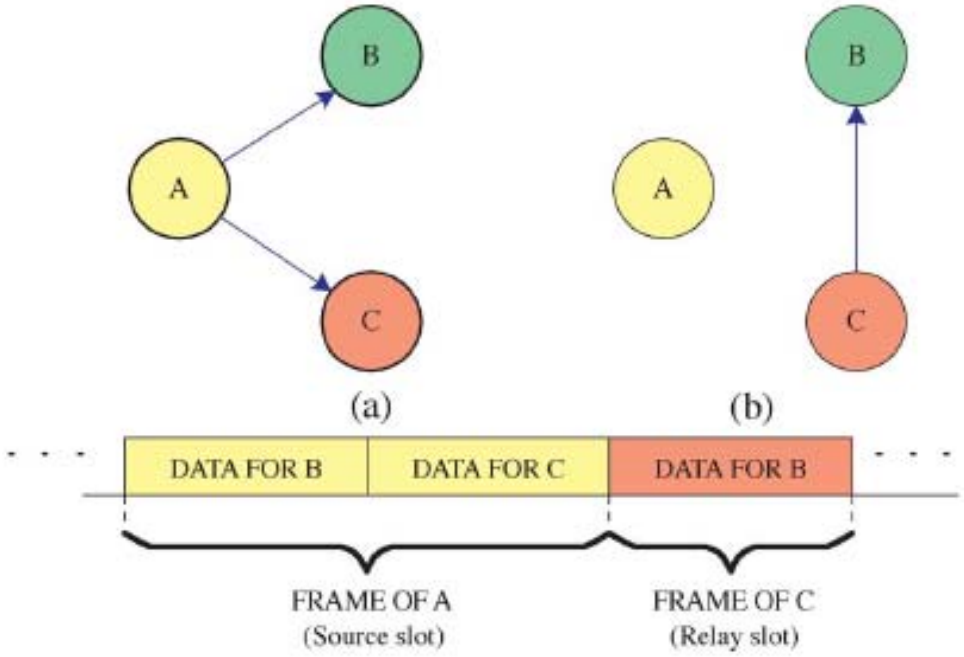
Introduction

- Consider a scenario of three nodes, each node has data for other two nodes.

- How to schedule the sequence of source, relay, and destination?



System model



System model

$$y_D^{(k)} = f_{i,k}x^{(k)} + n_{i,k}$$

$$y_D^{(j)} = f_{i,j}x^{(j)} + n_{i,j}$$

$$y_R^{(j)} = Gf_{k,j}(f_{i,k}x^{(j)} + n_{i,k}) + n_{k,j}$$

i: source j: destination k: relay

$y_D^{(k)}$: received signals of i→ k

$y_D^{(j)}$: received signals of i → j

$y_R^{(j)}$: received signals of i → k → j

n: noise

$x^{(k)}$: data for k

$f_{i,j}$: channel coefficient

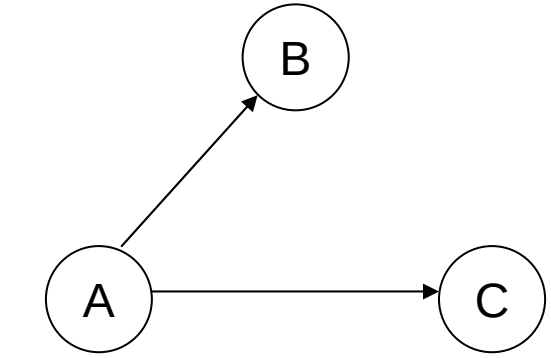
G: amplification factor

Features of scheduling algorithm

- Fairness
  - Shared resources.
  - Relay node with higher power consumption.
- Channel adaptation
  - Take channel condition into consideration.
- Distributed coordination
  - Complexity.

One source and select relay

- Consider that source A is determined, and A has data for B and C.
- Choose B or C as a relay node to amplify and forward?

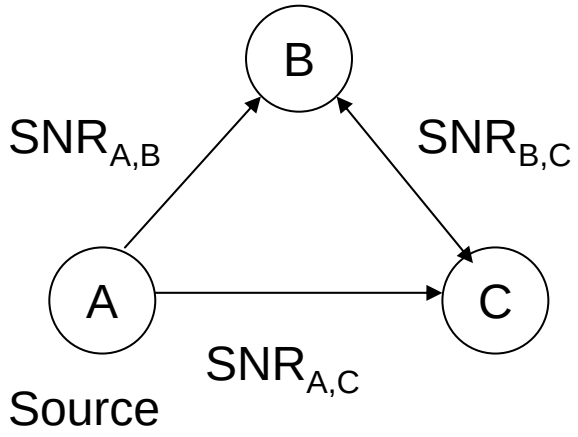


One source and select relay

- Round Robin (RR)
  - B and C are relay nodes by turns.
  - Fair, low complexity and distributed.

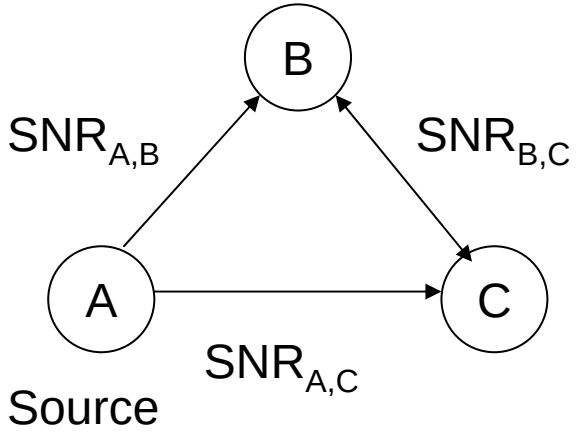
One source and select relay

- Relay for the worst link
  - Select a relay node with best instantaneous SNR of two direct links.
  - For example, if $SNR_{A,B} < SNR_{A,C}$, C is the relay node.



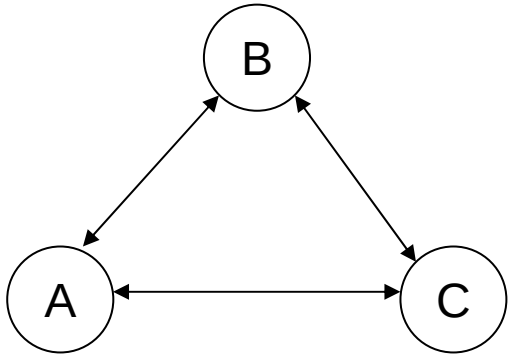
One source and select relay

- Relay for the worst link with normalization
  - Similar as “relay for the worst link”, but base on normalized SNR.
  - Normalized SNR
    = instantaneous SNR / average SNR.



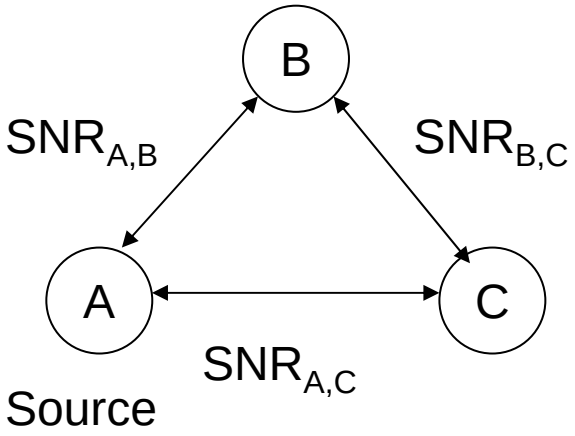
Three sources and select source

- A, B, and C have data to transmit to other two nodes.
- How to schedule that who is the next source?



Three sources and select source

- Optimal source selection
  - Select source with best two instantaneous direct links, but suffer from fairness problem.
  - If base on normalized SNR, fairness problem is solved.
  - Centralized, and need signal exchange.



Three sources and select source

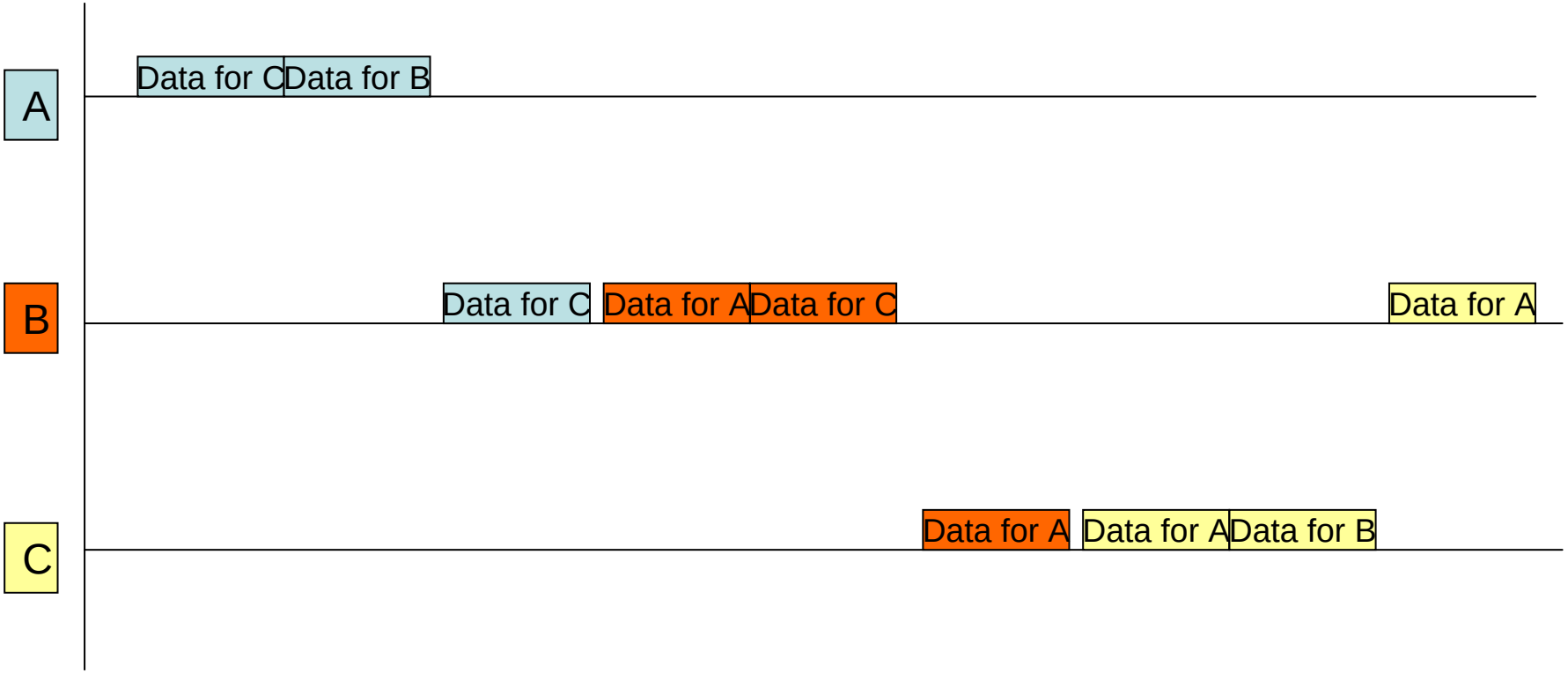
- RR source selection
  - Fair, low computational complexity, and distributed.
  - Select relay node according to normalized SNR.

Three sources and select source

- “Smart” RR source selection
  - The source is the relay in previous slot.
  - Ex. A is source, and B is relay in $slot_i$. Then B is source in $slot_{i+1}$.
  - The choice of relay is still based on normalized SNR.

Three sources and select source

- “Smart” RR source selection

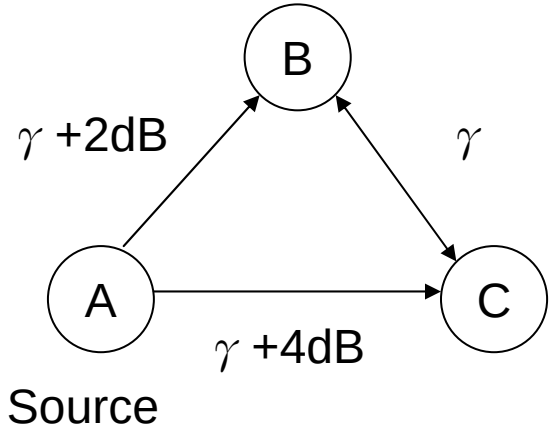


How about N >>3 ?

- Consider a network with many nodes.
  - If set a centralized controller to choose source and relay
    - N(N-1) parameter signals.
    - Update frequently.
  - If use proposed “smart” RR source selection + relay selection based on normalized SNR.
    - No parameter signals.
    - Solve fairness problem.
    - Distributed and low complexity.

Simulation

- Assume A is source, and B,C are destinations.
- Evaluate different scheduling scheme.



Simulation-relay selection

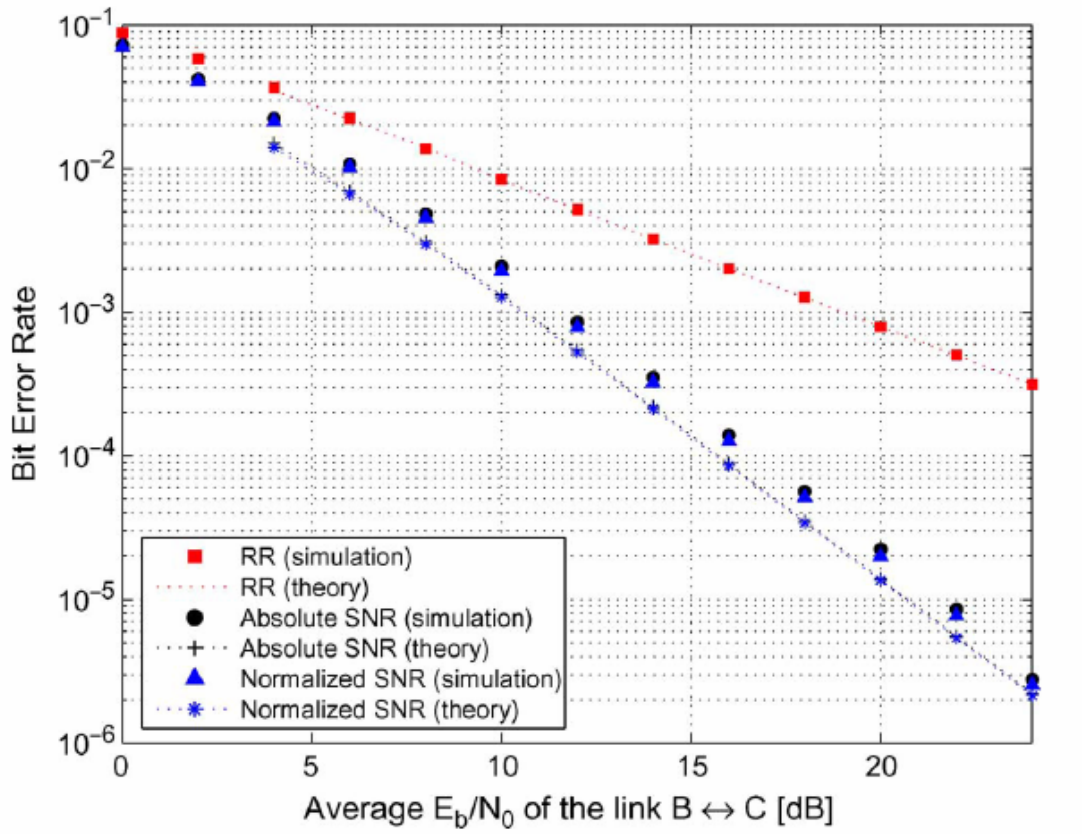


Fig. 2. BER performance for the node B.

Simulation-relay selection

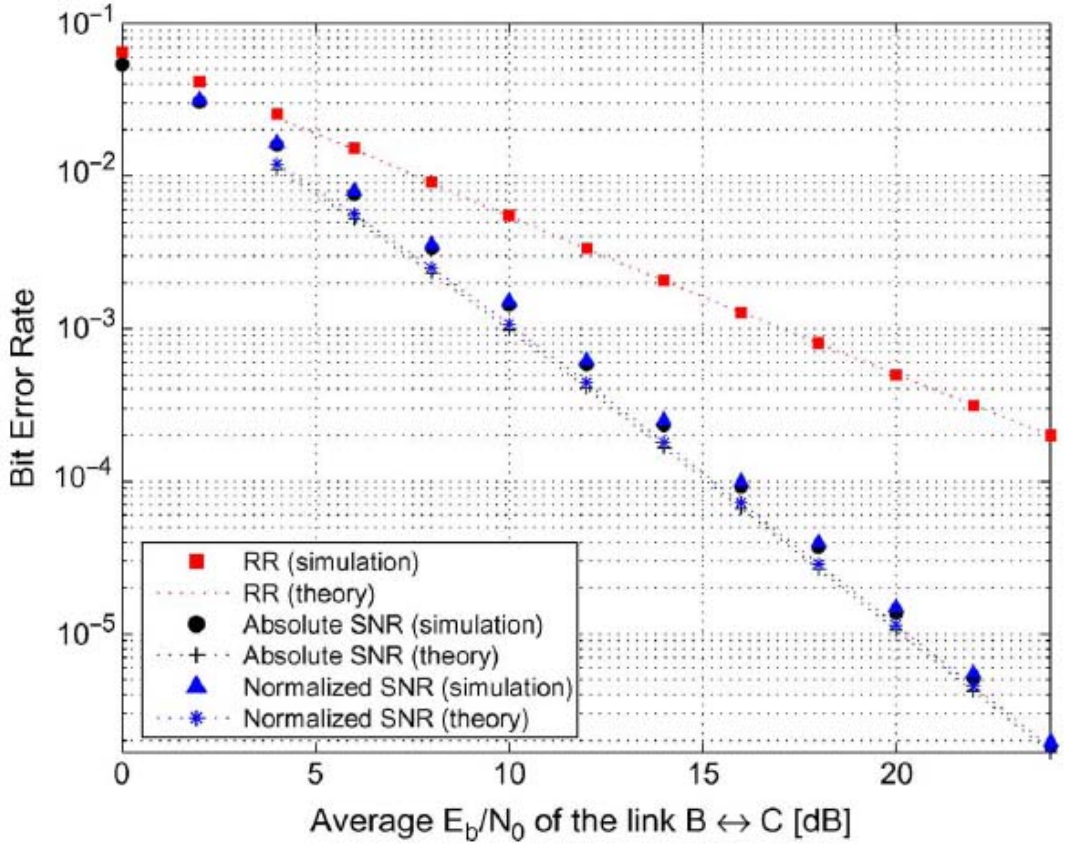


Fig. 3. BER performance for the node C.

Simulation-source selection

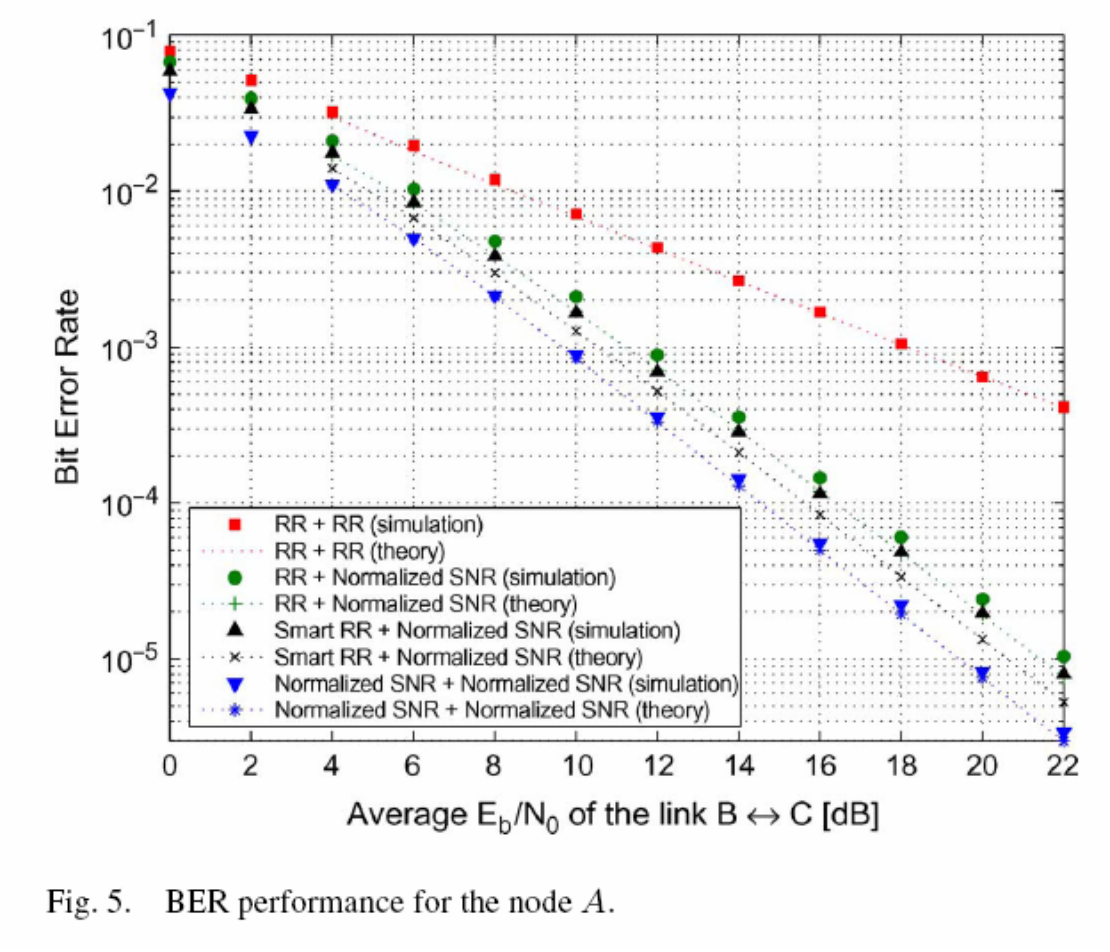
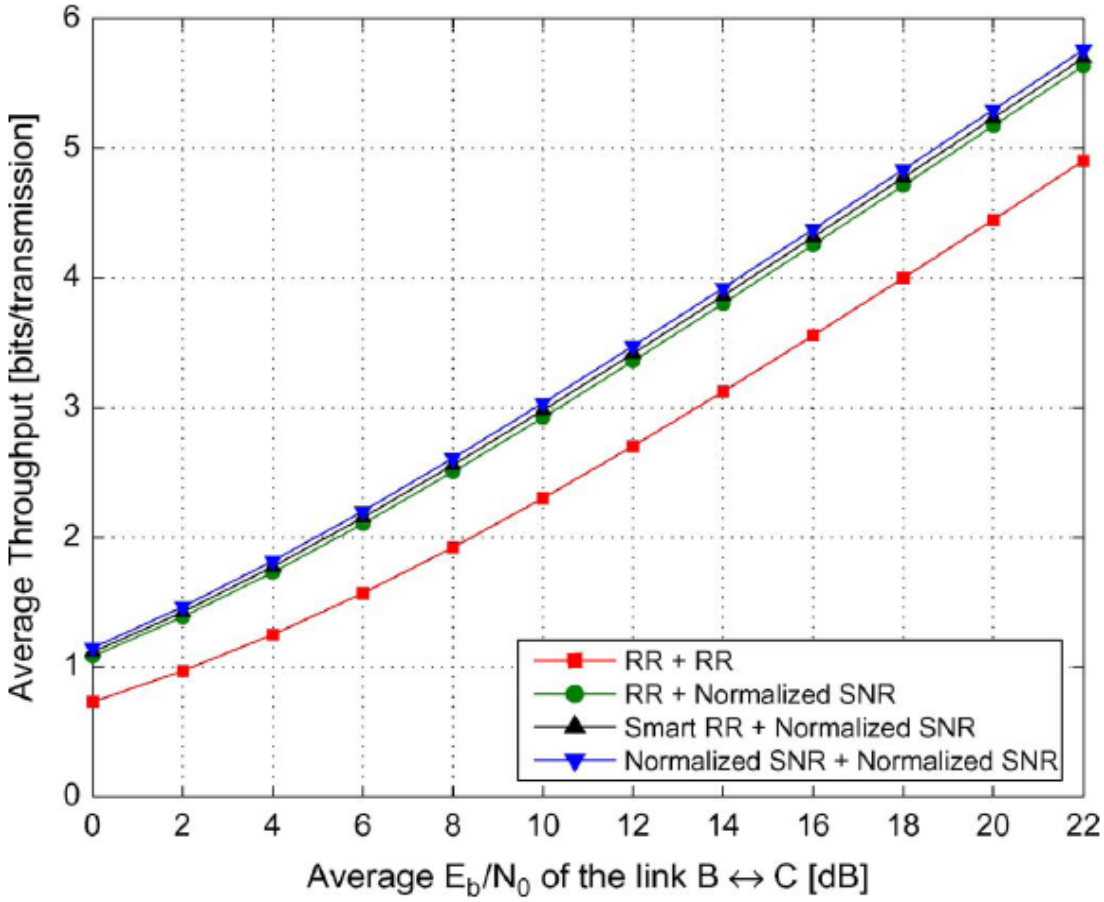


Fig. 5. BER performance for the node A.

Simulation-throughput



Conclusion

- Relay selection
  - Round Robin (fair but lower performance)
  - SNR based (unfair)
  - Normalized SNR based (fair)
- Source selection
  - Normalized SNR based (optimal but centralized)
  - Round Robin
  - “Smart” RR (relative to previous slot)