Throughput Improvement with Relay-augmented Cellular Architecture

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Document Number:

IEEE C80216mmr-05_008

Date Submitted:

2005-9-14

Source:

I-Kang Fu, Wern-Ho Sheen, Ren-Jr Chen, Chang-Lung Hsiao, Shou-Sheu Lin.
ITRI, Computer & Communications Research Labs
195 Sec. 4, Chung Hsing Rd.
Chutung, Hsinchu, Taiwan 310, R.O.C.

Voice: +886-3-591-7921
Fax: +886-3-582-0044
E-mail: apatch.cm91g@nctu.edu.tw

Venue:

IEEE 802.16 Session#39, Taipei, Taiwan

Base Document:

None

Purpose:

Information

Throughput Improvement with Relay-augmented Cellular Architecture

I-Kang Fu[1], Wern-Ho Sheen[2], Ren-Jr Chen[2], Chang-Lung Hsiao[2] and Shou-Sheu Lin[2]

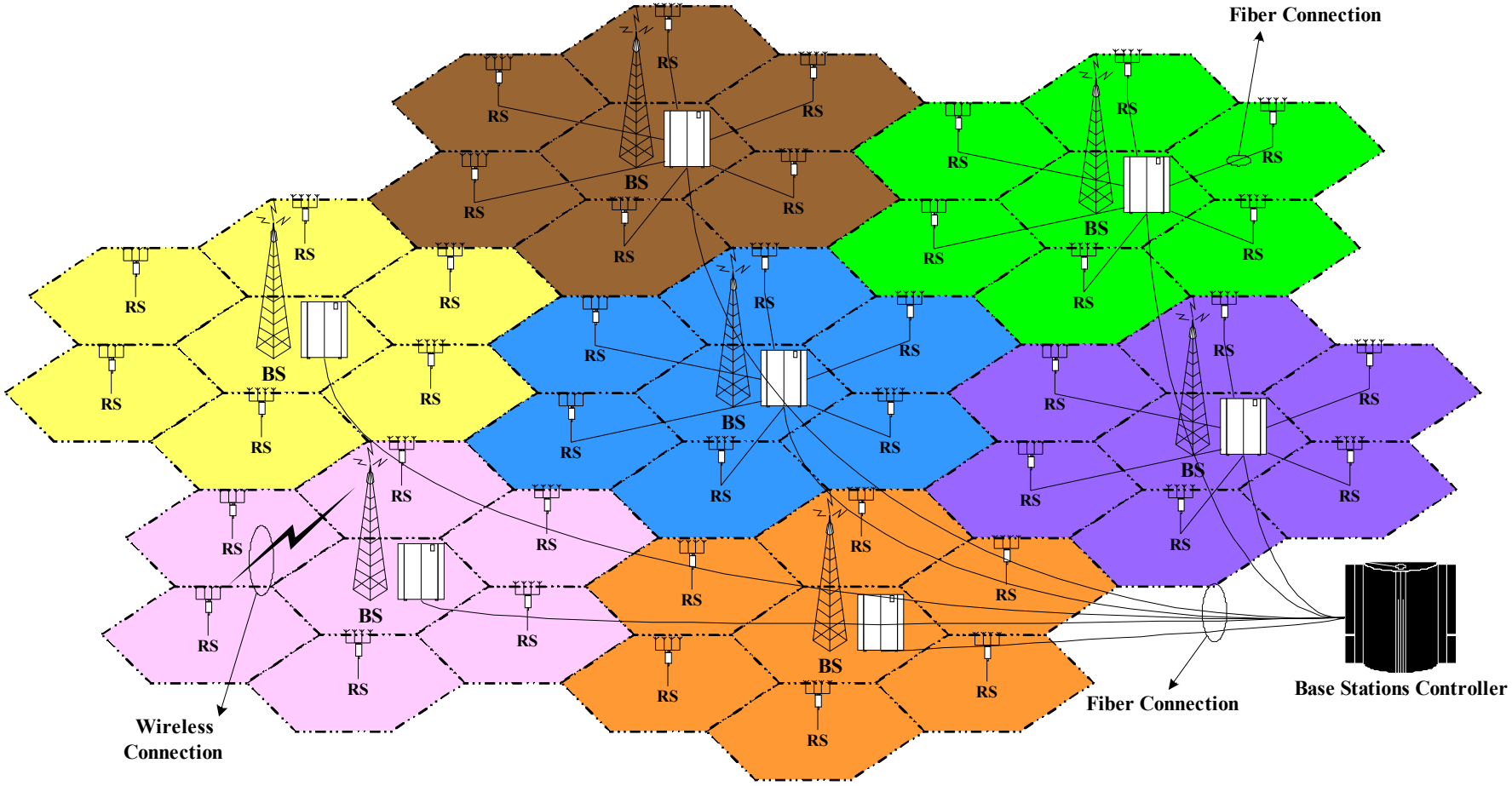
National Chiao Tung University[1]
ITRI Computer & Communications Research Labs[2],
Taiwan,2 R.O.C.

September, 2005

Outline

- Relay-augmented Cellular Architecture
- Classification of Relay Scenarios
- Simulation Results
- Summary

Relay-augmented Cellular Architectures



Classification of Relay Scenarios

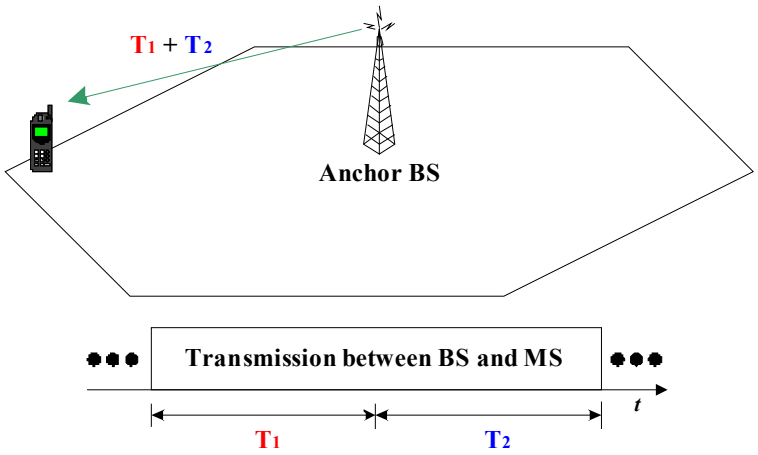
- Classified by function of relay station (RS)
  - **Amplify-and-Forward**
    - Analog repeater, less delay.
  - **Decode-and-Forward**
    - Digital repeater, more delay.
- Classified by interfaces of BS↔MS and RS↔MS transmission
  - **Homogeneous**
    - BS↔MS and RS↔MS transmissions are both in the same interface
      - Ex. Both interfaces are in IEEE 802.16 air-interface
  - **Heterogeneous**
    - BS↔MS and RS↔MS transmissions are in difference interfaces
      - Ex. BS↔MS in analog fiber interface, RS↔MS in IEEE 802.16 air-interface
- Classified by the mobility of relay station
  - **Fixed relay** (considered in following study cases)
  - **Mobile relay**

Classification of Relay Scenarios

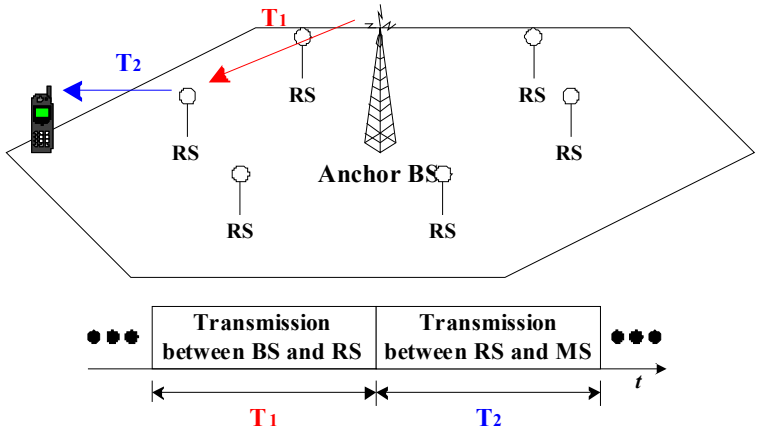
Downlink Homogeneous Relaying

Signal Reception Scenario

No Relaying

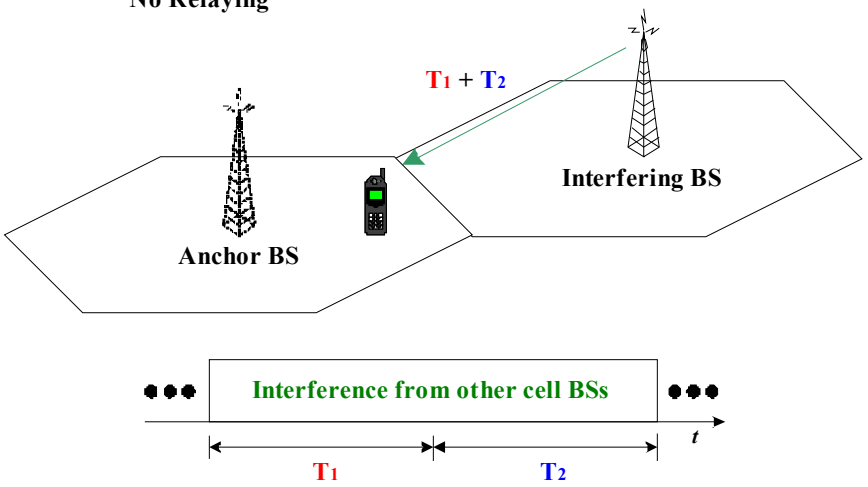


Decode-and-Forward Relaying

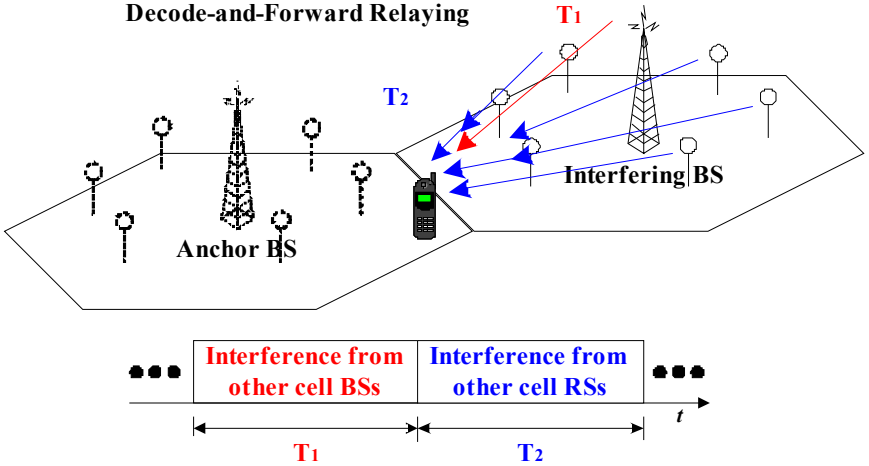


Interference Reception Scenario

No Relaying



Decode-and-Forward Relaying

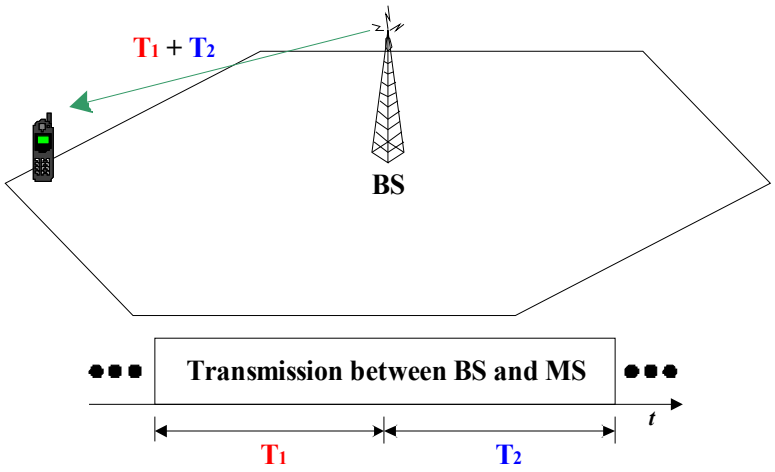


Classification of Relay Scenarios

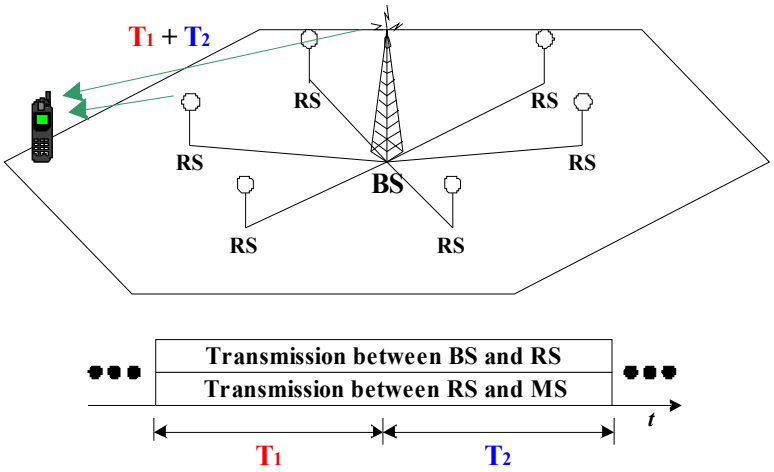
Downlink Heterogeneous Relaying

Signal Reception Scenario

No Relaying

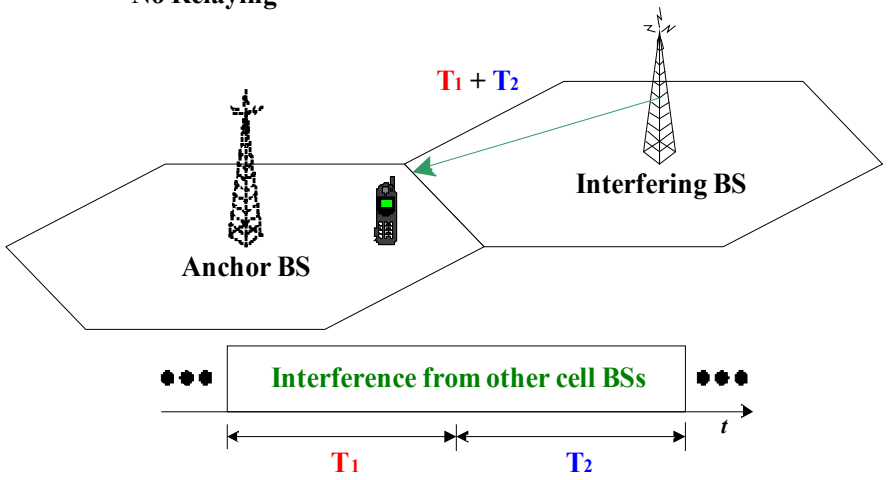


Amplify-and-Forward Relaying

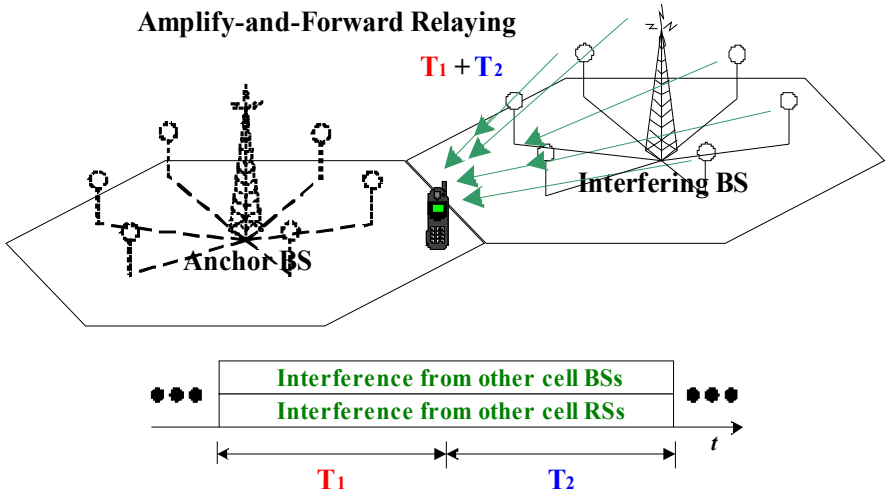


Interference Reception Scenario

No Relaying

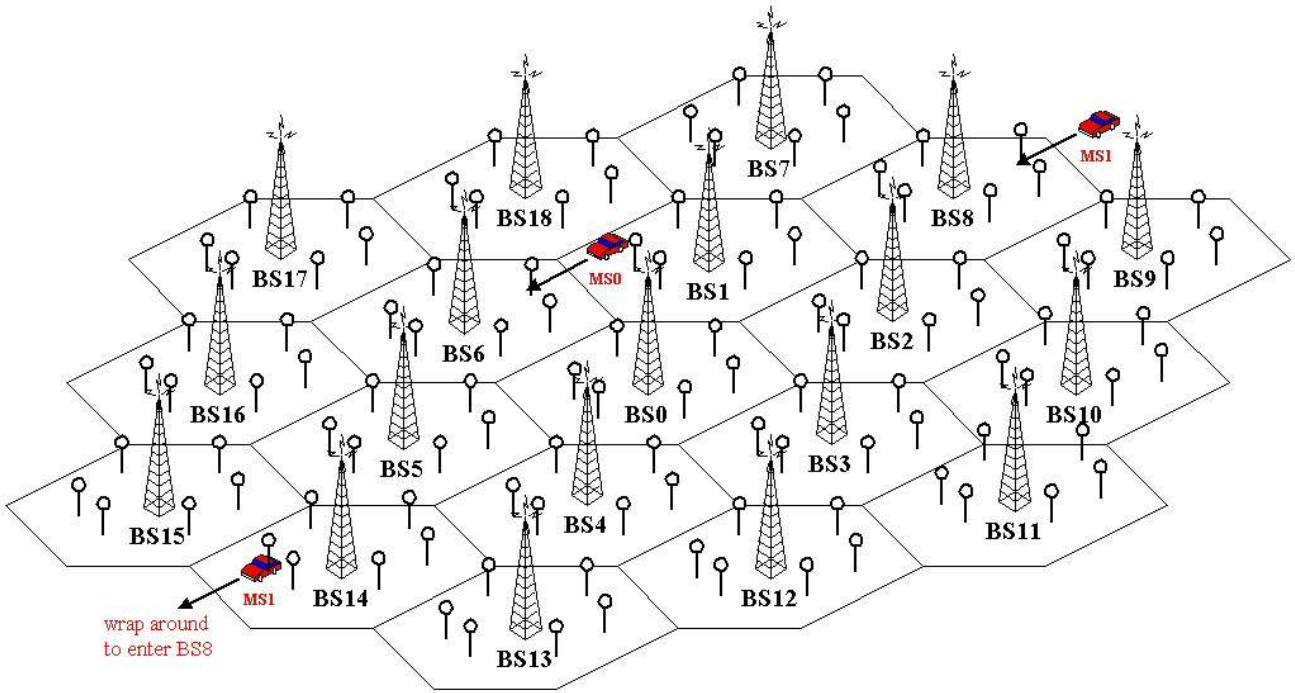


Amplify-and-Forward Relaying



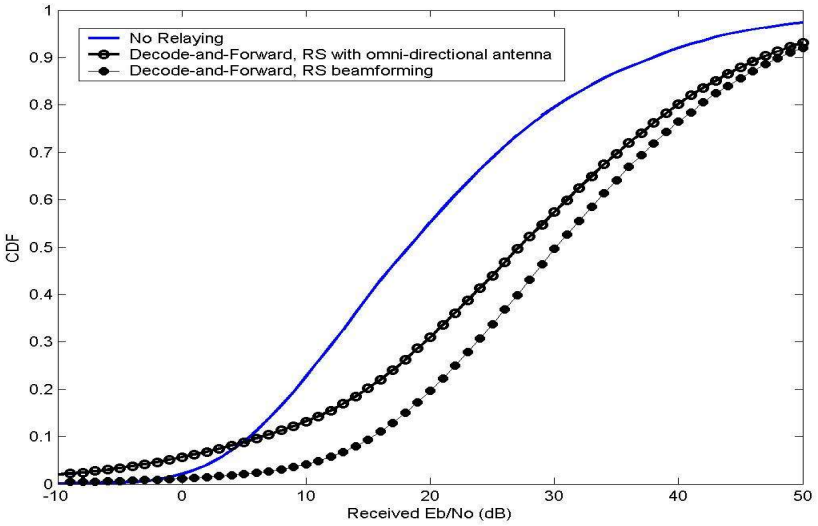
Simulation Results

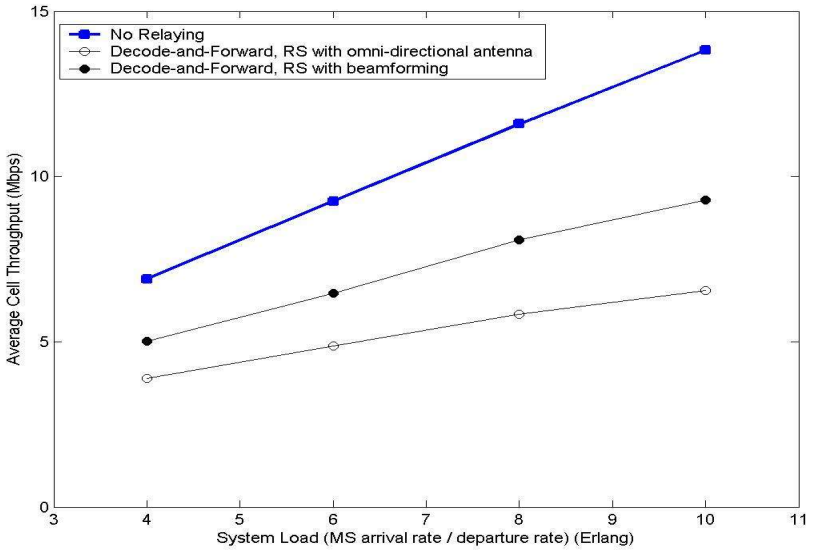
- Relay-augmented cellular OFDMA system
  - Downlink transmission
  - 19 cells with universal frequency reuse and FUSC permutation
  - Each cell has with 6 sectors and 2km coverage
  - Each cell has 6 relay stations (RS) with half base station (BS) coverage
  - Radio bandwidth: 6MHz (2048 sub-carriers)
  - Vehicular test environment



Simulation Results

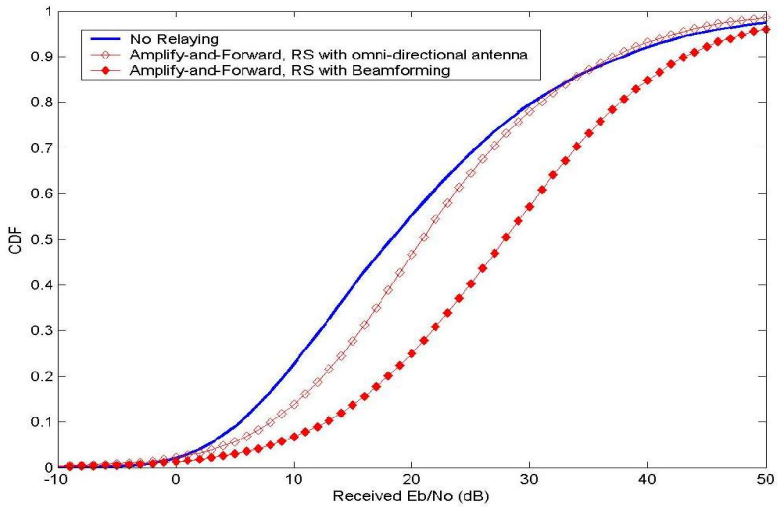
- Case I
  - Homogeneous decode-and forward relaying
- Observations
  - **Data rate coverage becomes more uniform** by increasing the percentage of high order modulation usage
  - **Throughput is reduced** by time division for BS↔MS and RS↔MS transmissions
  - Beamforming on RS can further improve performances by increasing antenna gain and reducing interference

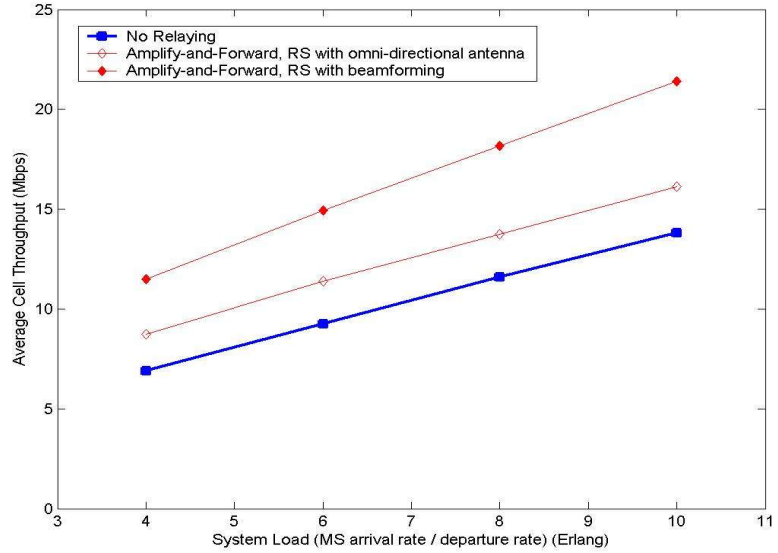




Simulation Results

- Case II
  - **Heterogeneous amplify-and-forward** relay
- Observation
  - **Data rate coverage becomes more uniform** by increasing the percentage of high order modulation usage
  - **Throughput is increased** by higher percentage of high order modulation usage
  - Beamforming on RS can further improve performances by increasing antenna gain and reducing interference





Summary

- Different relay deployment scenarios may lead to various performances tradeoffs
  - Ex. Tradeoff between uniform data rate coverage enhancement and throughput incensement in previous study cases
  - Before choosing relay scenarios, design objective should be ensured first.
- **Interference avoidance** may achieve substantial performances improvement in relay-augmented cellular systems
  - Up to **36%** throughput improvement was achieved in simulation results by applying beamforming on RSs
  - For decode-and-forward relaying, cooperation on RSs transmission may be beneficial to reduce the interference from other cell RSs.