

Throughput Improvement with Relay-augmented Cellular Architecture

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I-Kang Fu, Wern-Ho Sheen, Ren-Jr Chen,
Chang-Lung Hsiao, Shou-Sheu Lin.
NCTU, Department of Communication Engineering
Broadband Radio Access Systems Laboratory
ED922, 1001 TA HSUEH Rd.
Hsinchu, Taiwan 30050, R.O.C.

Voice: +886-3-571-2121

Fax: +886-3-571-0116

E-mail: apatch.cm91g@nctu.edu.tw

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Throughput Improvement with Relay-augmented Cellular Architecture

I-Kang Fu¹, Wern-Ho Sheen¹, Ren-Jr Chen²,
Chang-Lung Hsiao² and Shou-Sheu Lin²

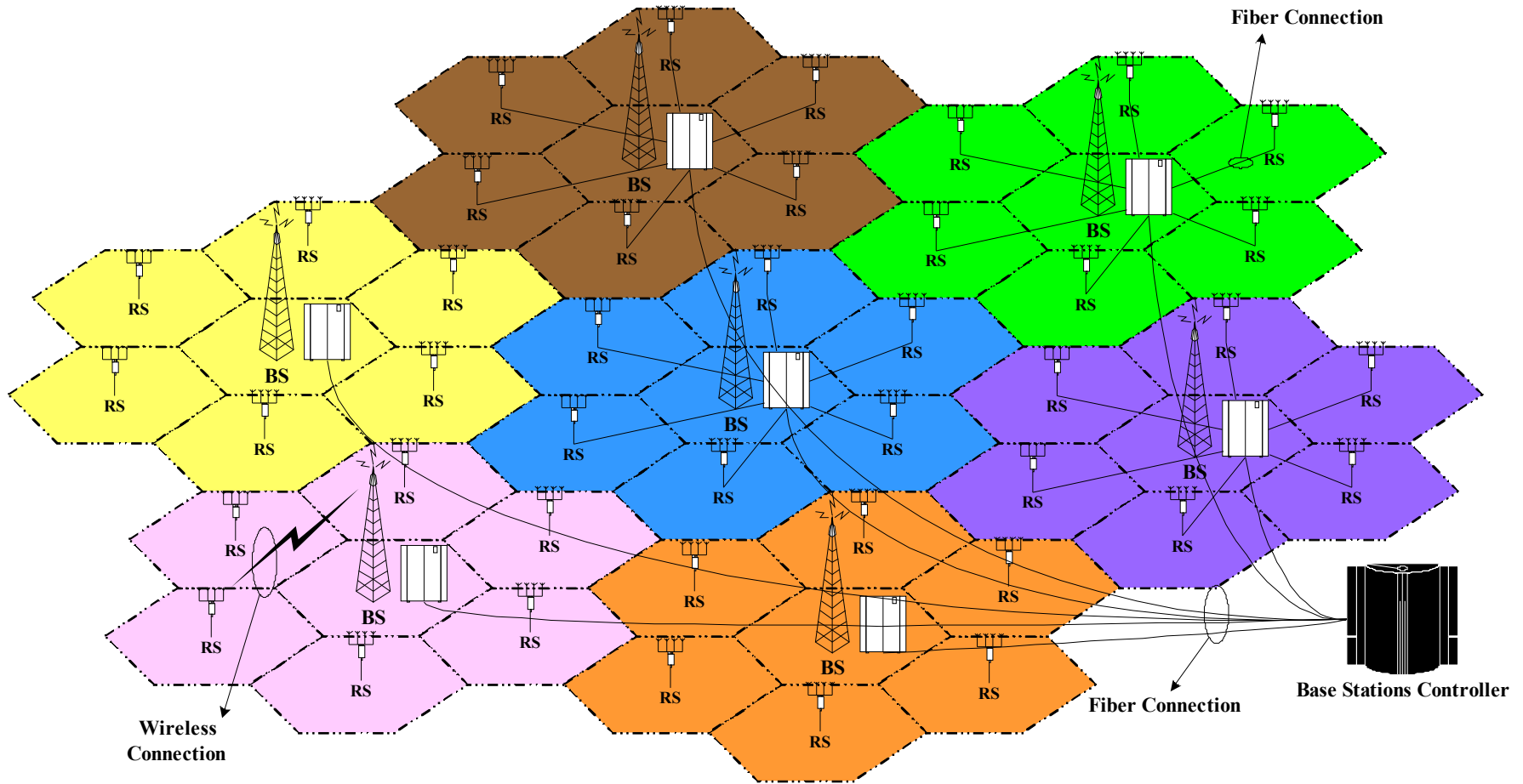
National Chiao Tung University¹
ITRI Computer & Communications Research Labs²,
Taiwan, R.O.C.

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Outline

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

Relay-augmented Cellular Architectures



Classification of Relay Scenarios

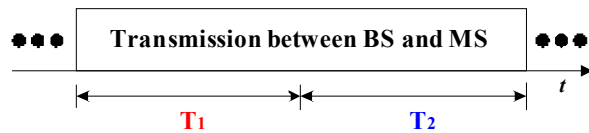
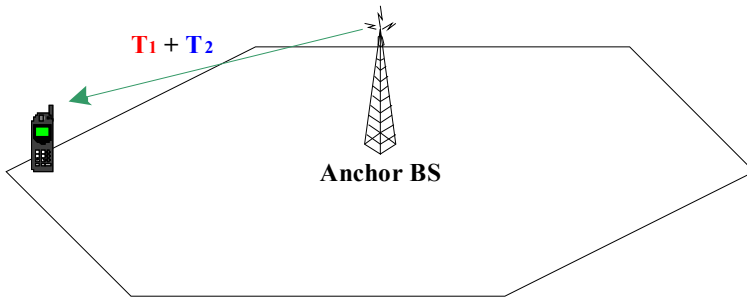
- Classified by function of relay station (RS)
 - **Amplify-and-Forward**
 - Analog repeater, less delay.
 - **Decode-and-Forward**
 - Digital repeater, more delay.
- Classified by interfaces of BS \leftrightarrow MS and RS \leftrightarrow MS transmission
 - **Homogeneous**
 - BS \leftrightarrow MS and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

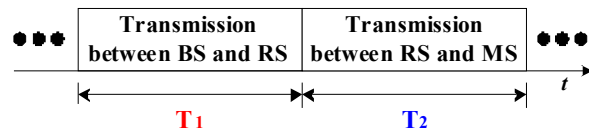
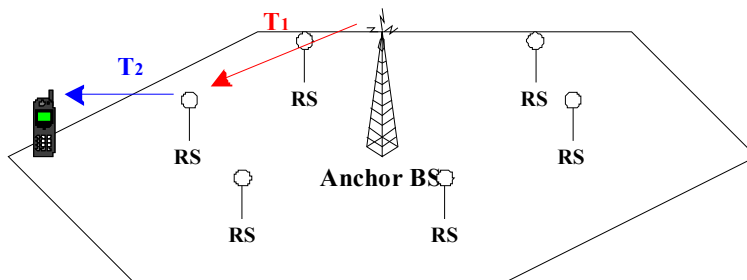
Downlink Homogeneous Relaying

Signal Reception Scenario

No Relaying

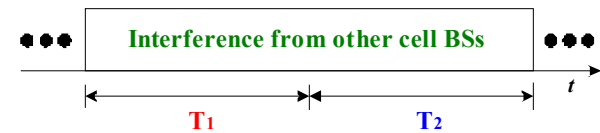
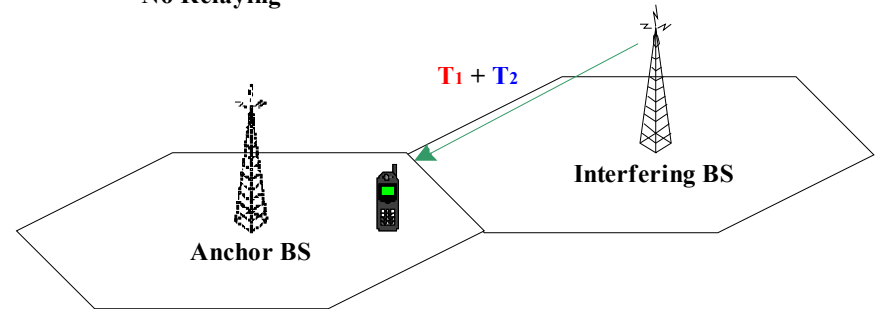


Decode-and-Forward Relaying

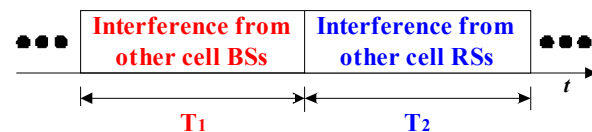
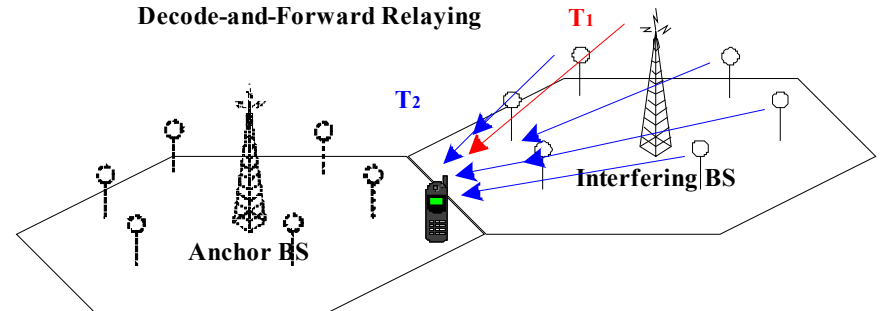


Interference Reception Scenario

No Relaying



Decode-and-Forward Relaying

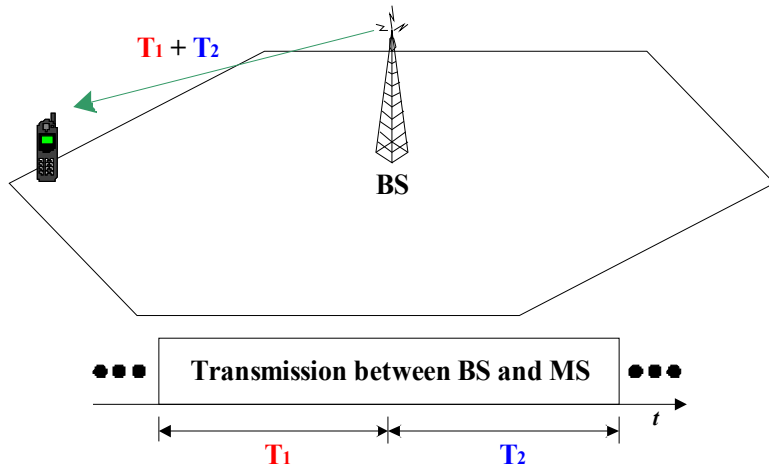


Classification of Relay Scenarios

Downlink Heterogeneous Relaying

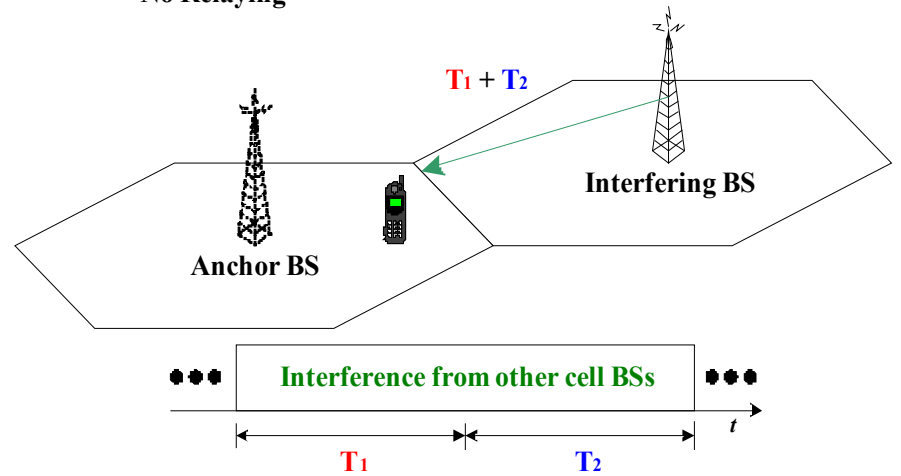
Signal Reception Scenario

No Relaying

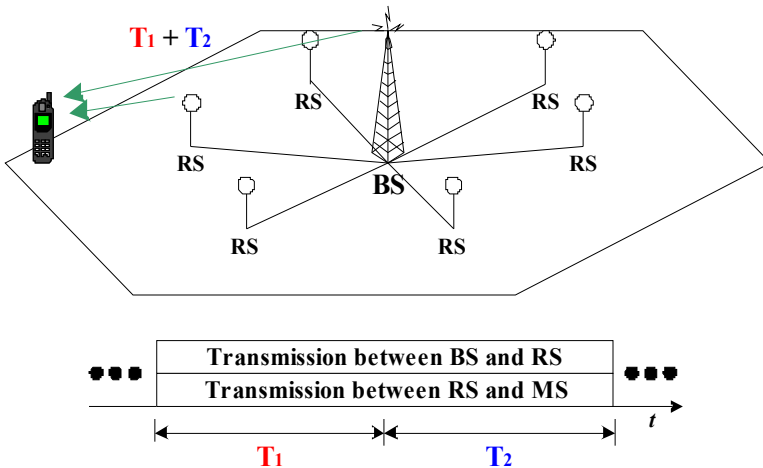


Interference Reception Scenario

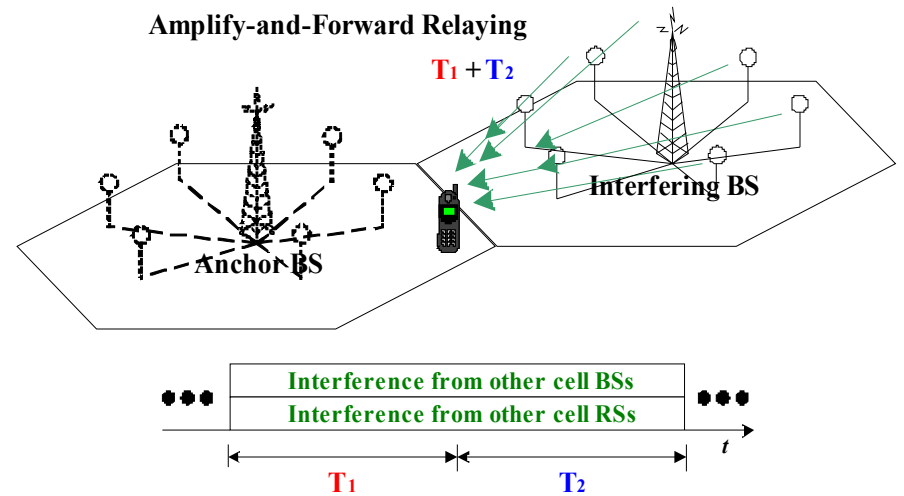
No Relaying



Amplify-and-Forward Relaying

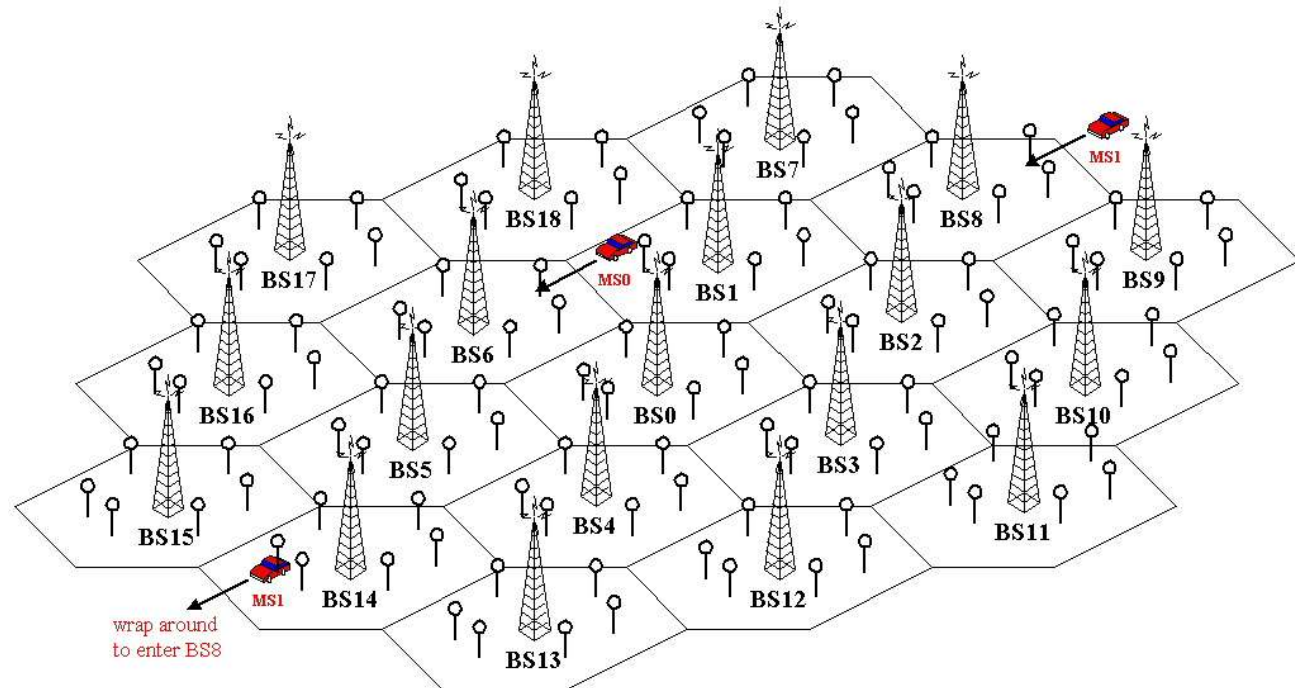


Amplify-and-Forward Relaying



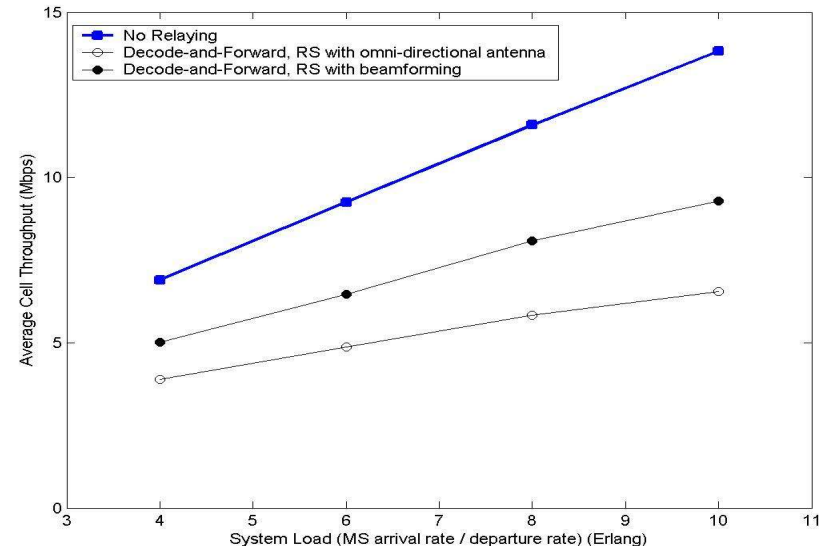
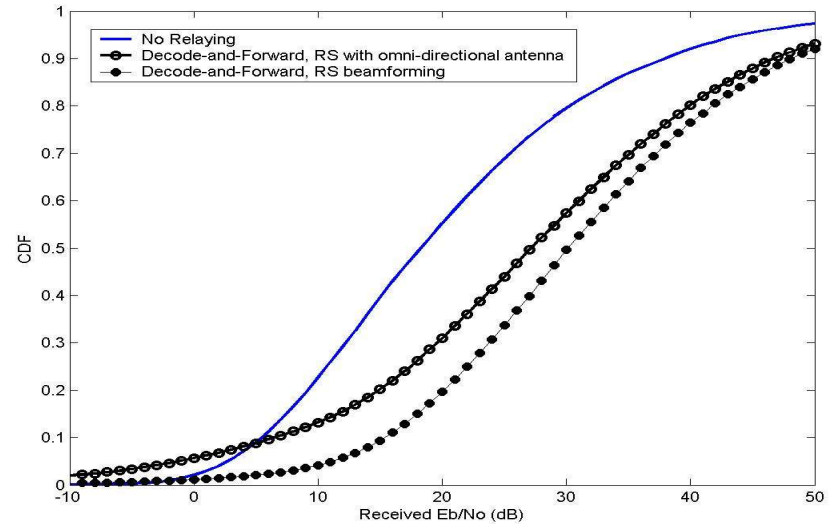
Simulation Results

- 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



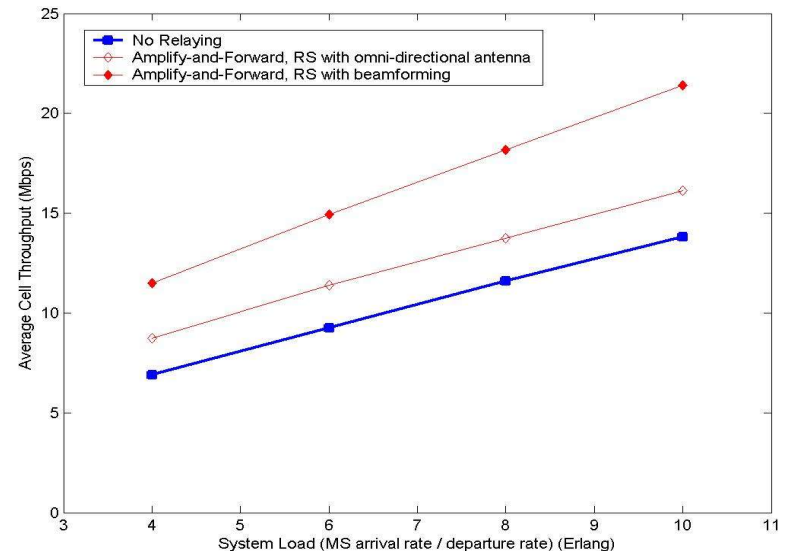
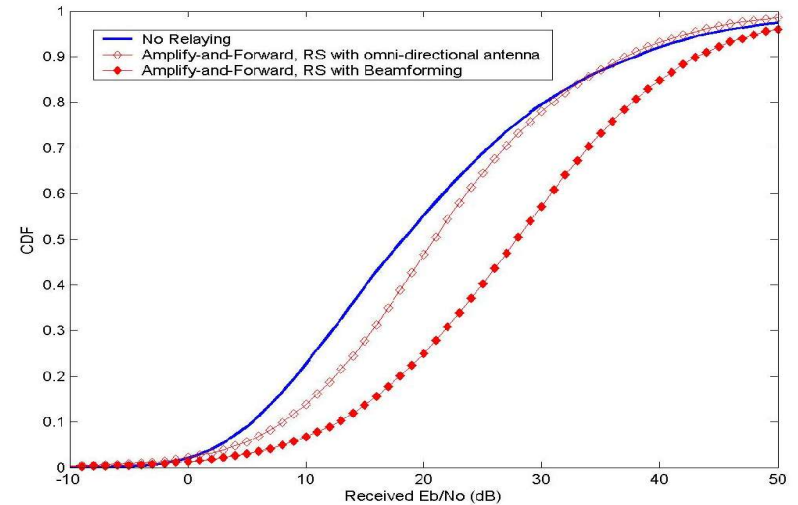
Simulation Results

- 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 \leftrightarrow MS and RS \leftrightarrow 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. When hop count increased, there may be a tradeoff between transmission rate and overall cell throughput.
 - Before choosing relay scenarios, the objective of relay deployment should be ensured first.
- **Interference avoidance** may provide 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.