

Throughput Improvement with Relay-augmented Cellular Architecture

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Throughput Improvement with Relay-augmented Cellular Architecture

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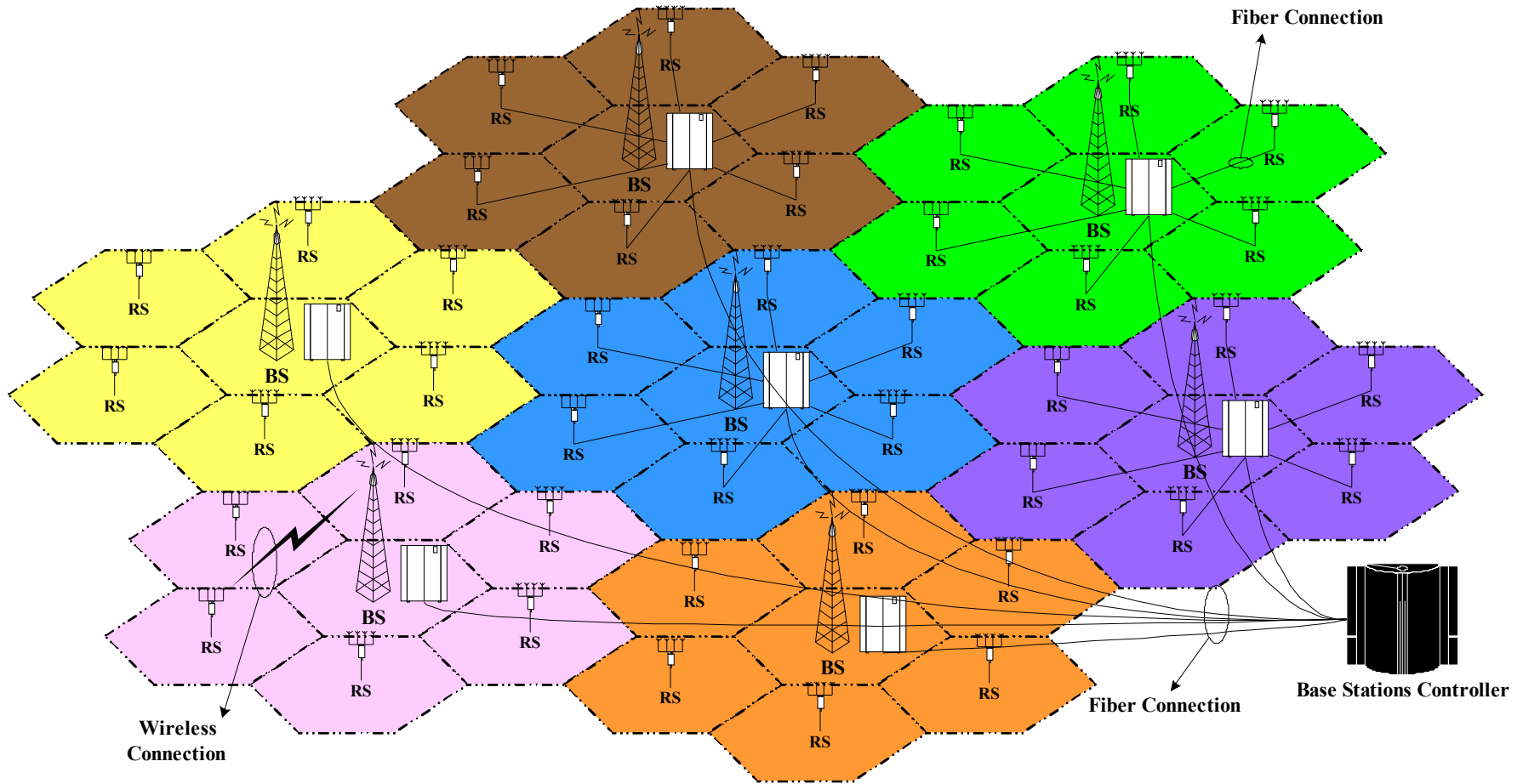
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Outline

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

Relay-augmented Cellular Architectures



Classification of Relay Scenarios

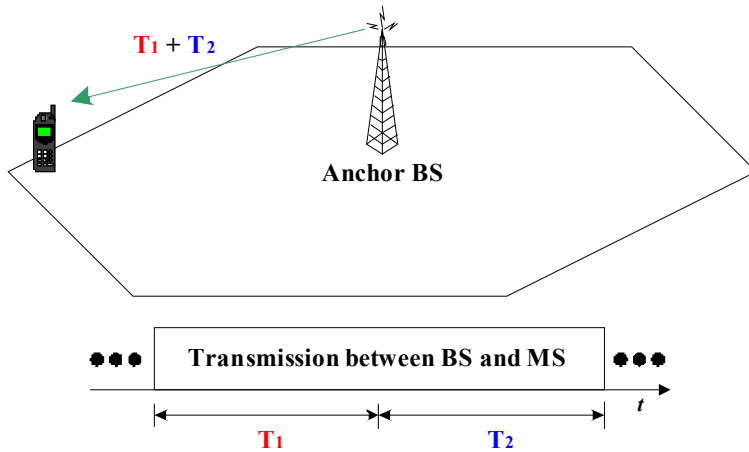
- Classified by function of relay station (RS)
 - **Amplify-and-Forward**
 - Analog repeater, less delay.
 - **Decode-and-Forward**
 - Digital repeater, more delay.
- Classified by interfaces of BS \leftrightarrow MS and RS \leftrightarrow MS transmission
 - **Homogeneous**
 - BS \leftrightarrow MS and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

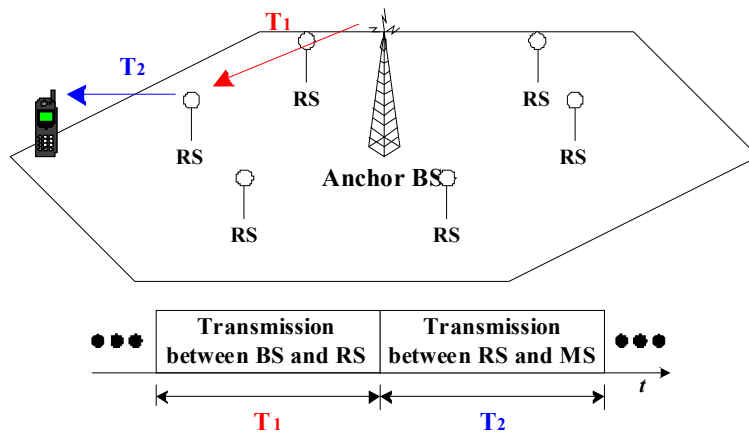
Downlink Homogeneous Relaying

Signal Reception Scenario

No Relaying

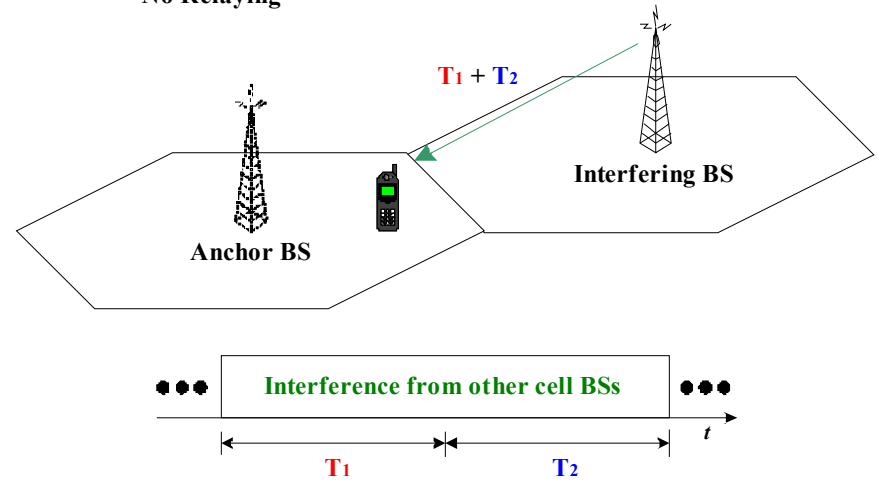


Decode-and-Forward Relaying

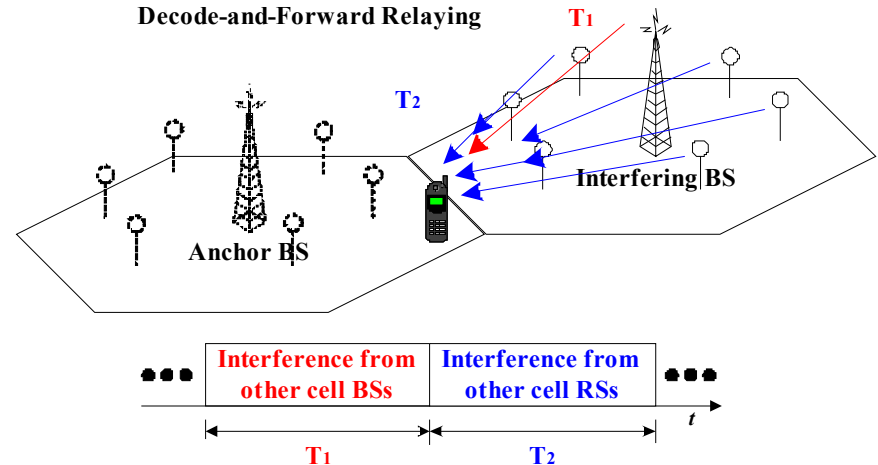


Interference Reception Scenario

No Relaying



Decode-and-Forward Relaying

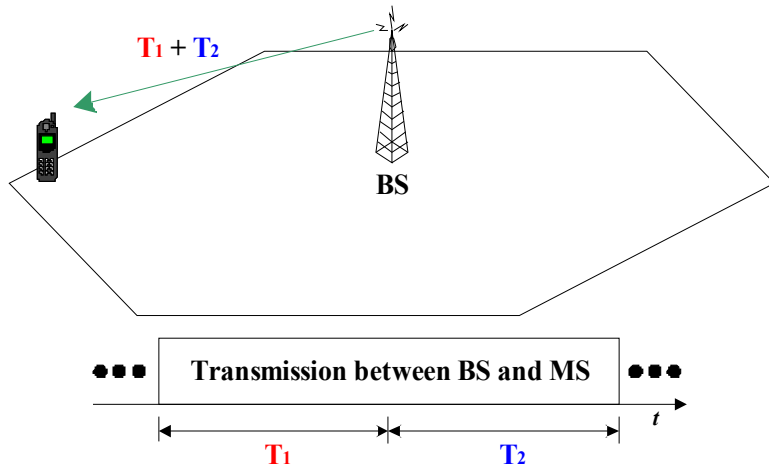


Classification of Relay Scenarios

Downlink Heterogeneous Relaying

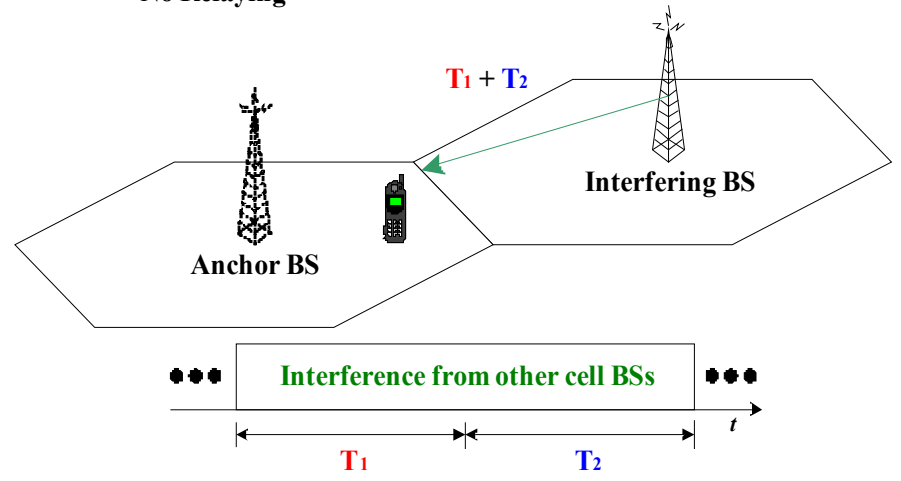
Signal Reception Scenario

No Relaying

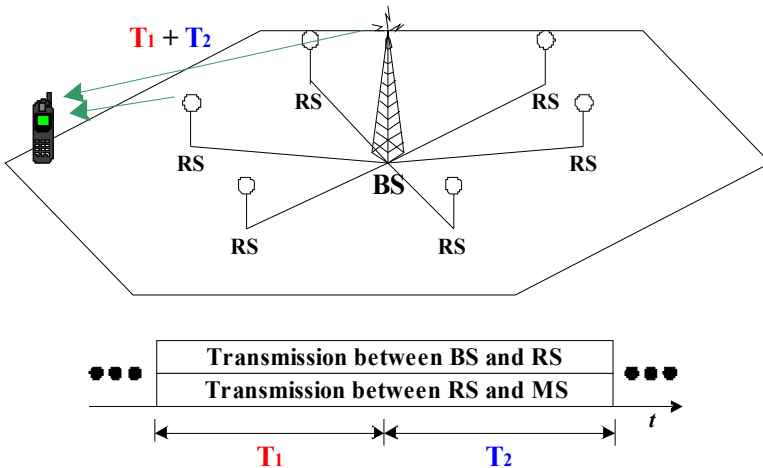


Interference Reception Scenario

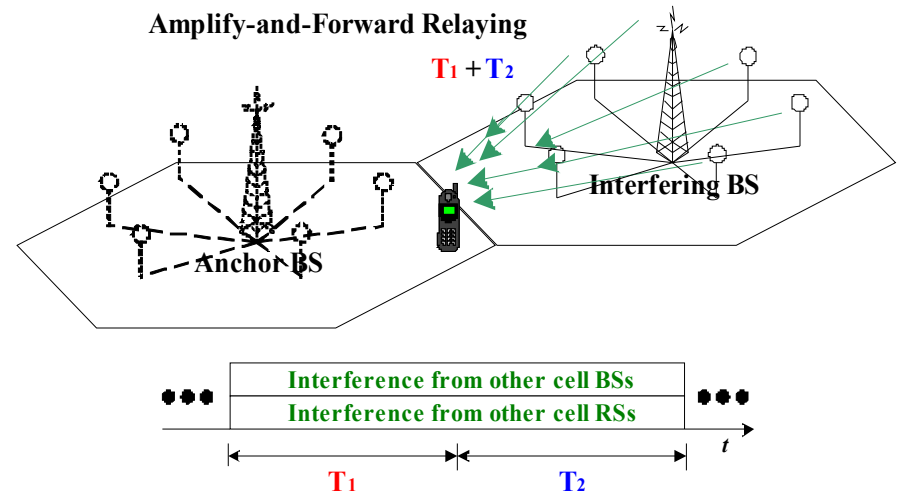
No Relaying



Amplify-and-Forward Relaying

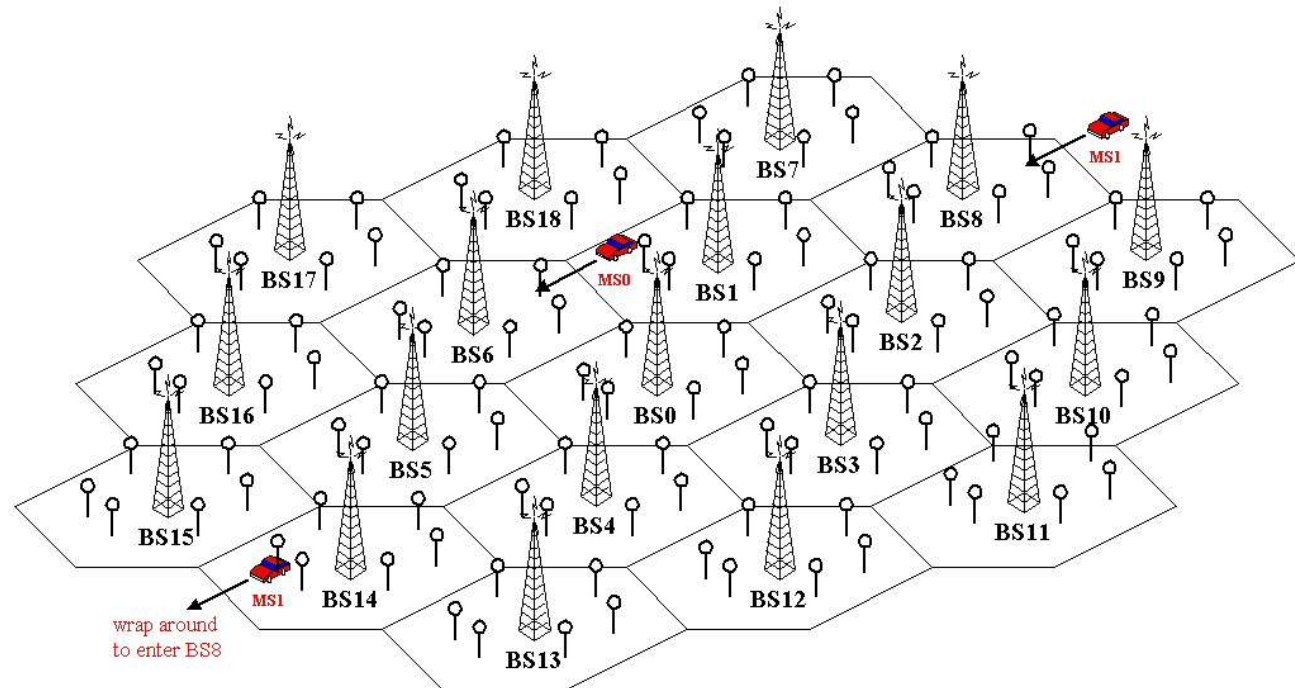


Amplify-and-Forward Relaying



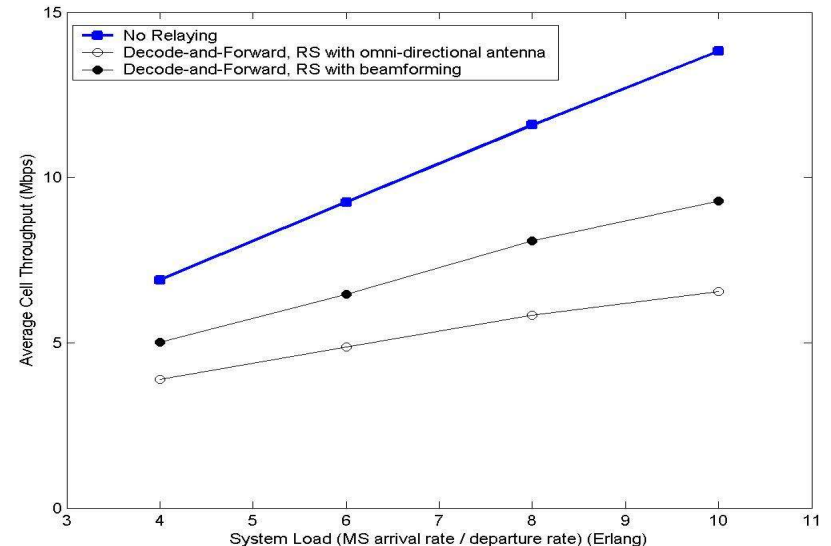
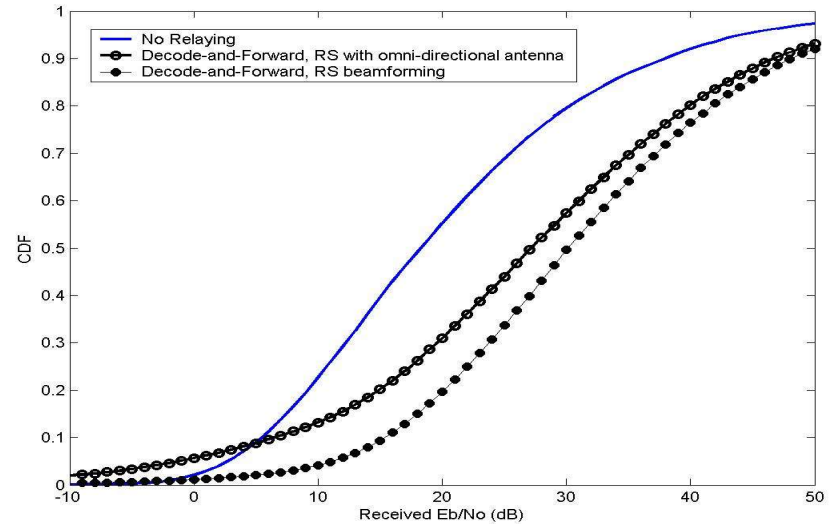
Simulation Results

- 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



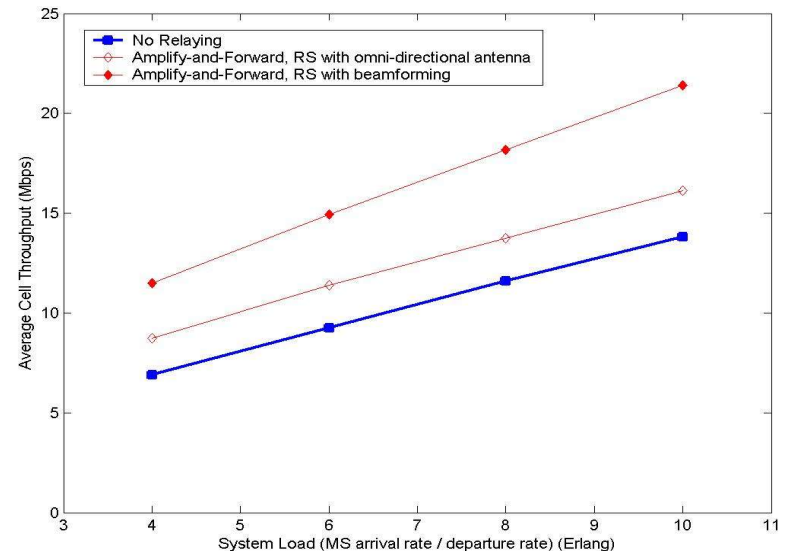
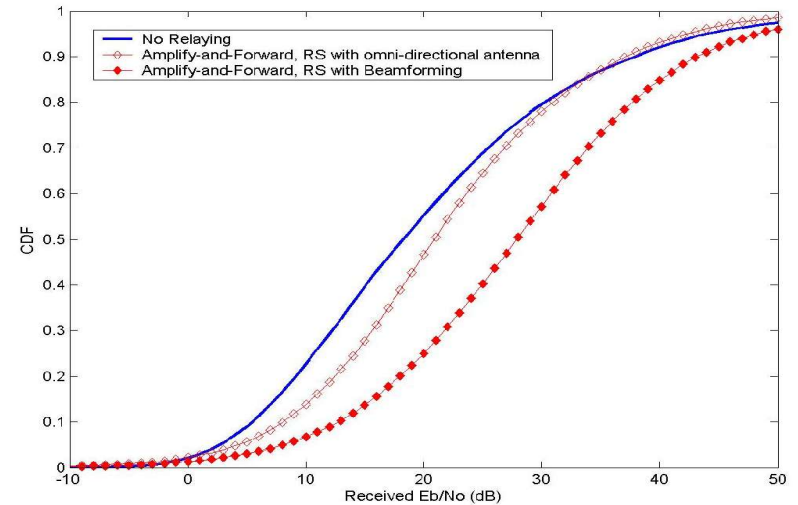
Simulation Results

- 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. 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.