

Throughput Improvement with Relay-augmented Cellular Architecture

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Throughput Improvement with Relay-augmented Cellular Architecture

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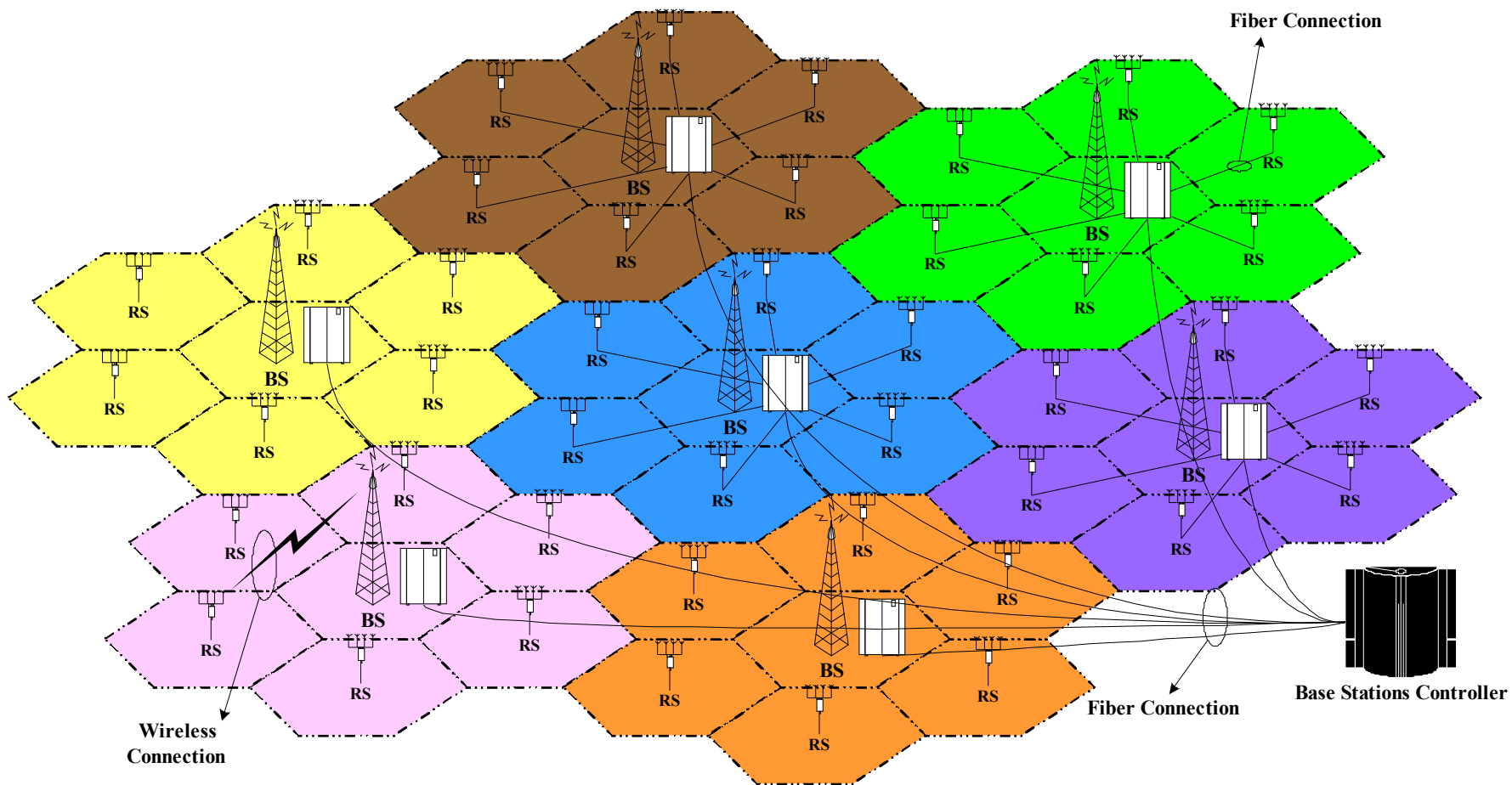
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Outline

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

Relay-augmented Cellular Architectures



Classification of Relay Scenarios

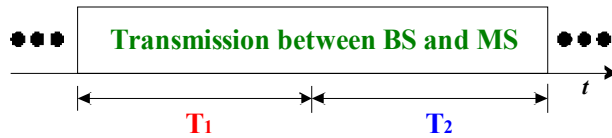
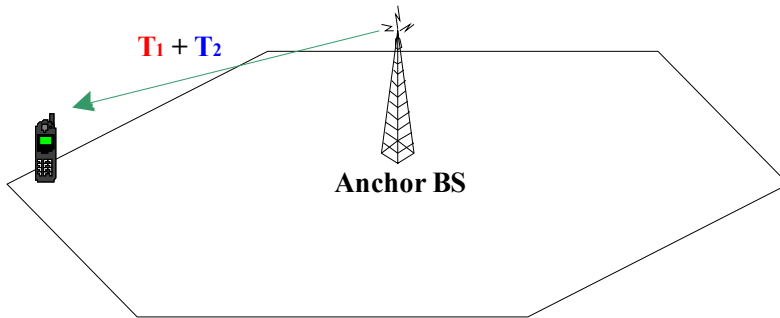
- Classified by function of relay station (RS)
 - **Amplify-and-Forward**
 - Analog repeater, less delay.
 - **Decode-and-Forward**
 - Digital repeater, more delay.
- Classified by interfaces of BS \leftrightarrow RS and RS \leftrightarrow MS transmission
 - **Homogeneous**
 - BS \leftrightarrow RS and RS \leftrightarrow MS transmissions are both in the same air-interface
 - Ex. Both of them are in IEEE 802.16 air-interface
 - **Heterogeneous**
 - BS \leftrightarrow RS and RS \leftrightarrow MS transmissions are in difference air-interfaces
 - Ex. BS \leftrightarrow RS in IEEE 802.16 interface, RS \leftrightarrow MS in IEEE 802.11 air-interface.
- Classified by the mobility of relay station
 - **Fixed relay** (considered in following study cases)
 - **Mobile relay**

Classification of Relay Scenarios

Downlink Decode-and-Forward Relaying

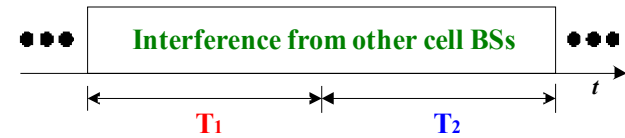
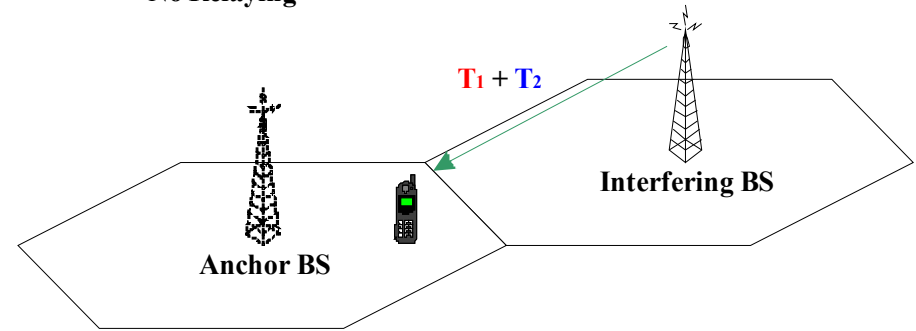
Signal Reception Scenario

No Relaying

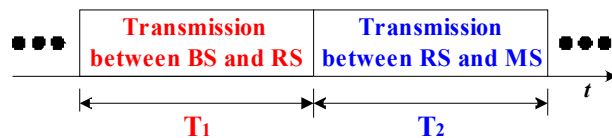
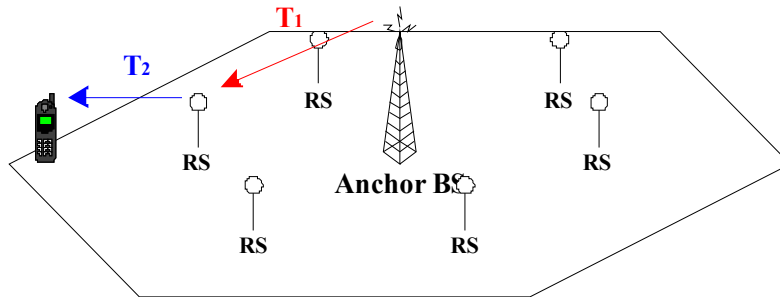


Interference Reception Scenario

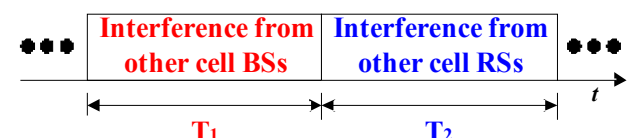
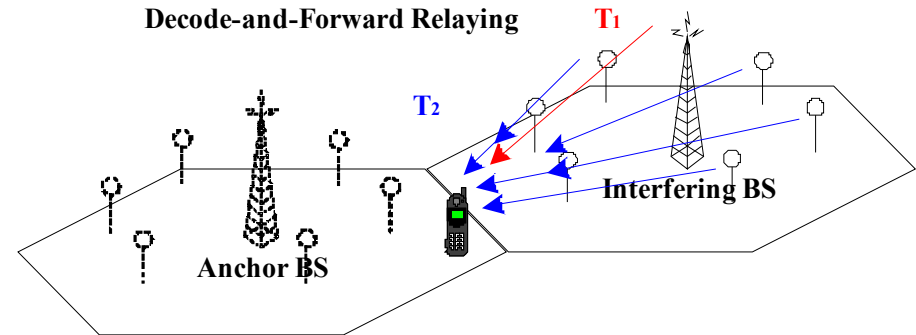
No Relaying



Decode-and-Forward Relaying



Decode-and-Forward Relaying

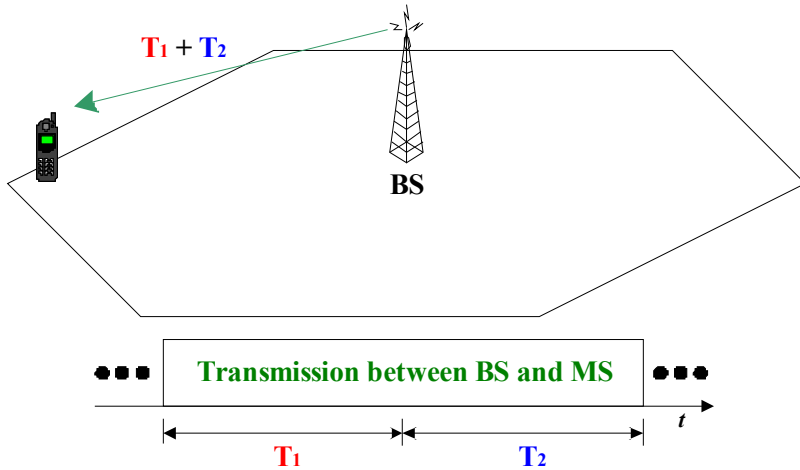


Classification of Relay Scenarios

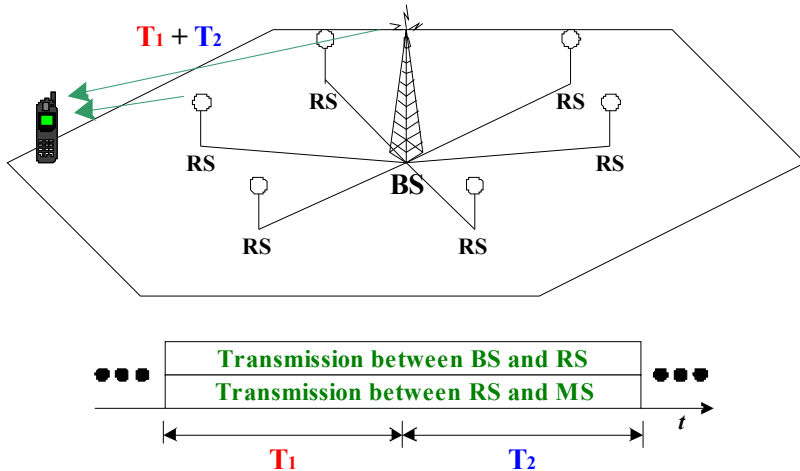
Downlink Amplify-and-Forward Relaying

Signal Reception Scenario

No Relaying

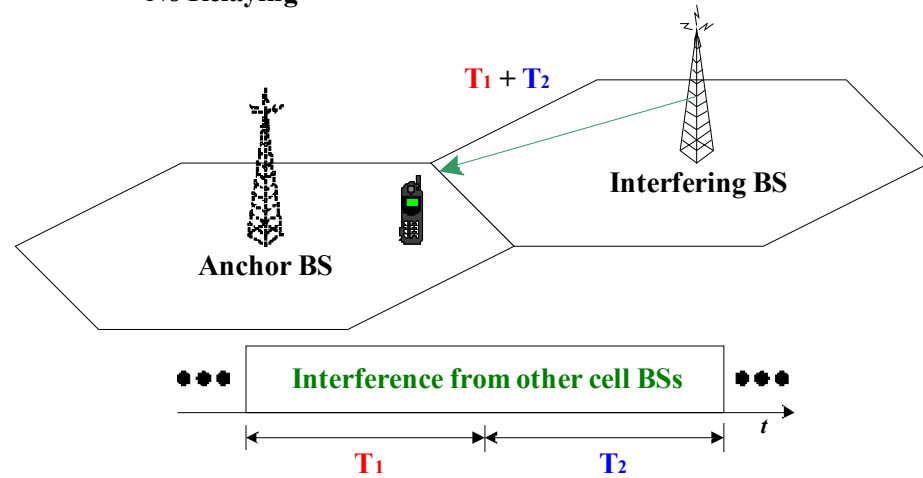


Amplify-and-Forward Relaying

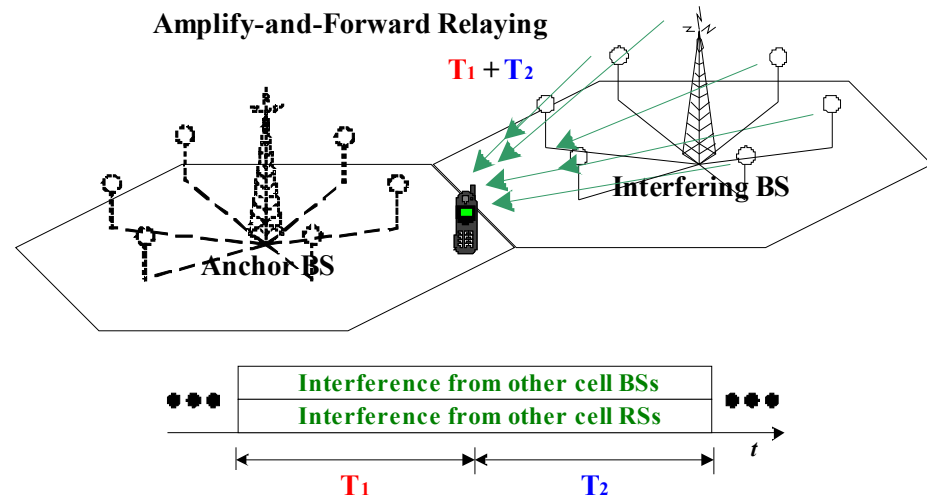


Interference Reception Scenario

No Relaying

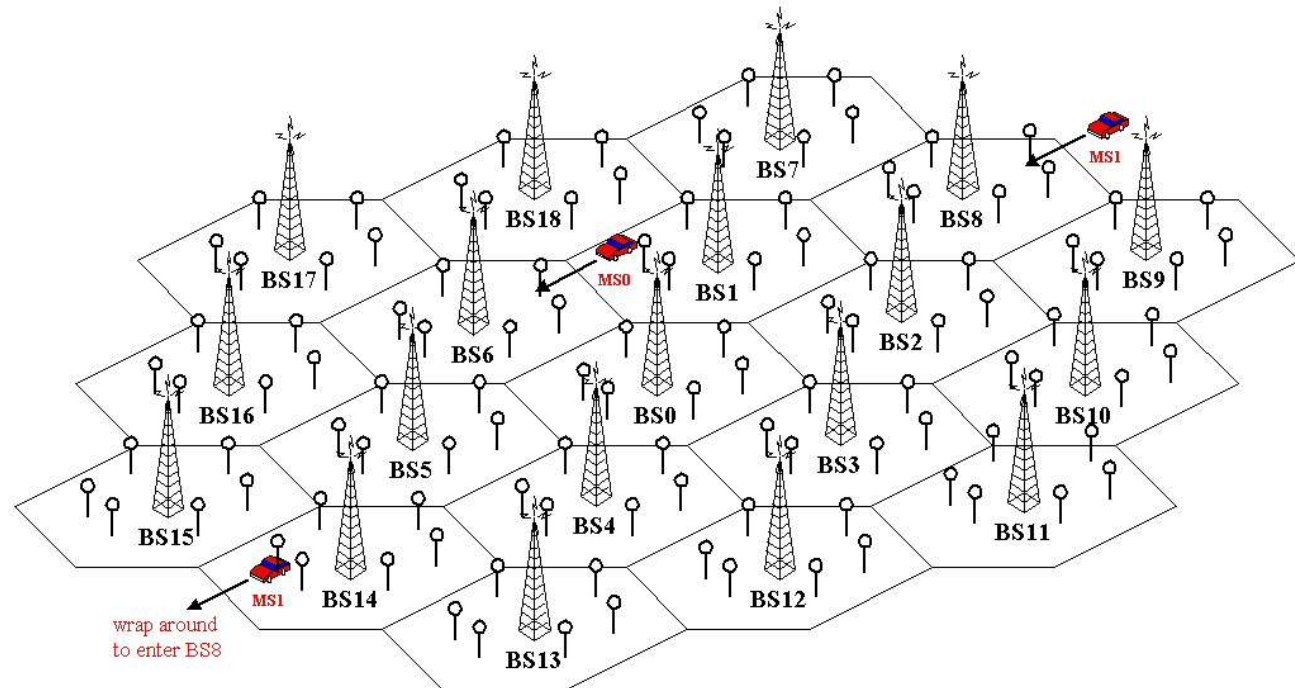


Amplify-and-Forward Relaying



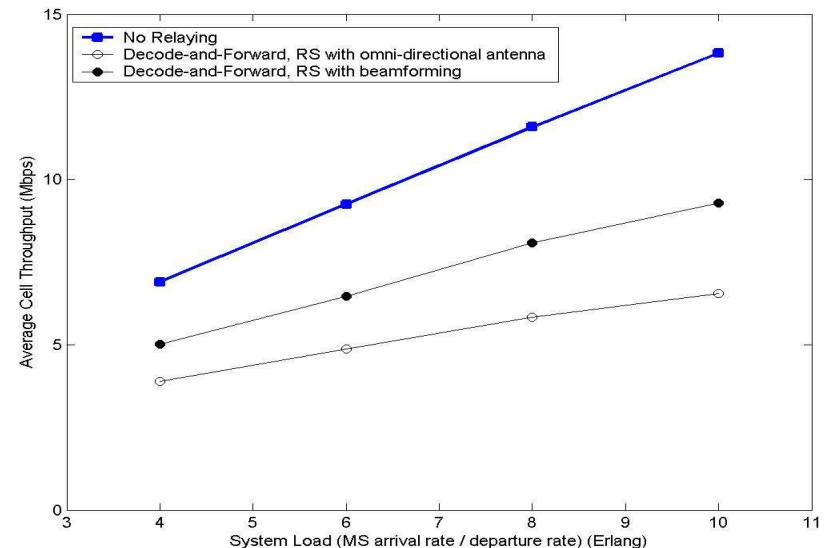
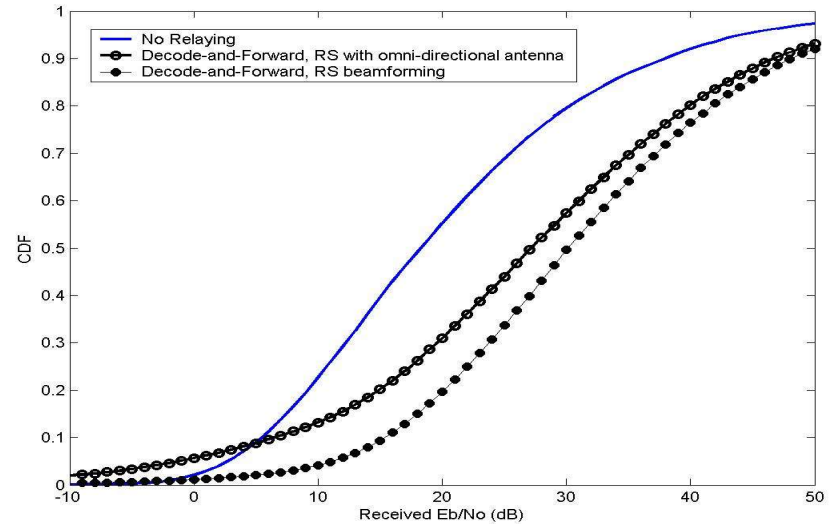
Simulation Results

- Relay-augmented cellular OFDMA system
 - Downlink transmission
 - 19 cells with universal frequency reuse and FUSC permutation
 - Each cell has 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



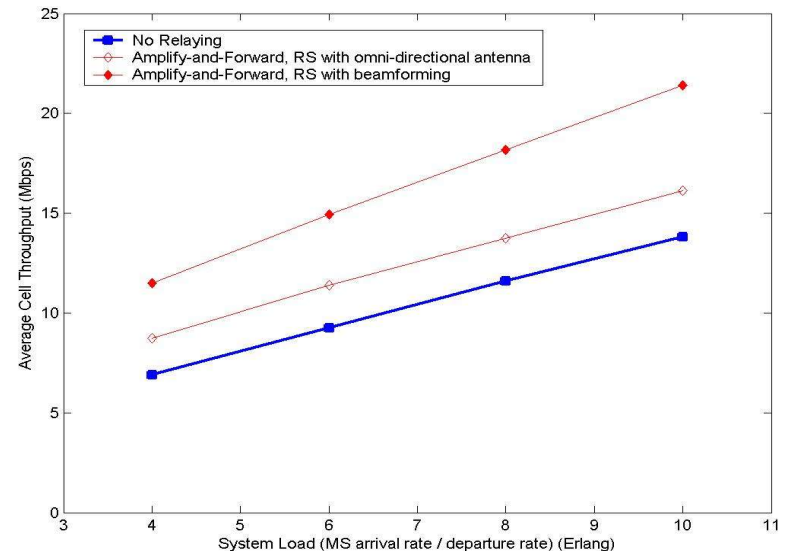
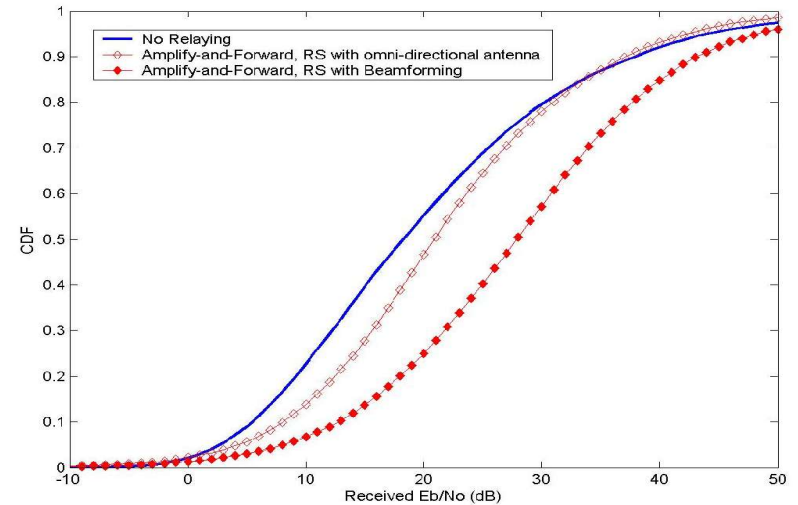
Simulation Results

- Case I
 - 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
 - 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
 - **Cooperation on RSs transmission** may be beneficial to reduce the interference from other cell RSs.