Throughput Improvement with Relay-augmented Cellular Architecture

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Information

Throughput Improvement with Relay-augmented Cellular Architecture

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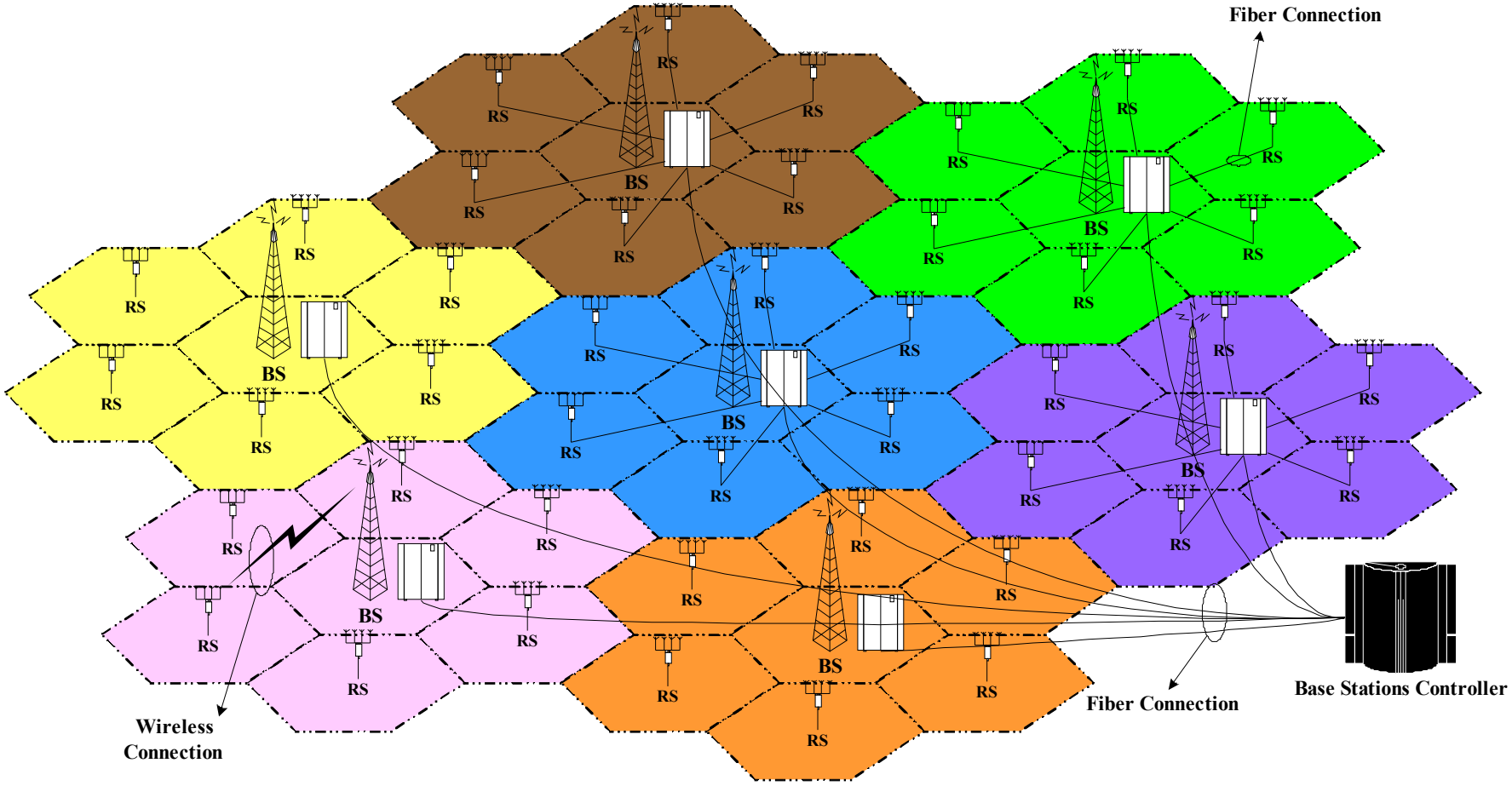
Outline

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

Relay-augmented Cellular Architectures



Classification of Relay Scenarios

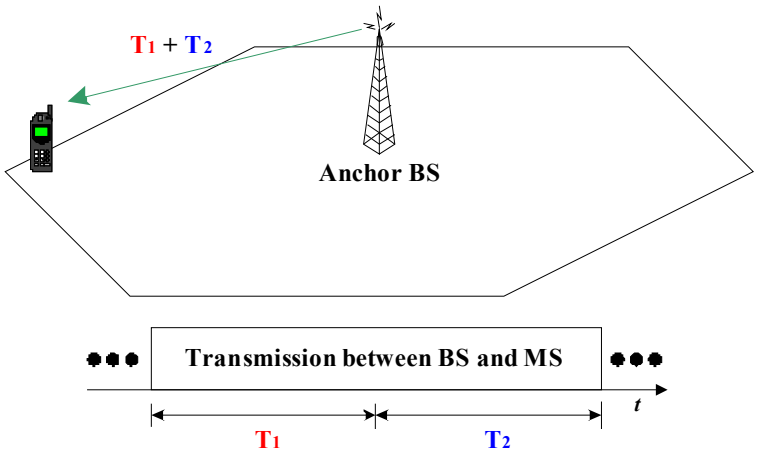
- Classified by function of relay station (RS)
  - **Amplify-and-Forward**
    - Analog repeater, less delay.
  - **Decode-and-Forward**
    - Digital repeater, more delay.
- Classified by interfaces of BS↔MS and RS↔MS transmission
  - **Homogeneous**
    - BS↔MS and RS↔MS transmissions are both in the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

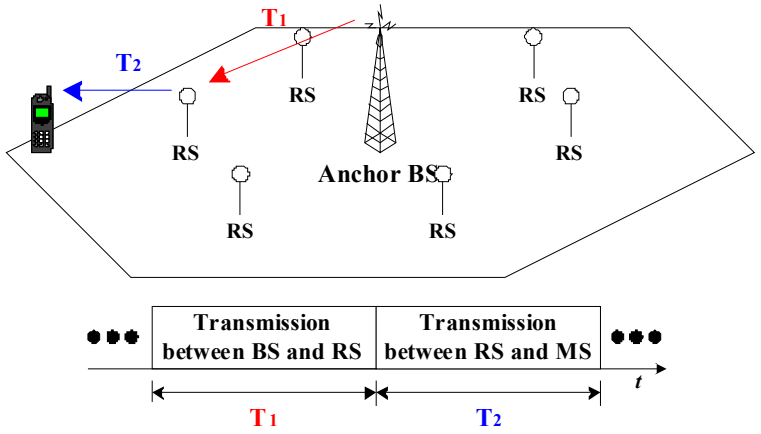
Downlink Homogeneous Relaying

Signal Reception Scenario

No Relaying

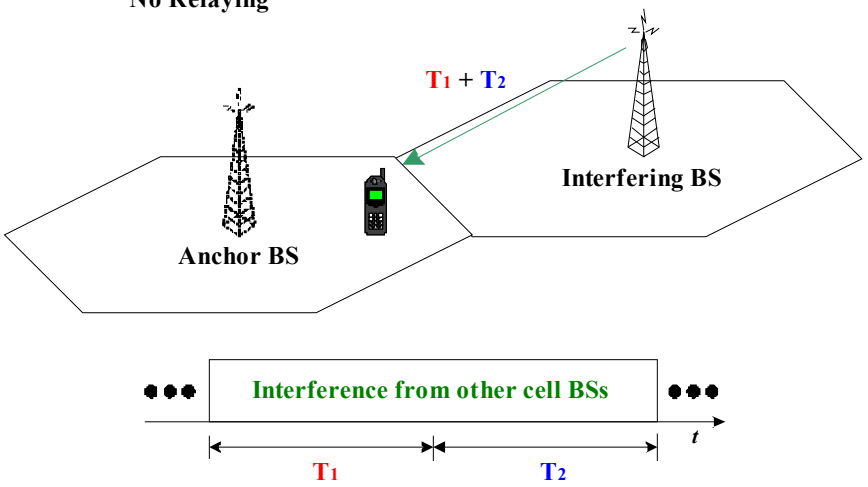


Decode-and-Forward Relaying

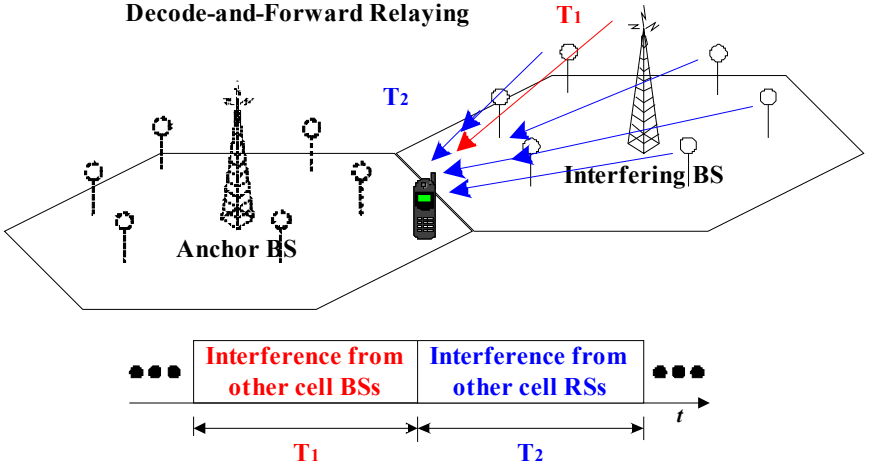


Interference Reception Scenario

No Relaying



Decode-and-Forward Relaying

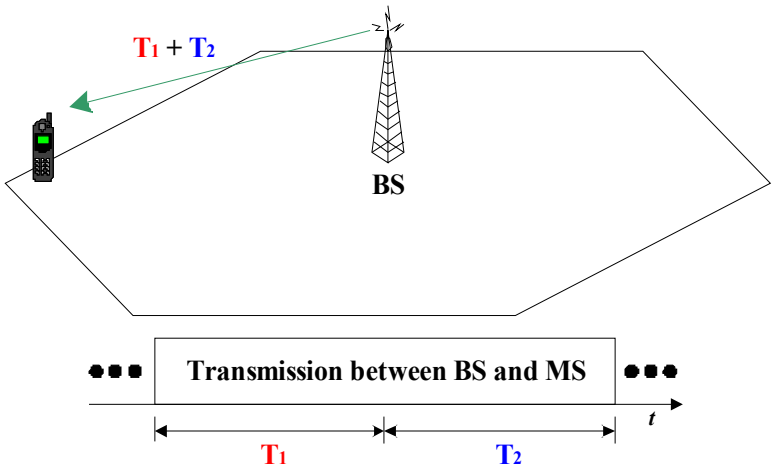


Classification of Relay Scenarios

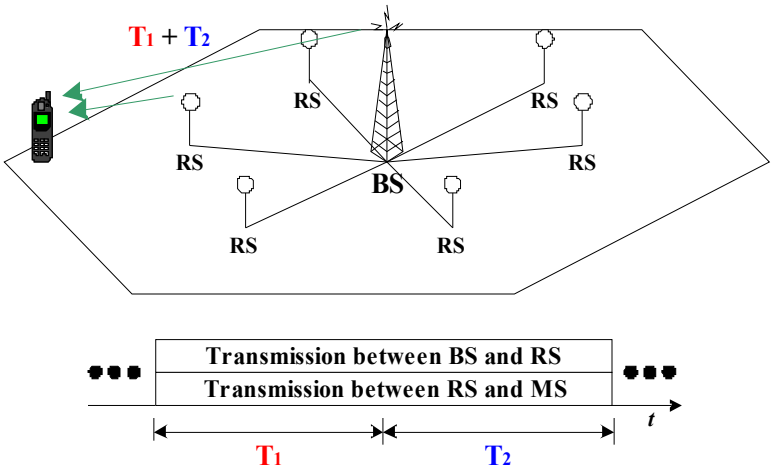
Downlink Heterogeneous Relaying

Signal Reception Scenario

No Relaying

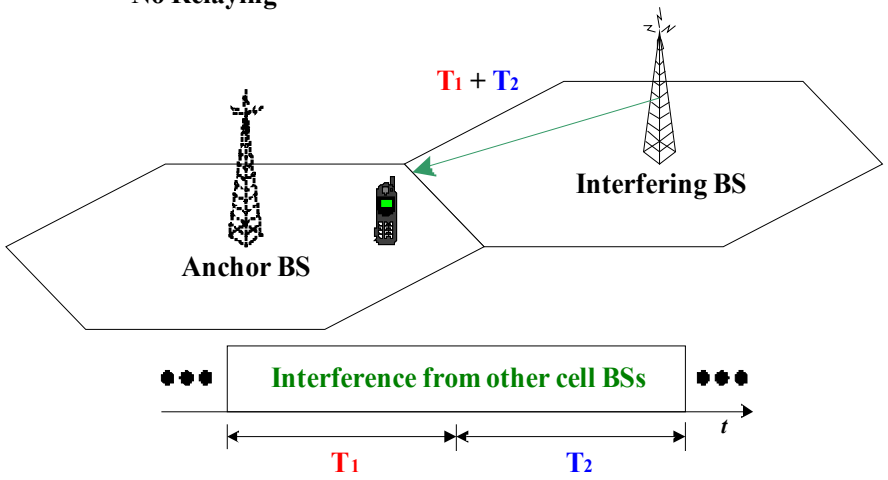


Amplify-and-Forward Relaying

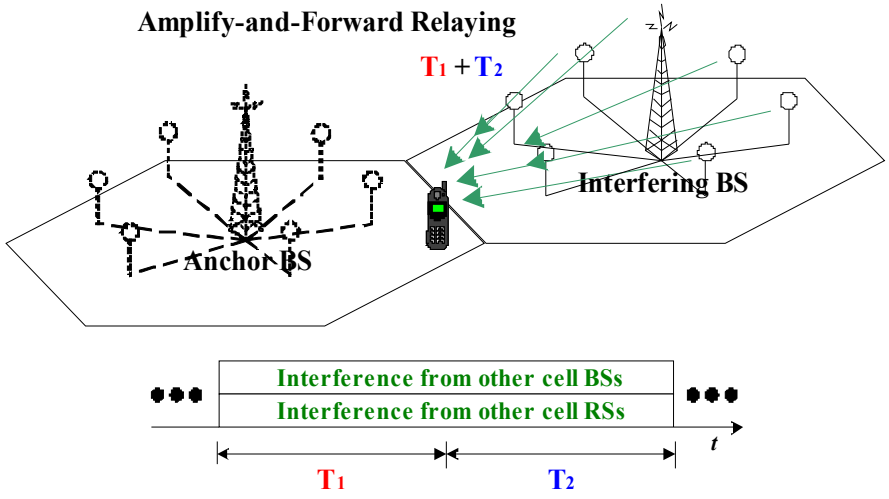


Interference Reception Scenario

No Relaying

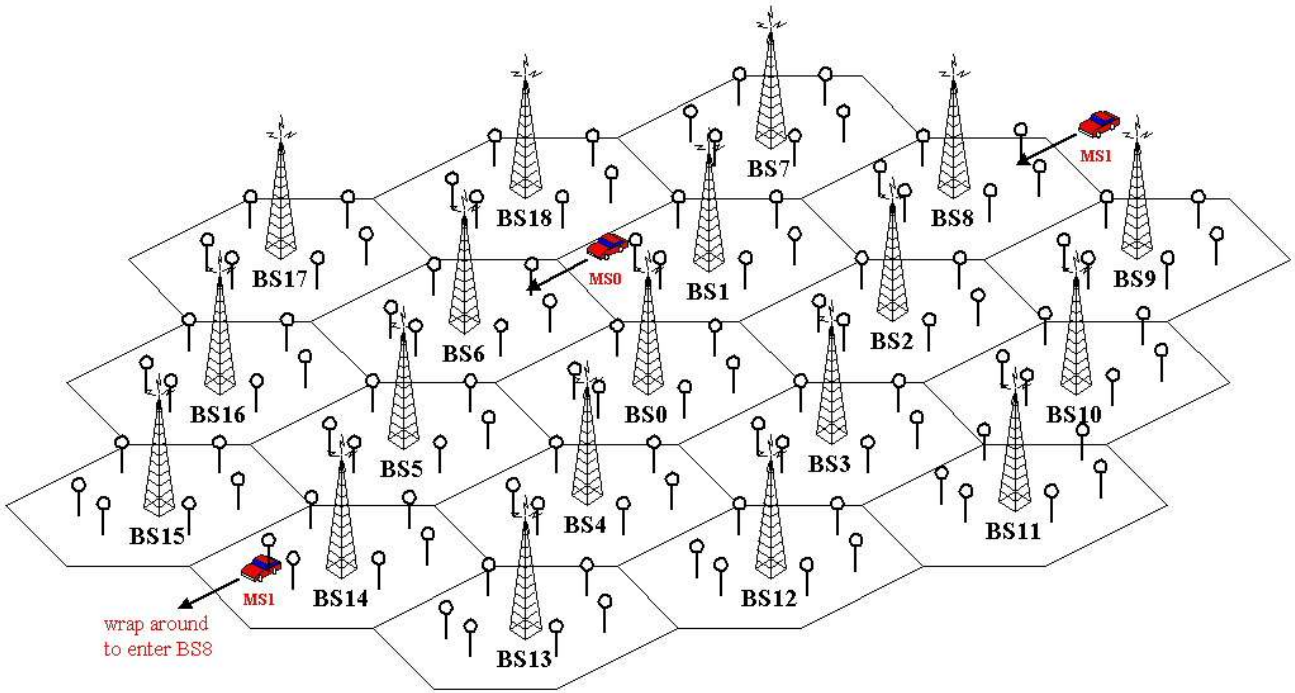


Amplify-and-Forward Relaying



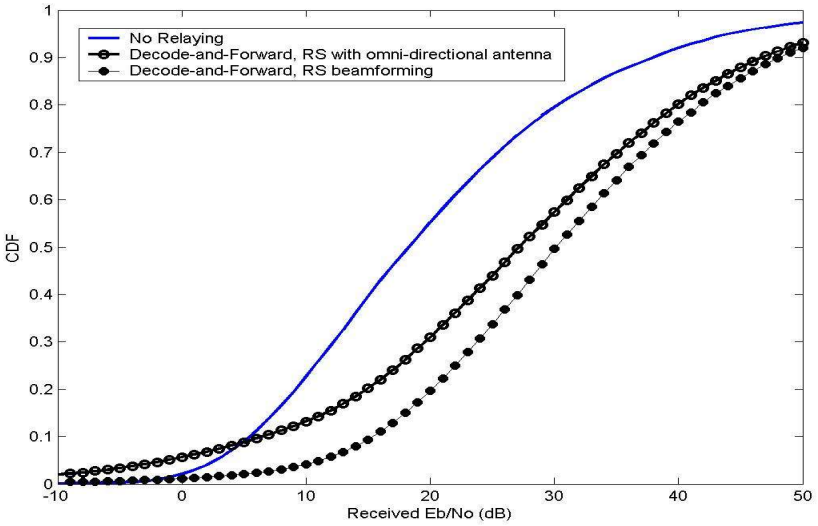
Simulation Results

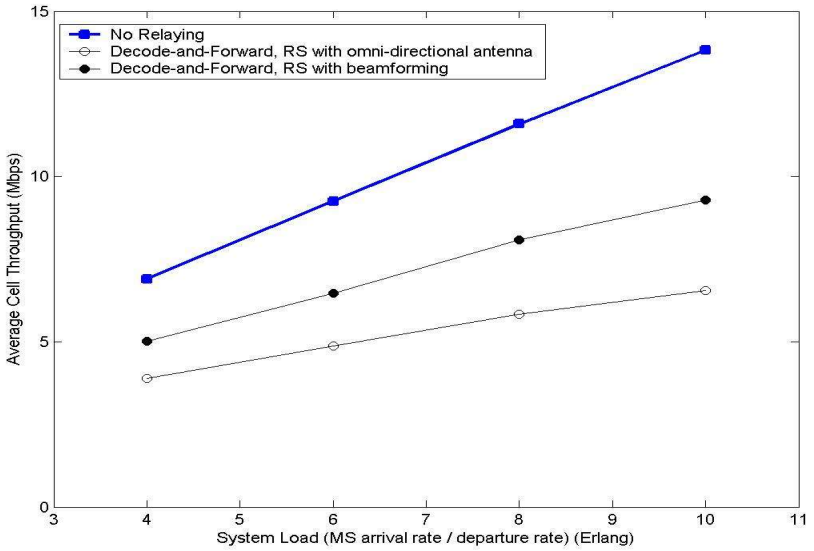
- Relay-augmented cellular OFDMA system
  - Downlink transmission
  - 19 cells with universal frequency reuse and FUSC permutation
  - Each cell has with 6 sectors and 2km coverage
  - Each cell has 6 relay stations (RS) with half base station (BS) coverage
  - Radio bandwidth: 6MHz (2048 sub-carriers)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



Simulation Results

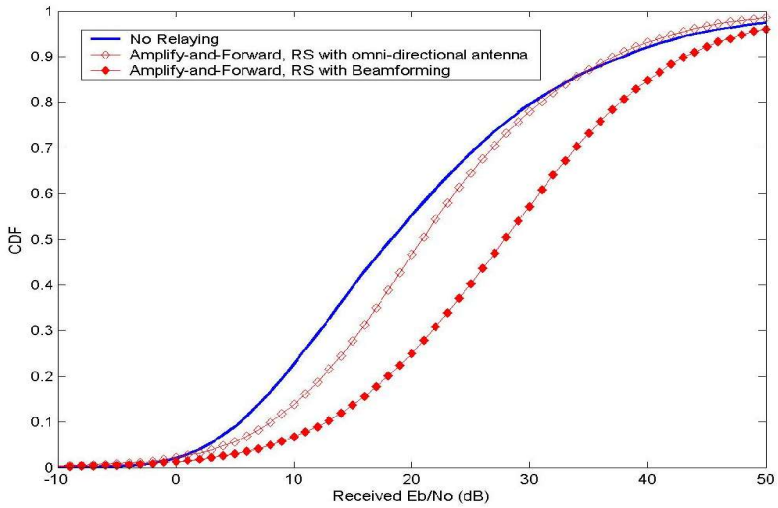
- Case I
  - Homogeneous decode-and forward relaying
- Observations
  - **Data rate coverage becomes more uniform** by increasing the percentage of high order modulation usage
  - **Throughput is reduced** by time division for BS↔MS and RS↔MS transmissions
  - Beamforming on RS can further improve performances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

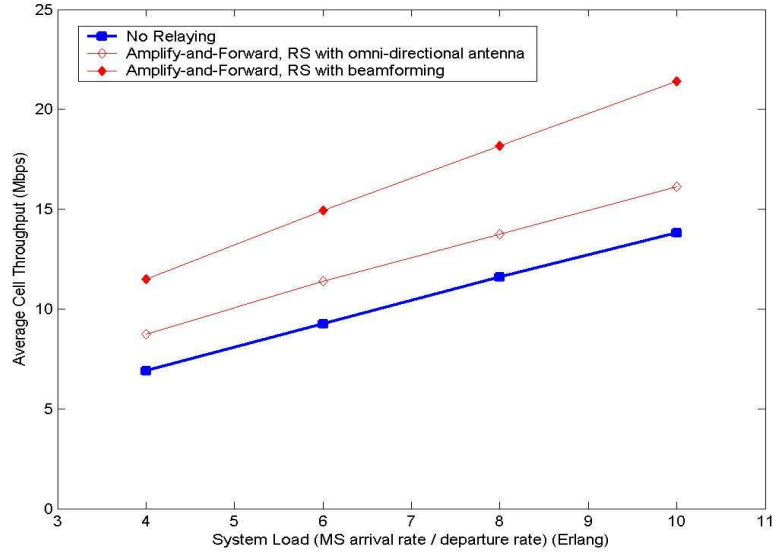




Simulation Results

- 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. 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.