

A Novel Algorithm for Utilizing Relay Stations for Enhancement Data Rate in 4G Mobile System

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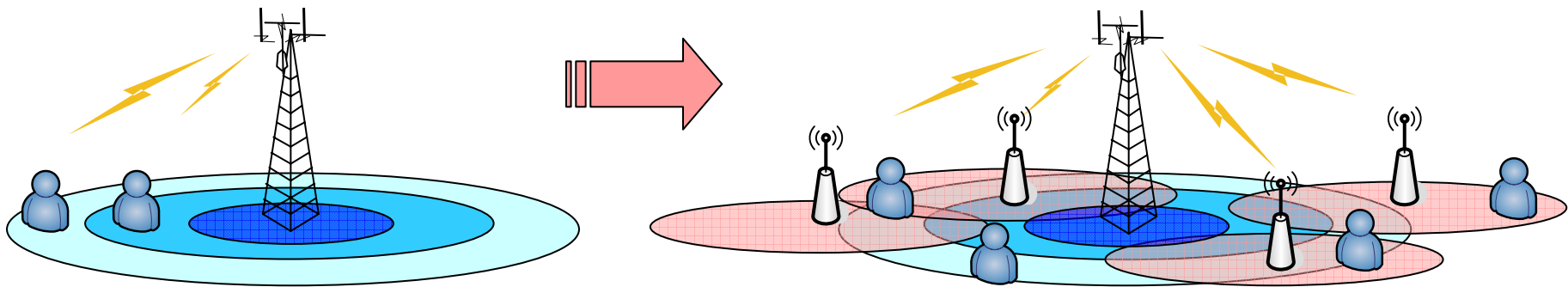
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Outline

- Introduction
- Problem Statement
- System Model and Assumption
- Proposed Algorithm
- Simulation
- Conclusions

Introduction

- Relay Station is introduced for:
 - Coverage extension
 - Throughput enhancement

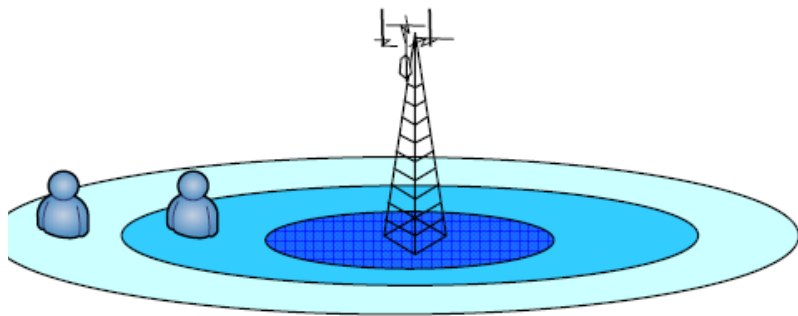


Introduction

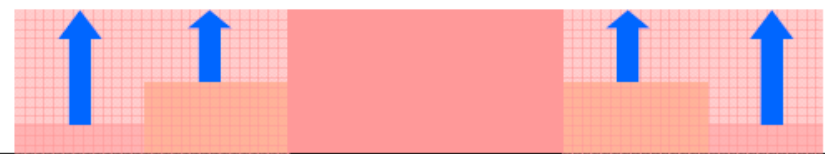
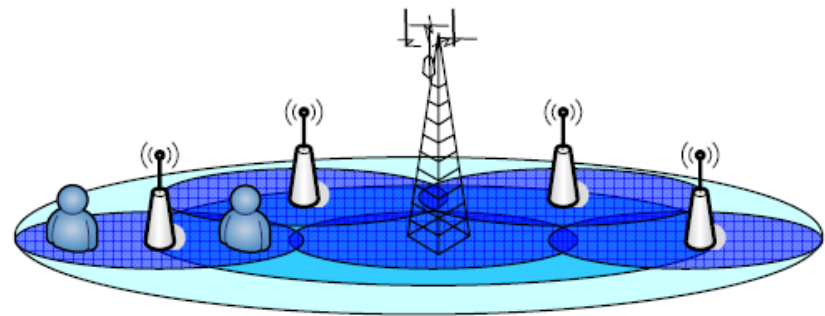
- What's IEEE 802.16j Task Group
 - One of the sub-system within IEEE 802.16 WG
 - Goals to provide the first wireless relay system
 - Backward compatible with 802.16e
 - Frame structure
 - PHY specifications
 - Network Access and operations
 - TDD system
 - PMP mode
 - License band

Introduction

- This study targets on throughout enhancement



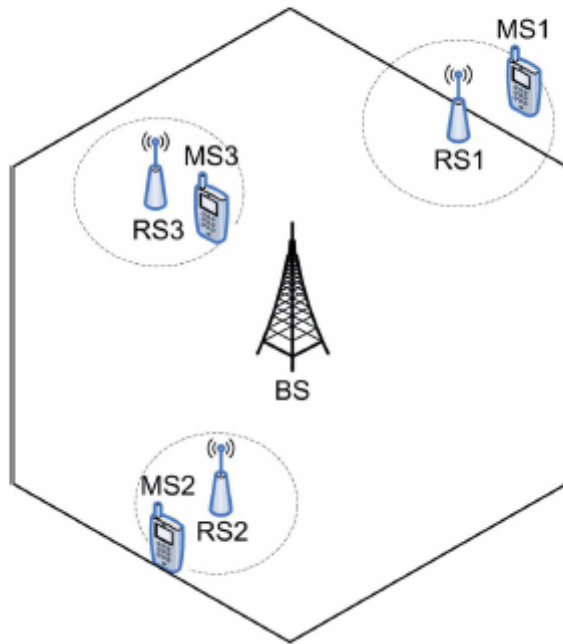
Traditional PMP



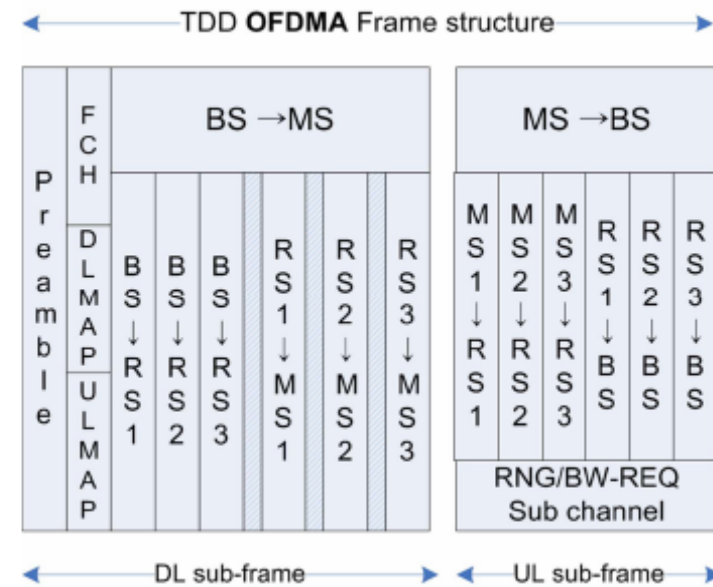
PMP + RS

Problem Statement

- The introduction of RSs causes inefficient time-slot allocation in TDD system



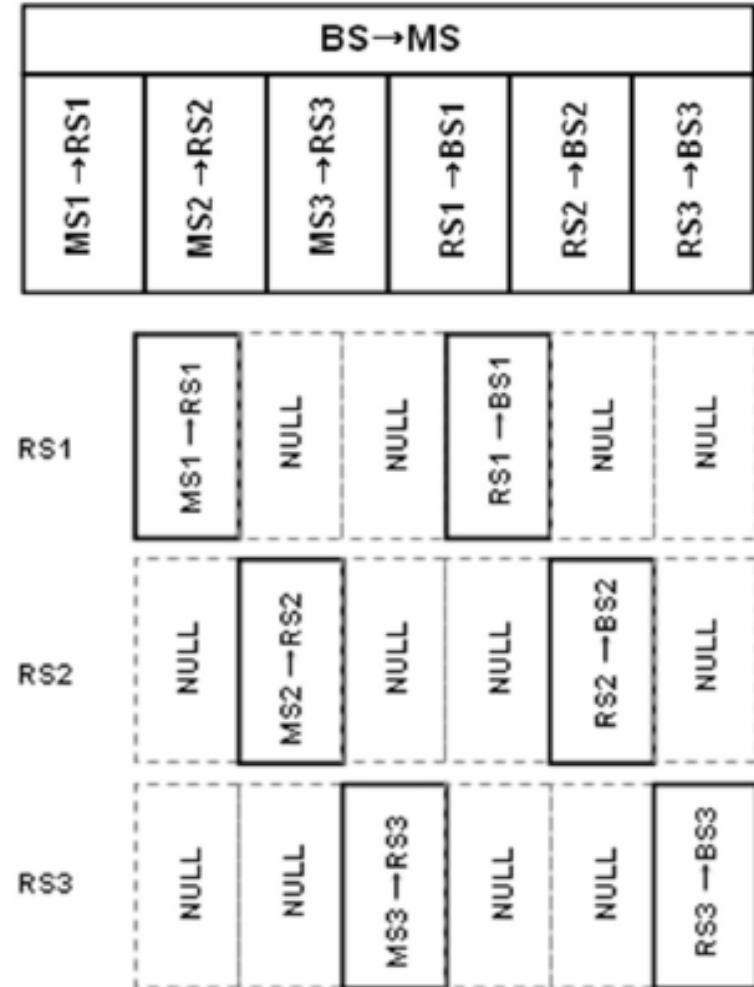
Relay Communication



Relay Frame Structure

Problem Statement

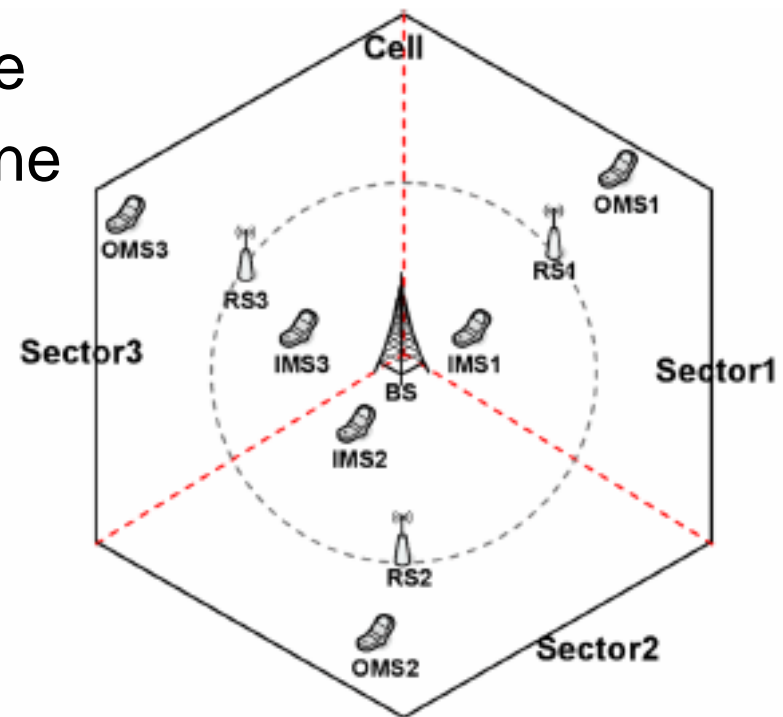
- Null slot:
 - Non-operation slot
 - Causes the opportunity reduction in connecting a BS and other MSs
- The problem of inefficient allocation gets worse when number of RS increases



Uplink frame

System Model and Assumption

- A cell is sectorized into 3 sectors and divided into inner and outer zone
 - IMS_i : the i_{th} MS in inner zone
 - OMS_i : the i_{th} MS in outer zone



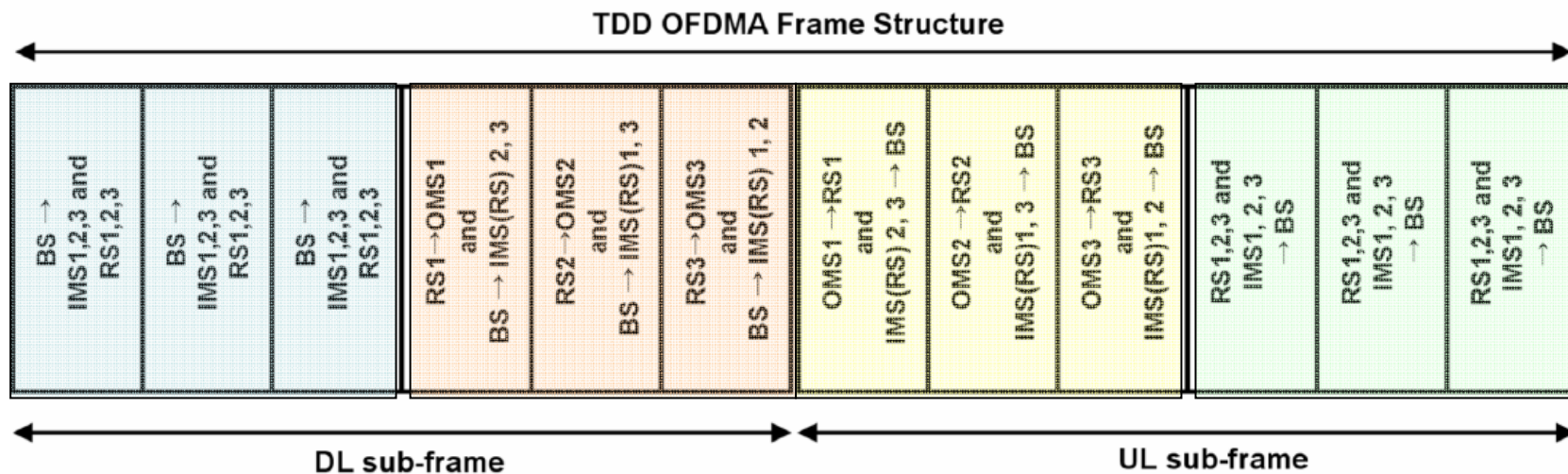
System Model and Assumption

- RS in the cell takes charge of relaying between the OMSi and BS
- It is assumed that
 - A BS transmits with just enough power to reach MSs in the inner zone
 - RS transmits with enough power to reach MSs in outer zone

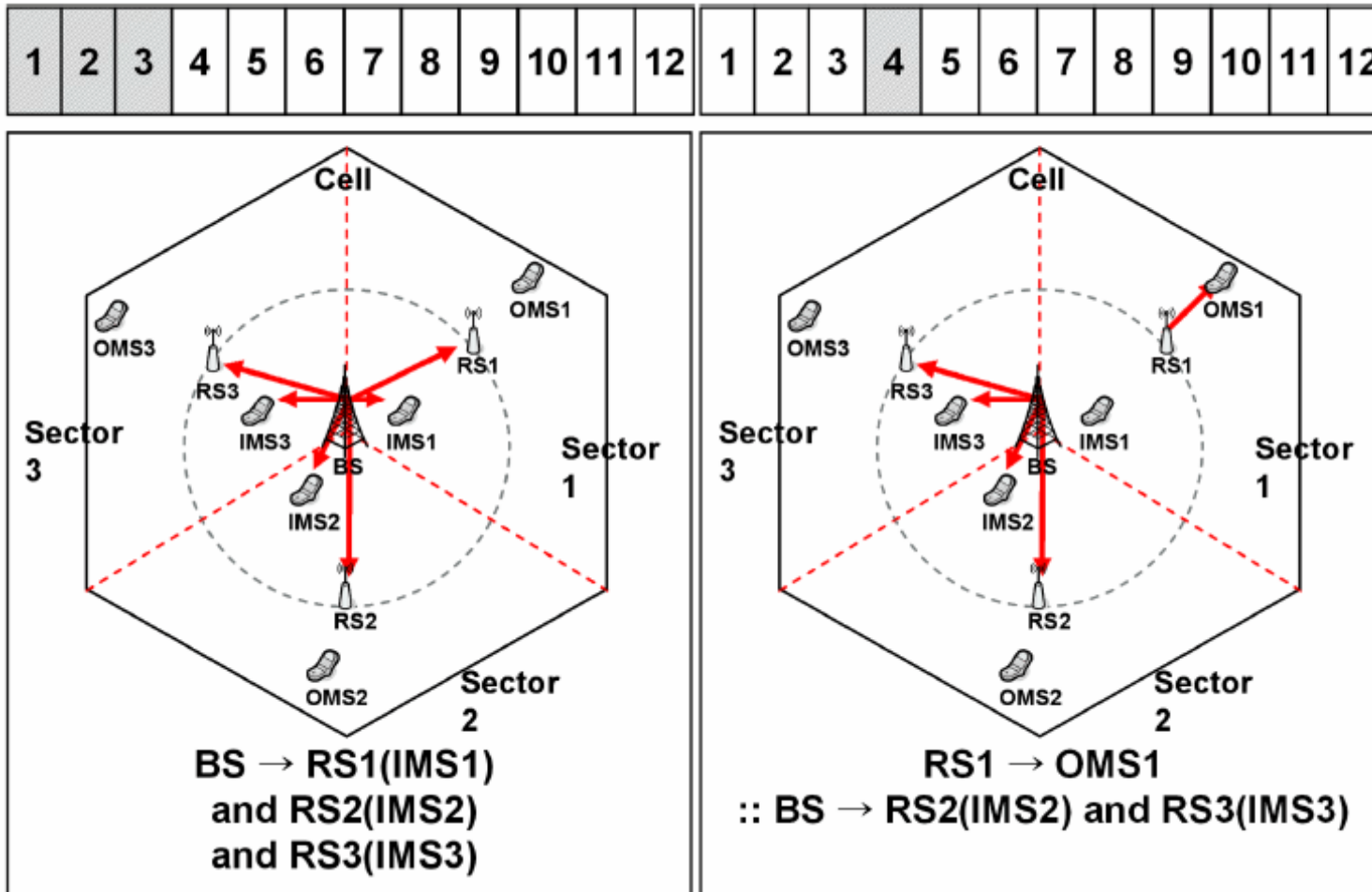
Proposed Algorithm

- DL sub-frame is divided into two parts
 - Slot 1 to 3 : BS-to-{RS, IMS}
 - Slot 4 to 6 : RS-to-OMS and BS-to-IMS*
- UL sub-frame
 - Slot 7 to 9 : OMS-to-RS and IMS*-to-BS
 - Slot 10 to 12 : {IMS, RS}-to-BS

* : particular sector



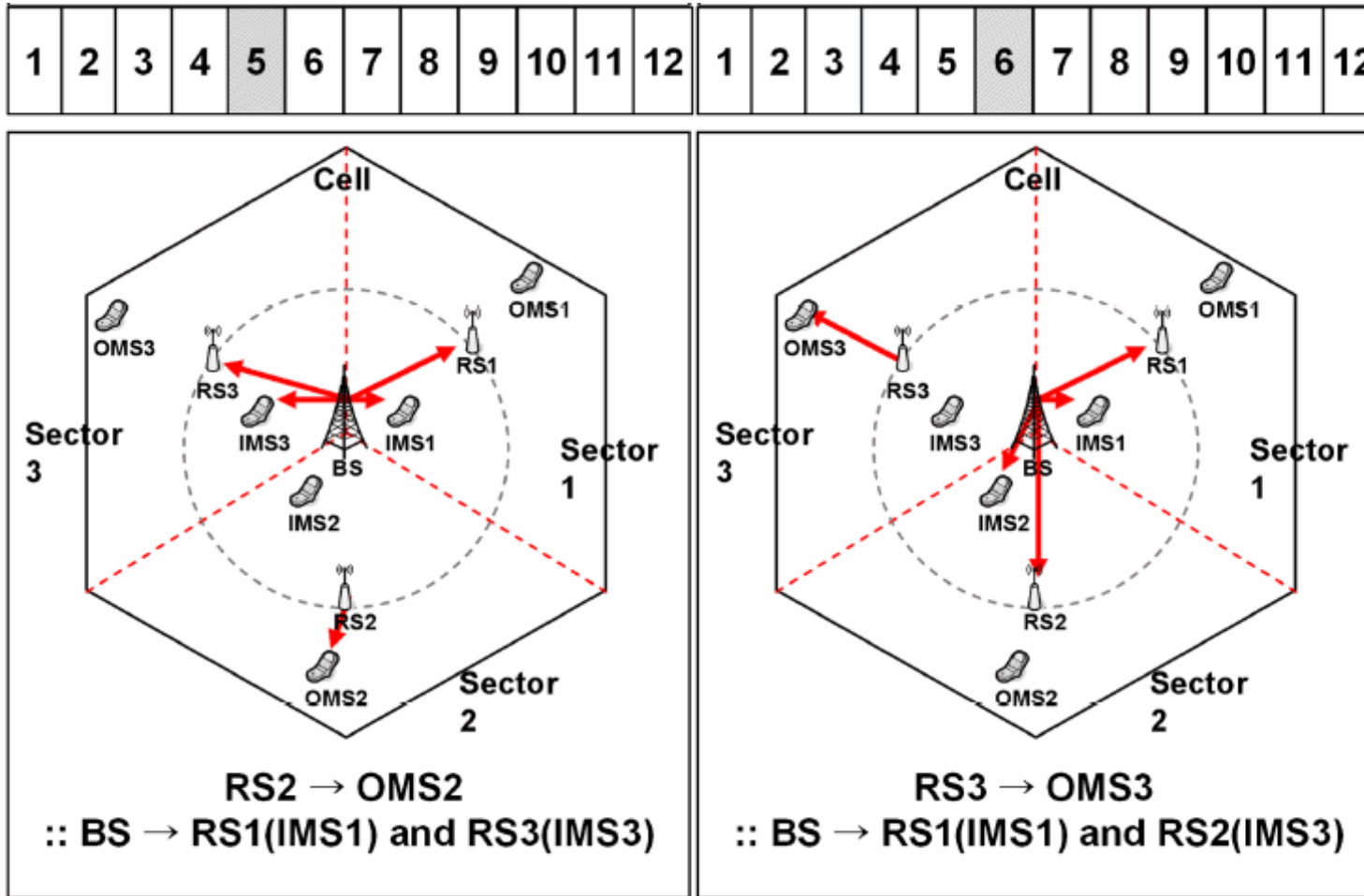
Proposed Algorithm



BS=> RS1/RS2/RS3
BS=>IMS1/IMS2/IMS3

RS1=>OMS1
BS=> RS2/RS3
BS=>IMS2/IMS3

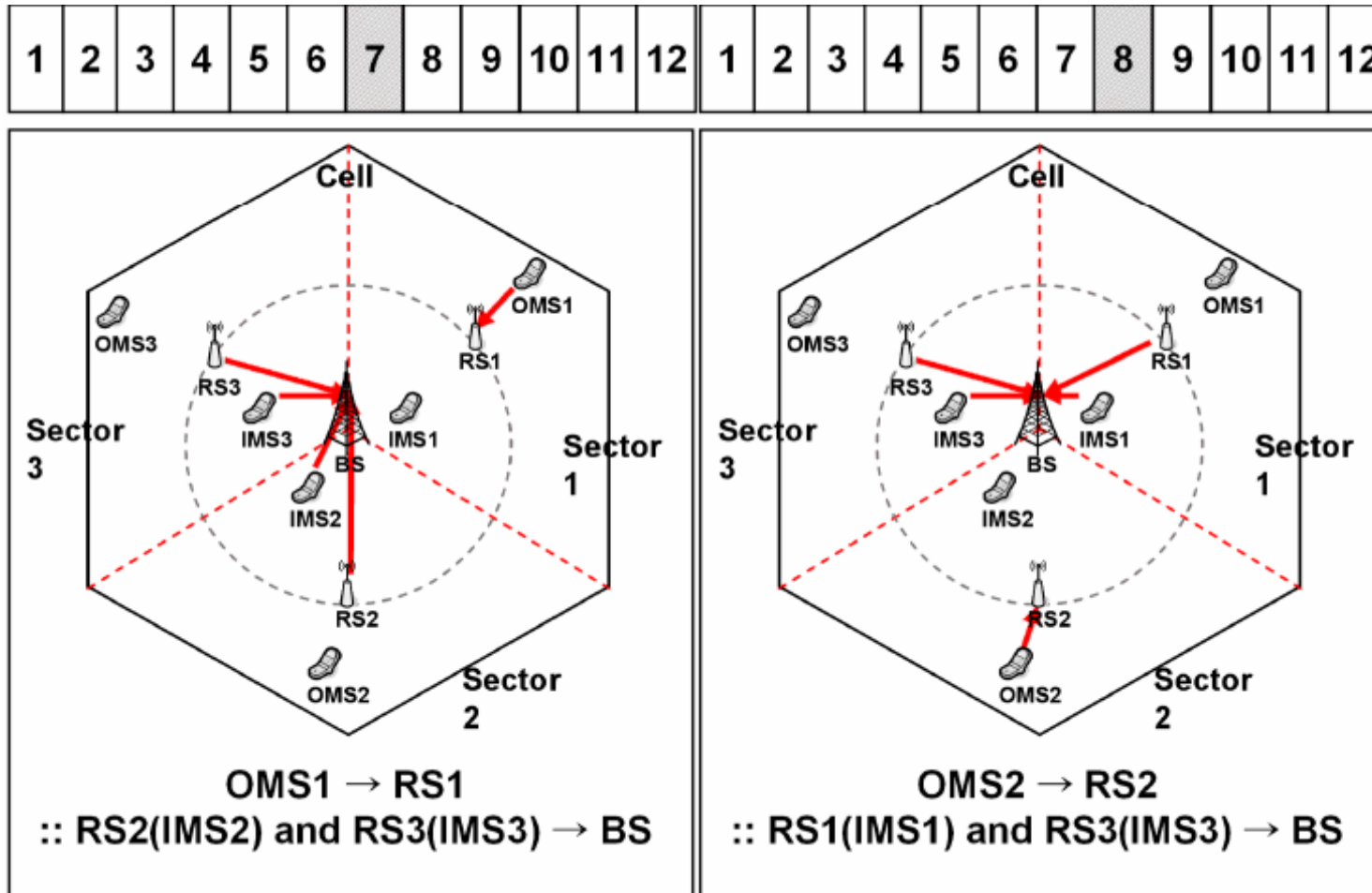
Proposed Algorithm



RS2=>OMS2
 BS=> RS1/RS3
 BS=>IMS1/IMS3

RS3=>OMS3
 BS=> RS1/RS2
 BS=>IMS1/IMS2

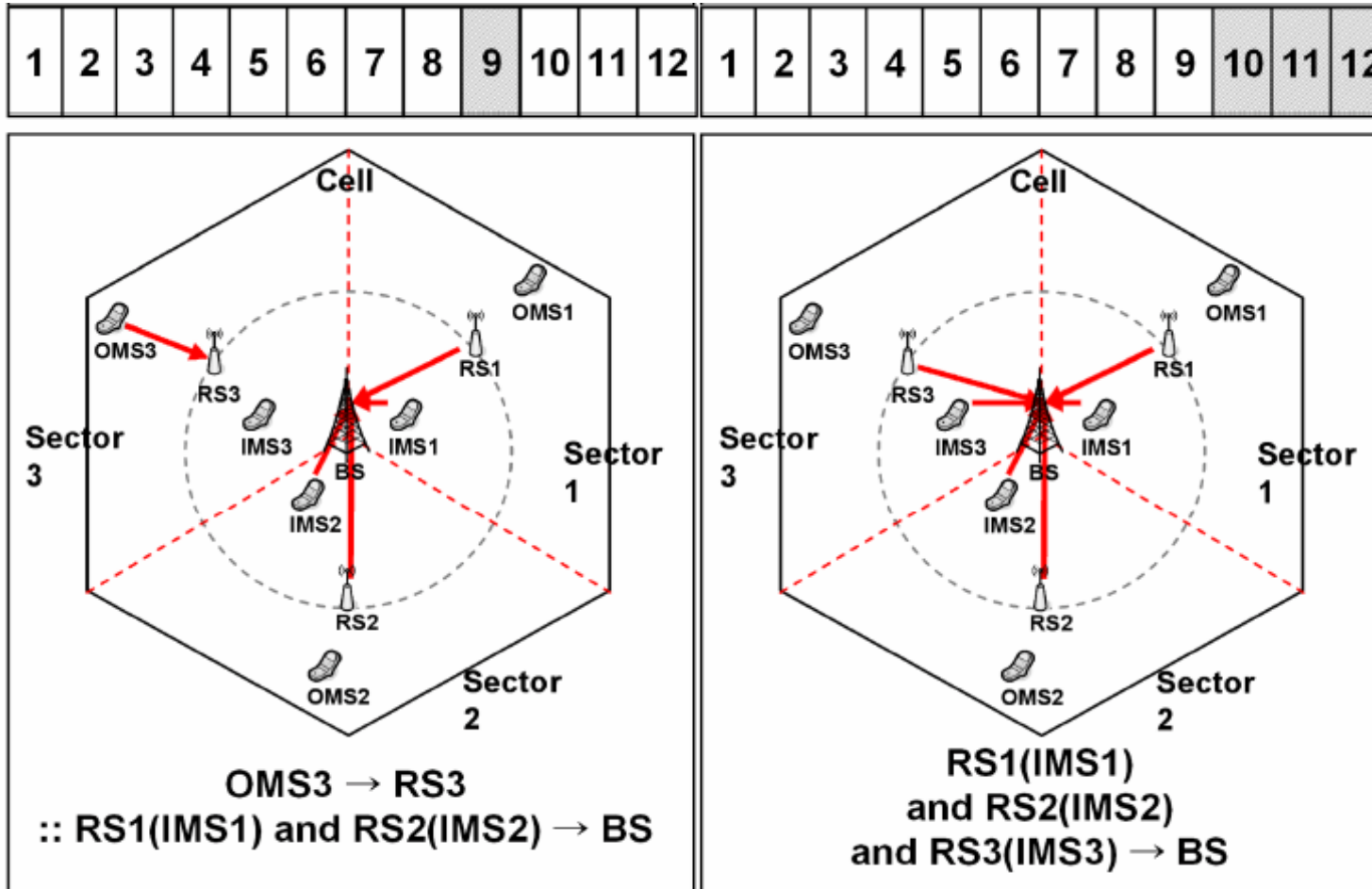
Proposed Algorithm



OMS1=>RS1
 RS2/RS3 => BS
 IMS2/IMS3 => BS

OMS2=>RS2
 RS1/RS3 => BS
 IMS1/IMS3 => BS

Proposed Algorithm



OMS3=>RS3
 RS1/RS2 => BS
 IMS1/IMS2 => BS

RS1/RS2/RS3 => BS
 IMS1/IMS2/IMS3 => BS

Proposed Algorithm

- Advantages
 - IMSs in two neighbor sectors can operate simultaneously when the third RS transmit signal to its OMS
 - Null slot can be utilized
 - Throughput increases as the number of RSs in a sector increases
 - MS can be also covered by more RSs

Simulation

$$SIR = \frac{\text{TransmittedPower}}{\sum \text{IntracellInterference} + \text{ThermalNoise}} \quad (1)$$

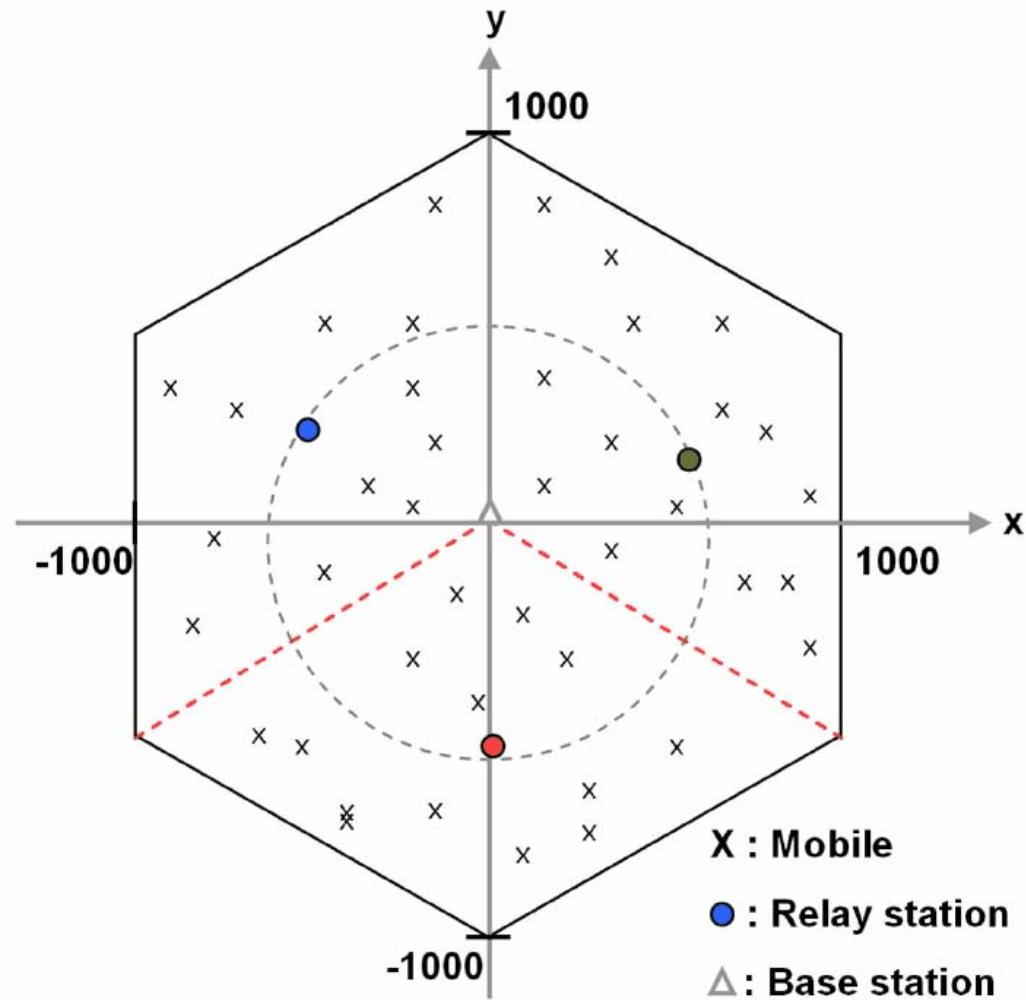
$$\text{CAPACITY} = B \cdot \log_2(1 + SIR) \quad (2)$$

$$G = \begin{pmatrix} G_{11} & G_{12} & \dots & \dots \\ G_{21} & G_{22} & \dots & \dots \\ \vdots & \vdots & \ddots & \\ \vdots & \vdots & & \ddots \end{pmatrix}$$

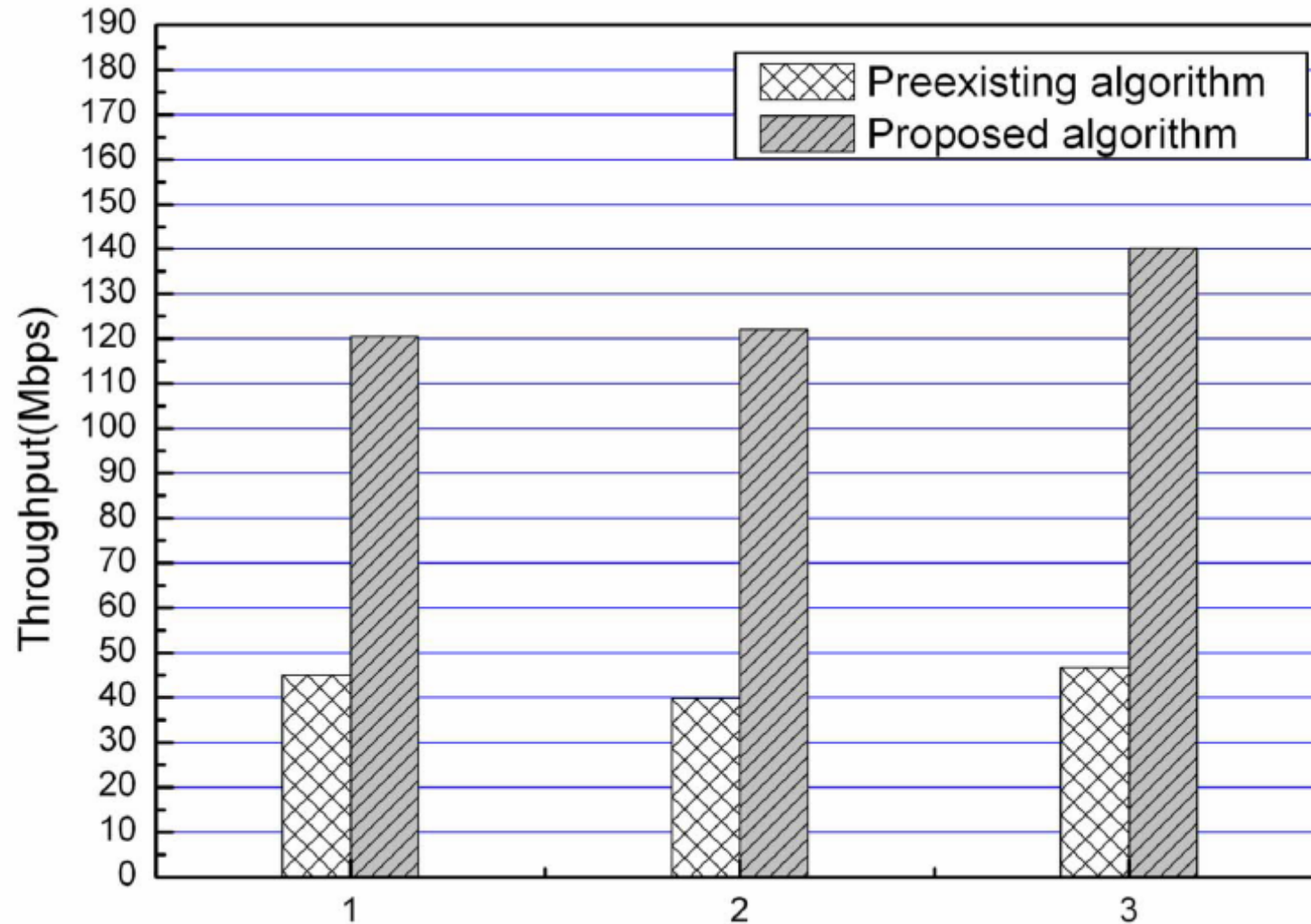
SIMULATION PARAMETERS

Parameter	Value(Unit)
Cell radius	1 (Km)
Inner zone radius	0.65 (Km)
BS power	20 (W)
RS power	10 (W)
MS power	2 (W)
Velocity of mobile	1 (m/s)
System bandwidth	1.25(M)
Thermal noise	-120 (dBm)
Observation time	1 (second)

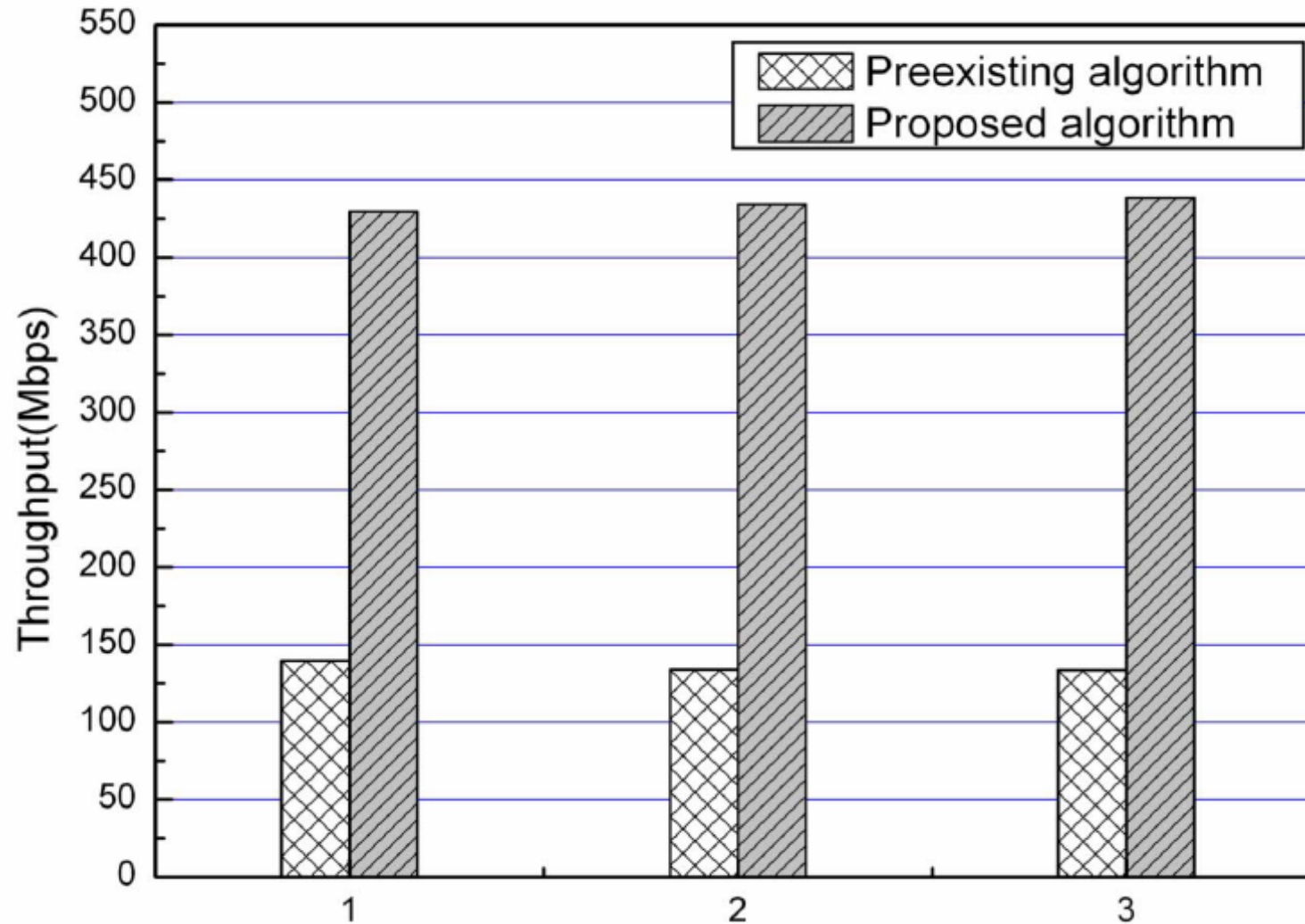
Simulation



Outer Zone Throughput



Inner Zone Throughput



Conclusions and Discussion

- The proposed scheme introduces sectorization and division technique of a cell and a RS is arranged in each sector
- Through simulations
 - Throughput increases about three times when the algorithm is applied
 - The proposed scheme allocates timeslot to each sector, not the RS
 - RS improves channel condition, and then increases system data rate
 - The system uses low power, inter-cell interference from neighbor cells will be reduced => effect system data rate also