A COMBINATIONAL USERS SELECTION SCHEME TO ENHANCE EFFICIENT RESOURCES ALLOCATION IN A FEMTOCELL

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INTRODUCTION

PROBLEM BACKGROUND

- Ever growing demand for mobile services
- More users need to get connected
- Need for higher bandwidth and faster connectivity
- Need to improve the quality of service.

PROBLEM STATEMENT

- Need to improve resource allocation
- Need to accommodate as many users as possible
- Factors that pose challenges to resource availability include:
  - SINR (Signal to Interference plus noise ratio)
  - Mobility
  - Power Levels
  - Optimal data rates

Main Objective

Development of a combinational algorithm to dynamically determine the best group of users to allocate resource requests in comparison to available resources in a given femtocell

SPECIFIC OBJECTIVES

- Determination of the effectiveness of combinations as a users’ arrangement technique
- Validation of combinational users’ selection scheme as an improvement on resource allocation technique over the existing methods.

JUSTIFICATION

- This research improves the quality of service being offered to cell phone users by improving the effectiveness at which resources are allocated in a femtocell

LITERATURE REVIEW

HISTORY OF EVOLUTION OF MOBILE NETWORKS

1G

- 1G - Japan by Nippon Telegraph and Telephone (NTT) in 1979.
- Total Access Communications Systems (TACS) and Advanced Mobile Phone Systems (AMPS)
- They utilized analog transmission, Circuit switching
- They had limited capacity and mobility
- Incompatibility between different mobile networks

2G – 2.75G

- Introduced in early 1990s
- Used Digital voice encoding
- Introduction of short Messaging Service (SMS).
- Developed schemes such as: Time Division Multiplex (TDMA) and Code Division Multiple Access (CDMA)
- Introduction to sharing of radio resources – Packet switching

3G

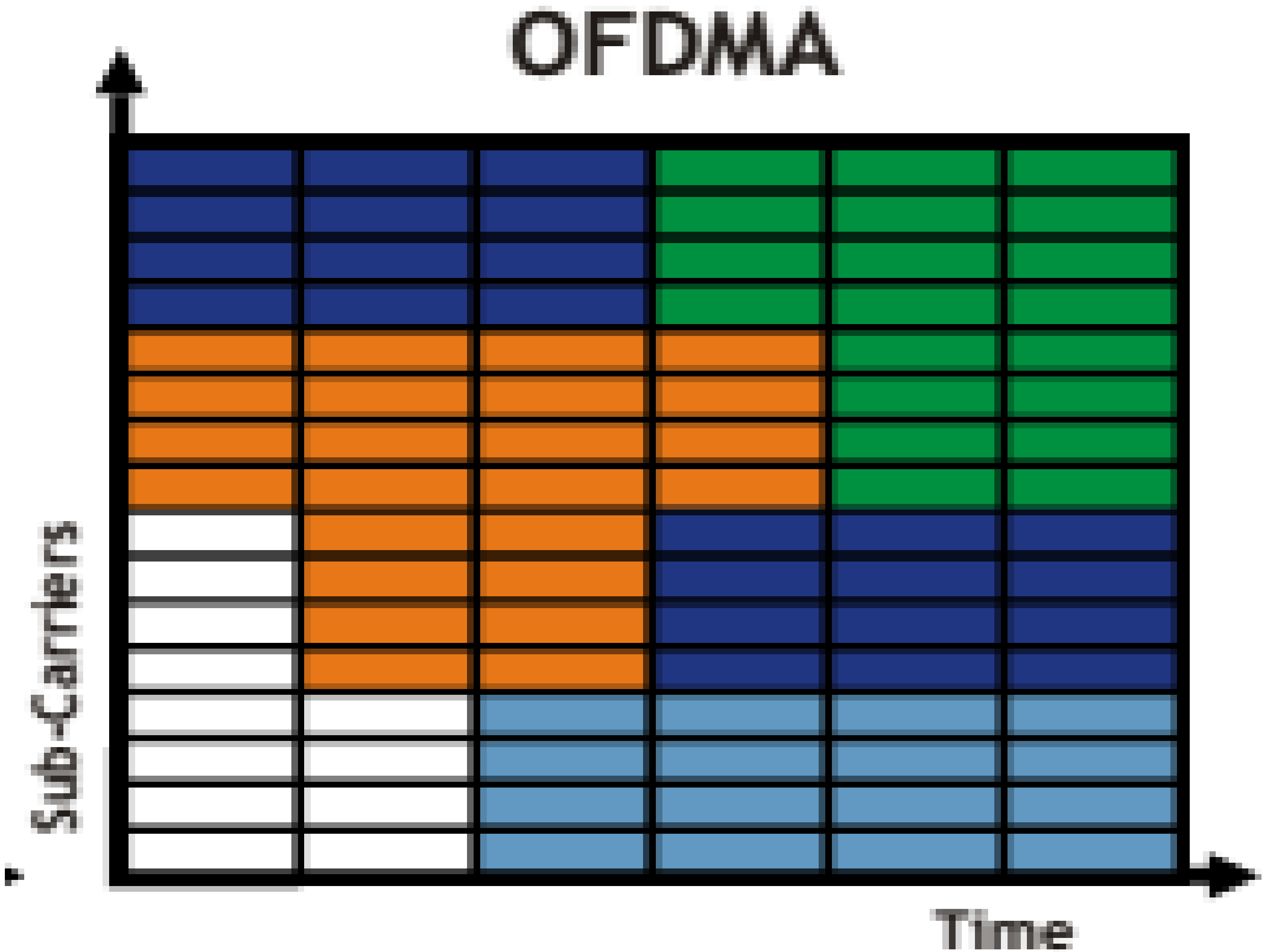
- UMTS (Universal Mobile Telecommunications Service) and W-CDMA (Wideband Code Division Multiple Access)
- High data rates

4G - LTE networks

- Next Generation Networks – all IP platforms
- Very high speeds: 100Mbps on the downlink and 50Mbps on the uplink

OFDMA

- Multiple users are allocated radio resources within the network
- **Subcarriers** -splitting of the frequency bandwidth into small sets of 15 KHz frequencies which are then allocated to users for modulation
- In the TDD, LTE uses radio frames. Each has 20 slots of 0.5 ms each. (each slot has 6 or 7 symbols)
- Modulation schemes normally used are QPSK, 16 – QAM and 64-QAM. [1] – Adaptive modulation and coding.



OFDMA
Sub-Carriers
Time

FEMTOCELLS

- Also referred to as Home eNodeB (HeNB).
- Low powered base stations are stationed *indoors* for mobile services provision in residential or enterprise use in workplaces
- Overall survey - indoors and in-building mobile services use at around 70%
- Are connected back to the mobile network operator via broadband connection, optical fibre cables or Digital Subscriber Lines (DSL)

- 40% of the users in building and residential areas experience mobile access coverage problems
- Can support up to 32 active calls depending on configuration
- Self Organizing Networks technologies. femtocells are configured and deployed so as not to cause interferences with the macrocells outside

LTE Parameters

1. **CHANNEL QUALITY INDICATOR (CQI)**
   – Measure of the channel's worth in terms of transmitting information to and from Femtocell
2. **SIGNAL TO NOISE RATIO**
   – Ratio of meaningful useful power in a signal in comparison to background noise

$$SNR = \frac{P_{SIGNAL}}{P_{NOISE}}$$

3. SIGNAL TO INTERFERENCE PLUS NOISE RATIO (SINR)

– Ratio of the power in a signal to the sum of the average of the interference power from adjacent cells

$$SINR = \frac{S}{I + N}$$

- S is the average signal power
- I is the interference
- N is the Noise.

REVIEW OF EXISTING SCHEMES

1. **RATE CRAVING GREEDY (RCG) AND AMPLITUDE CRAVING GREEDY (ACG)**
   - Checks for users with the highest transmission rate and gain then allocates the available subcarrier to that user
   - Target in usually is to get as much data as possible through the system

Area of improvement: Need to consider resource requests alongside the available ones so as to allocate the best combinations of users

2. MAXIMUM FAIRNESS ALGORITHM

– Ensures that the minimum user’s data rate is maximized
– Water filling power allocation algorithm is carried out to distribute power to users with low power levels
– All users are allocated equal power

Drawback:

– Lowers SINR for users with higher values
– Users with low data rates who have low signal to noise ratio tend to get the most resource allocation

3. PROPORTIONAL RATE CONSTRAINTS ALGORITHM

– A predetermined system parameter β_k, is introduced as a constraint to each user's data rate of transmission, given by R_k

$$\frac{R_1}{\beta_1} = \frac{R_2}{\beta_2} = \cdots \dots\dots\dots\dots\dots \frac{R_K}{\beta_k}$$

– Data rates can be varied at any level by varying β_k
– Takes care of the throughput.
– **Drawback**: Variation of users' data rates affect quality of SINR
– **Area of improvement:** additional parameter of considering the resources requests plus present ones

4. MOBILITY AWARE RESOURCE ALGORITHM

- A hybrid centralized/distributed resource allocation algorithm
- Stages involved:
  - Cluster formation
  - Resource allocation with user mobility awareness
  - Global and Local user position prediction

- **Drawbacks**
  - position of a user at a particular femtocell which may not be very accurate at times
  - May have problems due to crisscrossing mobility paths taken by many users

COMBINATIONS

- A mathematical evaluation of arranging objects in several manners in a given space.
- Given that 'x' is a subset sample from a population of 'n'

$$\frac{n!}{x!(n-x)!} = {}^{n}C_{x}$$

- Gives the number of different ways 'n' items can be arranged in 'x' spaces

Combinational users selection scheme steps

1. Determine the number of resource requests from ‘n’ users.
2. Determine the number of available resources ‘x’
3. Determine the user individual Signal to interference plus noise ratios (SINRs)
4. Do all possible combinations of all users to determine all possible users’ groups
5. Sum users’ group to determine the total user group SINR values

6. Arrange the users' groups SINR total in an ascending order. (Lowest to Highest)
7. Select the last group with the highest group SINR total
8. Allocate the users in that group (best SINR levels)

KEY FINDINGS

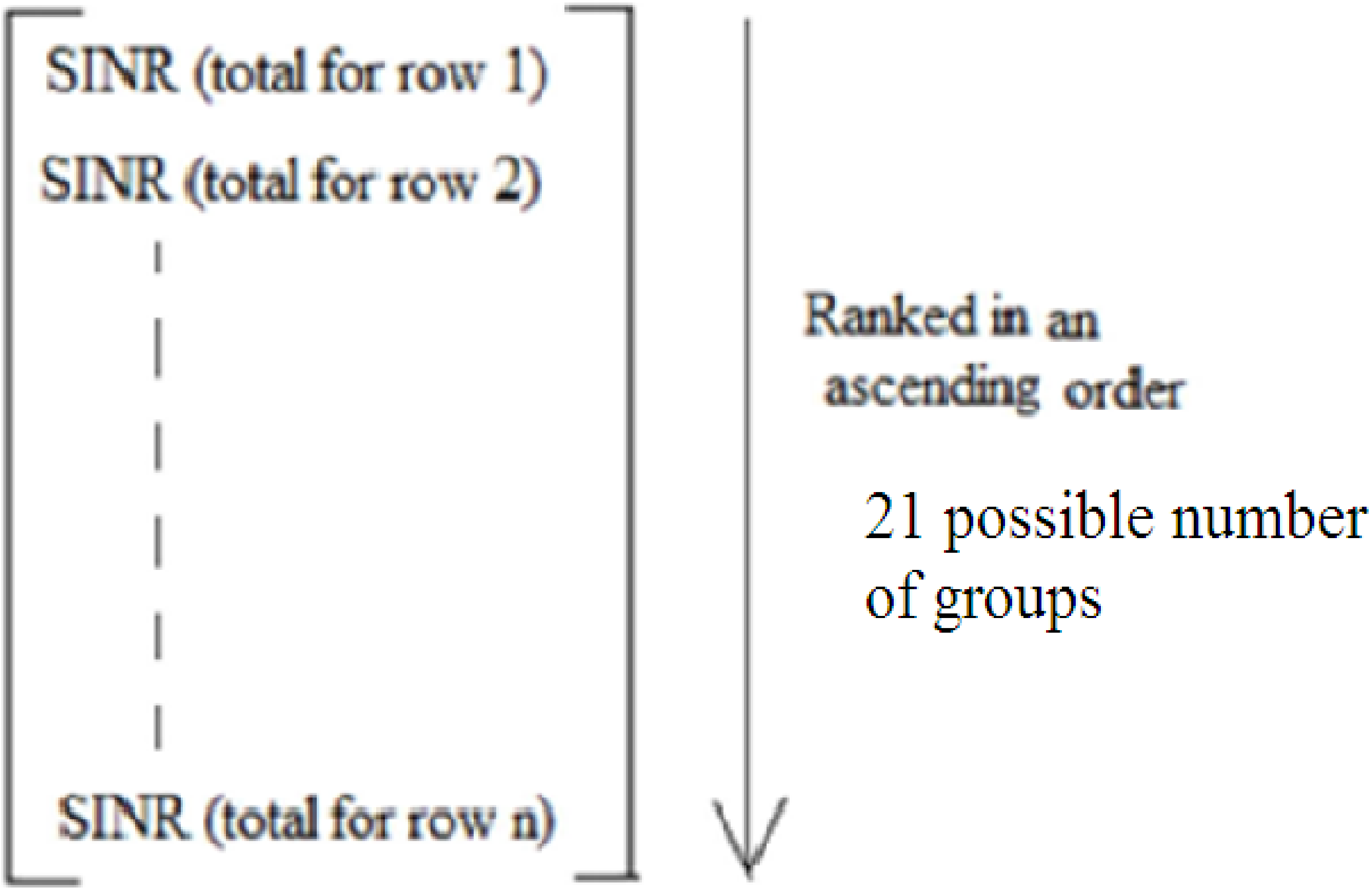
- A sample of 7 users in a femtocell
- The individual SINR values of the users is determined
- Only 2 resources available
- From combinations, a total of 21 possible groups can be formed [7C2 = 21]
- Their total SINR values are tabulated alongside their various combinations and ordered in an ascending manner
- The group with the highest SINR values is allocated the resources

21 - User groups

1	2
1	3
1	4
1	5
1	6
1	7
2	3
2	4
2	5
2	6

2	7
3	4
3	5
3	6
3	7
4	5
4	6
4	7
5	6
5	7
6	7

Matrix of users groups’ total SINR values



Groups of 2 users

Merits of the Combinational users selection approach

1. Takes into account the number of users resource requests versus the number of resources available at the femtocell
2. The algorithm does all possible combinations of users giving an all overview of possible users’ SINRs
3. Can be implemented in a dynamic environment where users mobility and SINRs vary from time to time.

THE END

THANK YOU

QUESTIONS AND RESPONSES