

Comparative Study of Different Topology of Cooperative Content Distribution Using Femtocell

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ABSTRACT: Content distribution is the process of delivery of media content through a delivery medium. In conventional method of content distribution every mobile terminal(MT) individually download the entire content from the Base Station but in cooperative content distribution (CCD), the mobile terminals (MTs) mutually cooperate with each other to deliver the content obtained from the Base Station. CCD is more efficient in terms of energy than traditional method of content distribution because in CCD the amount of long range transmissions has been reduced by increasing the amount of transmissions in short range. This paper suggests an CCD algorithm by using femtocells and also compares the efficiency of the suggested algorithm in three different network topologies i.e. RING, MESH, RING-STAR topologies and concludes that RING-STAR topologies is more energy efficient than the other two topologies.

KEYWORDS: CCD(Cooperative Content Distribution), Femtocell, Ring, Mesh and Ring-Star topology

I.INTRODUCTION

The first GSM call took place nearly 23 years ago i.e. in 1991 in Finland and there were over 2 billion GSM users after 15 years [1]. In the same time, the numbers of internet servers are also increasing at a high rate. In order to serve all those users both the wired and wireless networks are rising at the same speed. It is assumed that in future, Information and communication technologies (ICT) will be the major contributor to the overall emissions of the green house gases[1]. At present, ICT produces 2% of total global CO₂ emission which is equal to one fourth of the CO₂ production of cars [1]. ICT is developing day by day in order to adjust with the increasing demands of the users. As a consequence of this, the percentage of energy consumed by the wireless communication system is also increasing. In order to prevent serious change in the climate, there is a need for green network, i.e. the wireless communication system should be made more energy efficient. Many works had been done in order to reduce the energy consumption of wireless network but they mainly focuses on the mobile stations, i.e. the uplink energy constraints, limited battery life or just transmission energy consumption [2][3][4]. But in a cellular network the energy consumed by the mobile stations is negligible as compared to the energy consumed by the Base Station. It has been stated that base stations consume 80% of the total energy of the cellular network [1]. Many works had been done in the field of energy efficient content distribution, but majority of them concentrate on the energy consumption of MTs during the process of content distribution.

In case of MTs it has been proved that the traditional approach where each MT downloads the entire content from the server on its own is more energy consuming than the CCD, where the content is divided into parts and each mobile terminal downloads a subsets of the parts of the content from the server and then distribute among themselves [5]. In this paper, an algorithm has been suggested which combines CCD with femtocells and it also compares the consumption of energy the suggested algorithm in different network topologies.

II. FEMTOCELL AND COOPERATIVE CONTENT DISTRIBUTION

A recent development in the area of wireless networks is femtocells. They are home based data access points that are installed by users to get better voice and data coverage inside the houses. Cooperative content distribution is a technique where every mobile terminal cooperates with every other terminal to distribute the content that it had downloaded from the server to every mobile terminal. Cooperative content distribution proved to have a lot of advantages in terms of increasing the network throughput and decreasing the energy consumption of the network.

A cooperative wireless network architecture is presented in order to reduce the consumption of energy in the MTs during real-time video streaming. It has been shown that the high consumption of energy of battery-operated MTs is one of the major limiting reasons for future wireless communication systems. Every MT receives from the server one part of the video stream that is divided using multiple description coding (MDC), and sends it to other MTs over SR links either by multicasting or unicasting.

III. PROPOSED ALGORITHM

The suggested algorithm combines CCD with femtocells.

ALGORITHM

Step 1: The Femtocell checks for the active number of mobile stations in its range. Then assigns the value to a variable N .

Step 2: The femtocell divides the total data into K/N parts.

Step 3: A **circular queue** is maintained for the mobile stations and A **Stack** is maintained for the data parts in the Femtocell.

Step 4: The data pointed by *Stack pointer* is sent to the mobile station pointed by the *Front* of the circular queue and waits for the Acknowledgement.

Step 5: If positive Acknowledgement is received by the Femtocell, then *stack pointer* and *Front* are decreased by 1.

If negative Acknowledgement is received by the Femtocell, then only *Front* is decreased by 1 and the *stack pointer* remains the same.

Step 6: Repeat Step 4 and 5 until both the Stack and Circular queue are empty.

Step 7: Content Distribution complete.

Now each of the mobile station has a part of the data and there is a need to send each part of data to all the mobile terminals so that every station gets the full data. For this purpose, every mobile terminals must cooperate with each other to distribute the data. For this cooperation, we have considered different network topologies i.e ring, mesh and ring-star topology.

The algorithm for RING topology:

Step 1: Starting from the first point (i.e., mobile station), the mobile sends all data it contain to the next mobile.

Step 2: On receiving the data, the mobile appends it along with its previous data, discarding the one which it already has.

Step 3: Repeat step 1 and 2 until each mobile has all the data.

The MESH topology follows the following algorithm

The algorithm for MESH topology:

Step 1: Each mobile sends its data to all the other devices present in the network.

Step 2: On receiving, the mobile appends particular data to particular position, discarding the data which it previously has.

As it is a mesh topology, after each mobile transmitting one time, all the devices will have the total data.

The algorithm for RING_STAR topology:

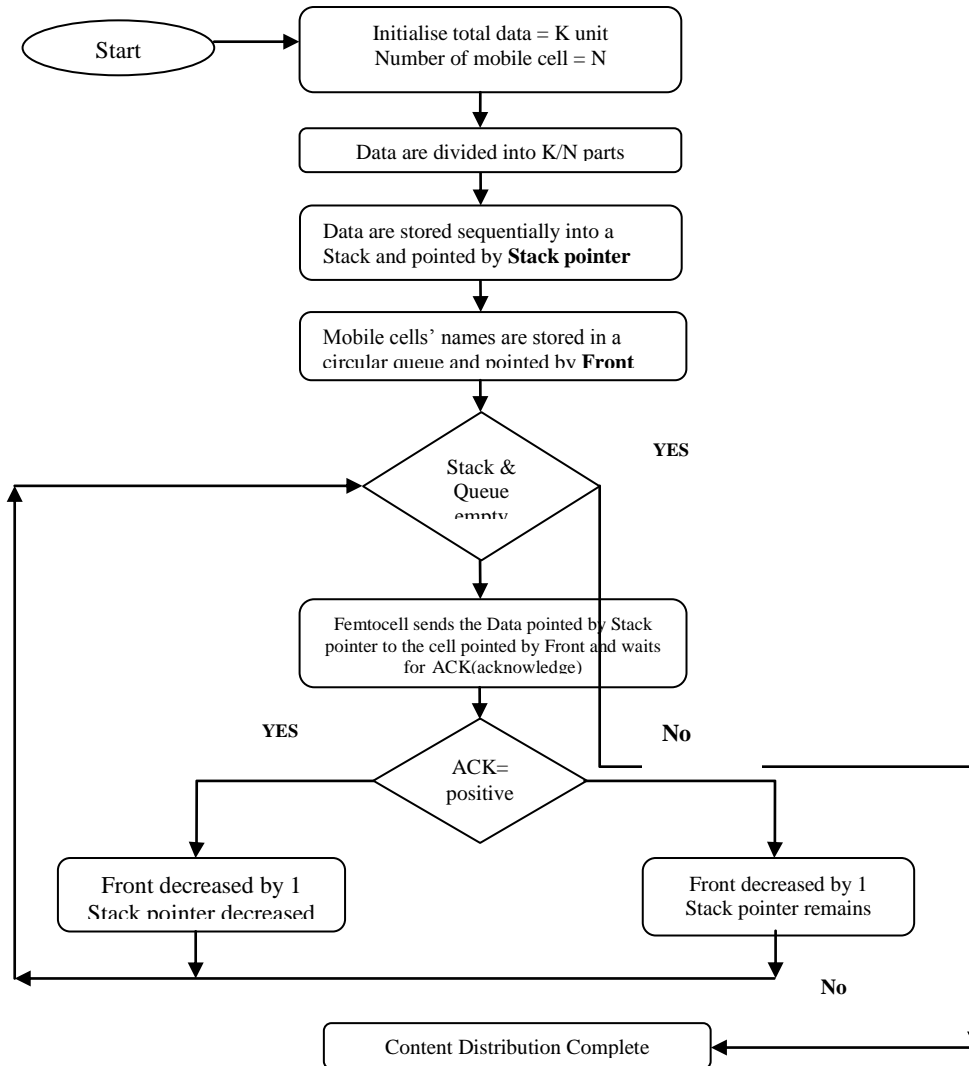
Step 1: Starting from the first point (i.e., mobile station), the mobile sends all data it contain to the next mobile.

Step 2: Step 1 continues up to the time when only a single mobile contains all the data.

Step 3: Now that all data containing mobile broadcasts the data over network.

Step 4: All the other mobiles will receive the broadcasted data, after discarding the repeated data, they all have the total data.

FlowChart:



IV. EXPERIMENTAL RESULTS

In order to calculate the energy consumed by the system i.e. Base Station and Mobile terminals, we use the formula:
Energy=power*time ... (1)

In this paper, the energy consumption of three different network topologies during CCD have been compared.

In case of RING topology, the total energy consumption, E_{mtM} is given by:

$$E_{mtR} = (s_r/K) * ((P_{rxL}/R_{lk}) + ((x_K * P_{tx})/R_{sm}) + ((x_{JR} * P_{rxS})/R_{sm}))$$

In case of MESH topology, the total energy consumption, E_{mtM} is given by:

$$E_{mtM} = (s_r/K) * ((P_{rxL}/R_{lk}) + ((x_K * P_{tx})/R_{sm}) + ((x_{JM} * P_{rxS})/R_{sm}))$$

In case of RING-STAR topology, the total energy consumption, E_{mtM} is given by:

$$E_{mRS} = (s_r/K) \cdot ((P_{rxL}/R_{lk}) + ((x_K \cdot P_{tx})/R_{sm}) + ((x_{JRS} \cdot P_{rxS})/R_{sm}))$$

Parameters:

Symbol	Meaning
K	No of mobile stations
$Dist$	Distance between the femtocell and M_k
P_{Tx}	Power consumed during mobile to mobile transmission
R_{Tx}	Power consumed during receiving
S_T	Total data
$R_{L,K}$	Long range transmission rate
$R_{S,M}$	Short range transmission rate
X_j	Mobile to mobile data
E	Energy consumed
P_C	Power Constant

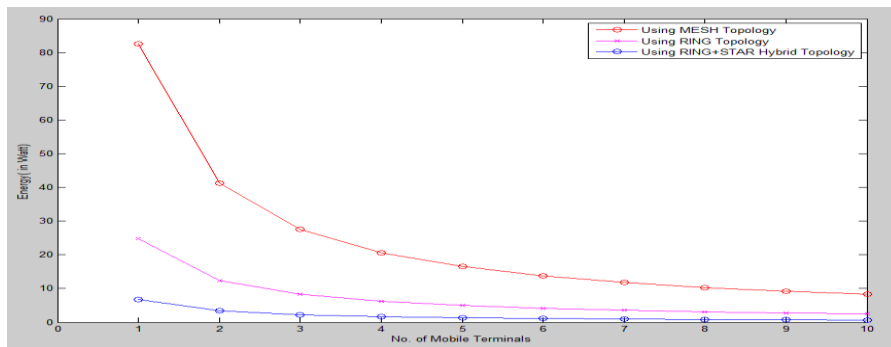


Figure:2 Simulation results of energy consumption of different topologies

V. CONCLUSION

We have compared the three energy consumption equations of the topologies in MATLAB which is shown in Figure:2 and concluded the RING-STAR topology is more efficient in terms of energy as compared to the other two topologies. The energy consumption of the RING-STAR topology is less because it broadcasts the total data over network, so the transmission power is lower and the energy consumption reduces as the number of mobile terminals increases.

REFERENCES

- [1] Fettweis, G. P., and Zimmermann, E., (2008). ICT energy consumption – trends and challenges, in Proceedings of the 11th International Symposium on Wireless Personal Multimedia Communications, Lapland, Finland.
- [2] Xiao, Y., (2005). Energy saving mechanism in the IEEE 802.16e wireless MAN, IEEE Commun. Letters, vol. 9, no. 7, pp.595-597.
- [3] Meshkati, F., Poor, H. V., Schwartz, S.C and Mandayam, N. B., (2006). An energy-efficient approach to power control and receiver design in wireless networks, IEEE Trans. Commun., vol. 5, no. 1, pp. 3306-3315.
- [4] Cheng, W., Zhang, H., Zhao, L and Li, Y., (2010). Energy Efficient Spectrum Allocation for Green Radio in Two-tier Cellular Networks, IEEE Communications Society, Xi'an, Shaanxi, China.
- [5] Al-Kanj, L and Dawy, L., (2010). Optimized Energy Efficient Content Distribution over Wireless Networks with Mobile-to-Mobile Cooperation, 17th International Conference on Telecommunications.