Minimizing Power Consumption in Mobile Usage

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ABSTRACT

The main purpose of the project is to minimize the power consumption. Power efficiency is necessary to lengthen the battery lifetime in the portable systems, as well as to reduce the operational costs and the environmental impact of stationary systems. This paper examines a new technique to enable power savings at the MT. The key idea is to split the connection between the MT and BS at an appropriate intermediary (another MT). Therefore, on the reverse link, the MT transmits to the intermediary and the intermediary forwards the call to the BS.

INTRODUCTION

The project will follow the flow as shown in the Fig 1. Initially mobile user will send an ACK to the base station to initiate call with another mobile user. Base station will check whether the mobile user in LOS or in NLOS. If it is in LOS it establishes a direct connection with the mobile user. If it is in NLOS to the base station, the BS will find appropriate intermediary nodes to establish a connection with the mobile user. For the selection of intermediary node BS uses greedy algorithm. After finding the intermediary nodes BS will establishes a stretched connection with the user using the intermediary nodes. During the connection BS will try to notify the status of the intermediary. If the intermediary node is still in idle state that node will remains in stretched connection. If intermediary node moves from idle state to ready state to carry another call then handoff will occur. At this time BS will try for another intermediary node. After the connection is closed between the BS and the mobile user the BS will releases the intermediary node from the stretched connection and make it as a normal node. Varying number of nodes, positions of the BS and the call rates analyzed this model under different parameters. By using energy model we will compare direct connection system with stretched connection system and we will calculate how much energy is taken by each system. By using different call rates to the mobile user we will compare how many handoffs will occur for each connection.

SIMULATION DESIGN

The paper gives a very detailed standards-compliant cell-site discrete event simulator to evaluate the stretched connection model. The propagation model implemented is a recursive model specified in and explained in. The arrival of calls at the BS is modeled as a Poisson distribution, with inter-arrival duration modeled as an exponential distribution. The node mobility is modeled as a Gaussian distribution. The mean velocity is a variable factor with the standard deviation equal to 10% of the mean. The mobility is assumed as a Gaussian distribution because most of the vehicles travel at the mean velocity, with few traveling at higher or lower velocities.

There are two types of events - external events and internal events.

External events dictate the time of call initiation, termination and node mobility. These are controlled using the call and mobility probabilistic models used in the simulator. In response to external events, internal events are generated. These internal events occur within the duration of a call. External events have higher priority over internal events. The simulator creates a grid- based map with user specified grid sizes. The user can add obstructions to simulate buildings as in a Manhattan environment. The user also specifies location of roads and intersections. Directional probabilities are assigned to each of the four roads originating from the Intersection. A mean velocity is assigned to each road with a standard deviation of 10% of the mean velocity. When a MT reaches an intersection, the direction and velocity are assigned using the above probabilities. The BS can be located anywhere in the map and this is also a user specified parameter. The size of the map is limited by the maximum allowable path loss for the terrain that the map is trying to simulate. For example, for speech in a pedestrian environment like the Manhattan model, the maximum reverse link path loss is 148.4dB.

STRETCHABLE CONNECTION MODEL

The following Fig 2 gives the details about the flow how the BS is selecting an intermediary. Whenever a request came from the mobile user the BS will try to find the intermediary mobiles. During the selection the BS tries to find out the status of the mobiles. If a mobile is in idle state then that mobile will be selected as an intermediary mobile. If the mobile is not in idle state BS will move to another mobile.

nodes. Then, by calculating the offsets of the distance that both the nodes have moved (zero in case of BS), we can find out the exact path loss.

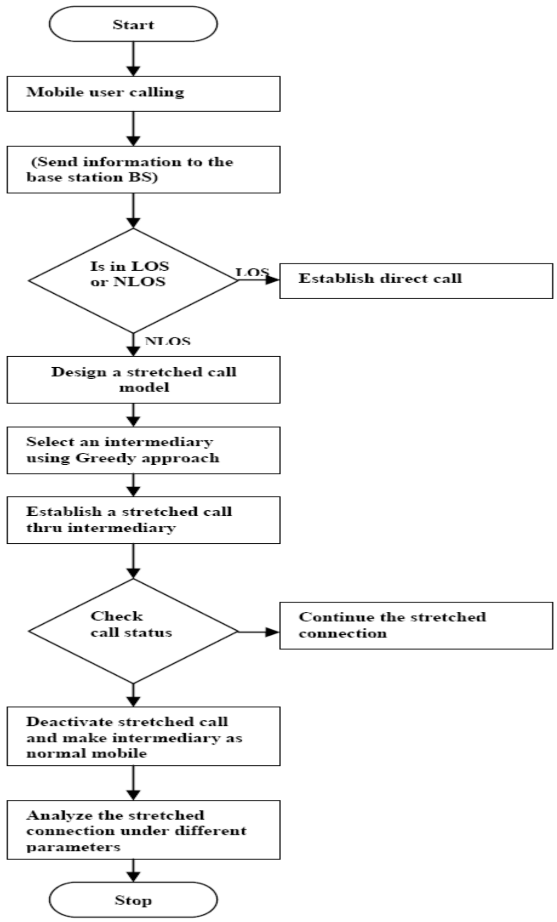

Fig.1 Overall Flow Chart

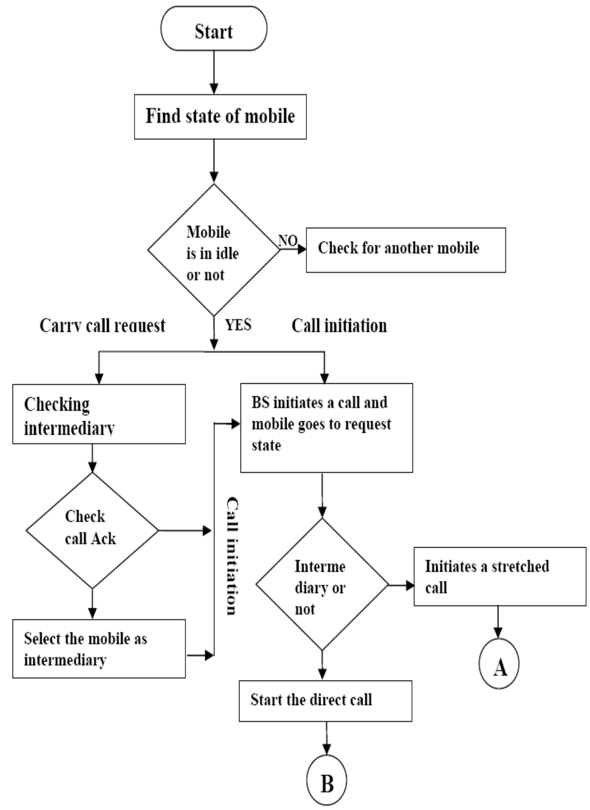

Fig2 Stretched Connection Model Flow Chart

If the mobile is in idle state then BS will send a call initiation request to that mobile. Then that node will go to the request state. If there is a possibility for direct connection it will establish a direct connection otherwise it will initiates a stretched call. During the stretched connection BS will find whether the intermediary node is in LOS or not. If it is in LOS it establishes connection. Frequently BS will check whether the call is finished or not. If the connection is not finished it will continue otherwise BS changes the intermediary to direct state. This information will be frequently updated to the other mobiles by BS. If the selected mobile is already in stretched connection state BS will check whether it is in moving state or not. During this it will check the ACKs from that mobile. If the mobile is moving far to the source node then BS selects another mobile as intermediary mobile. Path loss between any two points in the terrain is calculated and stored for repetitive experiments. For improved accuracy, we use the inverse square weighted interpolation formula. This formula takes the path loss between centers of the current and next grids of both

EXPERIMENTAL SETUP

The size of a grid is fixed for our simulations at 20meters. The factors considered here are numbers of nodes call rate and cell antenna gain. The numbers of nodes is varied from 5 to 30 in steps of 5. The call rate is 1 and 2 calls per hour per MT. The call duration has a mean value of 120seconds. The antenna gain was set at either 6dB or 10dB. The simulations are done for a single cell with only one BS. Two sets of experiments were conducted. In the first, the BS was kept in the center of the cell and in the second case, the BS was kept in the corner of the cell. The mean node speed is 1.5meters/sec. The BS finds the best intermediary whenever the call state changes or when a MT (either the MT itself or its intermediary) changes grid location.

For the link budget of the lower arm of the reverse link, there is no BS gain because it involves communication between mobiles and the mobiles are assumed to have isotropic antennas. Similarly, for the forward link in the lower arm of the stretched connection, there is no BS gain. For the upper arm of the reverse link the link budget is similar to a direct connection. The mobile antenna gain is assumed to be zero for all cases.

PERFORMANCE ANALYSIS

For an evaluation of our stretched call model, we used the following metrics:

- Total energy used during a run of 1000s (direct calls between MT and BS or stretched calls where the intermediary is selected using the greedy algorithm).
- Number of handoffs between intermediaries.
- The energy used per node.

Fig.4 Total system energy for always-direct system and stretched system with BS at center

Fig 4 shows the total system energy as a function of the number of nodes in the cell for two different call rates. *Fig 5* shows the same information on a per node basis. As can be easily seen, higher call rates consume more energy. However irrespective of call rates the stretched model consumes less energy as compared with the direct model. For a call rate of 1, the savings are greater than 50%, while for a call rate of 2 the savings vary from 3x to more than 7x. Also the spread in confidence interval is less for stretched system.

Fig.5 per node energy for always-direct system and stretched system with BS at Center

Fig 6 shows the number of handoffs during periods of length 1000s. As we can see, the number of handoffs is higher at higher call rates. This is because at higher call rates, more MTs are actively placing calls and thus, if they are serving as intermediaries when a new call request arrives, the carried call will need to be handed off to another idle MT. This figure shows the handoff rate for the case when the BS is at the center of the cell. We observe similar numbers for the case when the BS is in a corner of the cell. Similar experiments ran when the BS was in a corner of the cell (this is a realistic scenario where the BS covers the cell using sectored antennas).

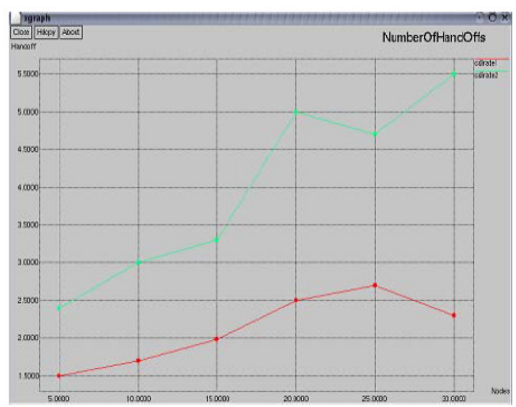

Fig.6 Number of handoffs required per node with BS at center

Fig 6 shows the direct and stretched mode energies. On comparing with Fig 4 when the BS was at center of the cell, it can be seen that for higher number of nodes, more energy is being spent. This is because the distance to the BS has increased thus directly impacting the energy of the direct or stretched call. In terms of savings, this project gives energy savings of up to 4x when using the stretched call model.

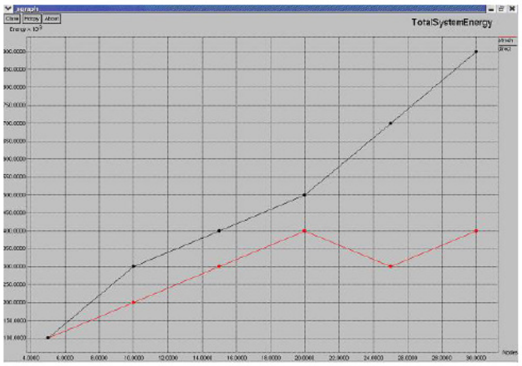

Fig.7 Total system energy for always-direct system and stretched system with BS at corner

CAPACITY AND THROUGHPUT ANALYSIS

The capacity of the system can be increased and at the same time number of intermediaries which will have an impact on the throughput of the system.

IMPLEMENTING INTERMEDIARY BASED SOFT HANDOFF

• Handoff is initiated by intermediaries and Assisted by BS.
• BS assists candidate intermediaries by passing location of MT, system parameters of the mobile.
• Relays listen promiscuously to MTs transmissions, assuming some changes to uplink
• Relays maintain 3 sets -active, neighbor and candidate sets of MTs in its vicinity: similar to Soft Handoff mechanism.
• BS selects the best intermediary
.

OPTIMIZATIONS FOR BEST INTERMEDIARIES

Use a better algorithm other than greedy algorithm in the selection of intermediary node to optimize the total system energy.

CONCLUSIONS

This project is presented a stretched call model for 3G systems in which high energy direct calls between mobiles and BS could be split at another mobile in order to reduce the overall energy used for the call. It described how this call model could be implemented in UMTS and CDMA2000 standards and guidelines for selecting different implementation parameters. Finally, it evaluated the stretched call model in a simulator to determine the extent of energy savings obtainable. As results show, energy savings of up to 7 times are possible! This huge energy reduction is a good reason for further exploration of the stretched call idea in next generation cellular systems. Results indicates the following are achieved in this project

• A 2-hop stretched connection yield significant power savings between 3X .7X!!!!
• The amount of time spent in relaying is 10-15% of idle time .not a significant overhead!!!!
• Handoffs increase linearly with number of nodes
• Intermediary initiated handoff reduces overhead for MT.
• No overhead of ad-hoc networking protocol for 2-hop stretched connection.
• 2-hop stretched connection suitable for real time Applications.

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