Masters Project Proposal

RACESIM: A Simulator for Evaluating the Resource Allocation in Wireless Networks

James M. Haring

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Approved By: **Date**

Dr. Edward Chow____

Dr. Marijke Augusteijn____________________________________

Dr. Jugal Kalita____

Problem Description

To optimize profit, companies managing wireless networks want to cover as much area as possible with as little monetary outlay as possible. They want to increase bandwidth in high population density areas and increase power in areas where costs restrict locating many antennas. They would like to optimize call switching algorithms to minimize delay, while at the same time preserving bandwidth. A dropped or blocked call is money out of their pockets, but on the other hand so is idle capacity. The desire of wireless network companies is to determine the values for all of these variables which would minimize cost and maximize earnings.

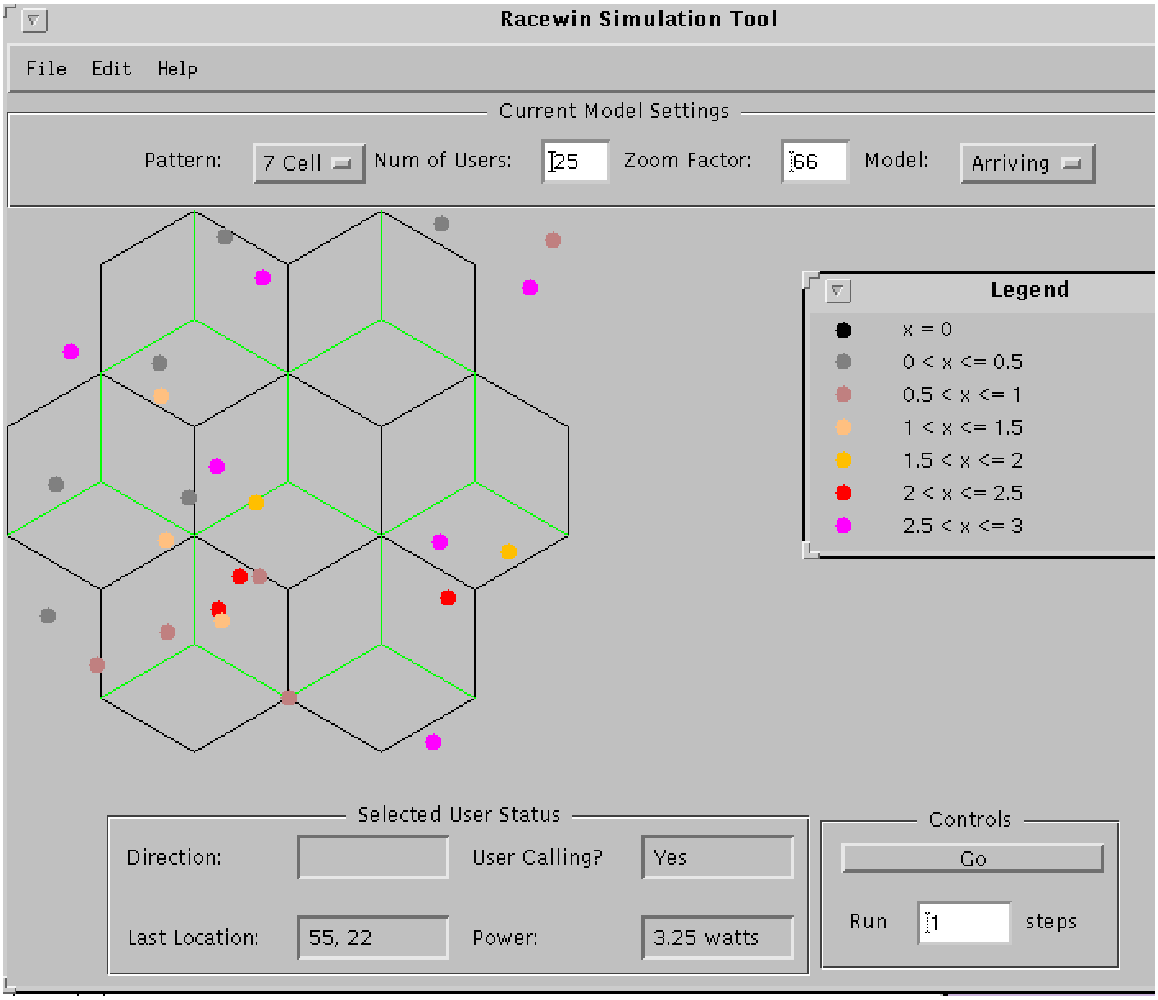
RACEWIN

The Resource Allocation and Admission Control Evaluator for Wireless Information Networks (RACEWIN) Project is currently being worked on by Dr. Edward Chow and his students. The project's goals is to build a software design system called RACEWIN to facilitate the design and analysis of efficient algorithms for cell size determination, hand-off procedures and traffic management of Personal Communications Services (PCS) Wireless Information Networks.

The RACEWIN approach includes building a wireless network simulation tool in order to test the variation of certain parameters to determine the optimal settings. My project will be to design and build a version of such simulator, called RACESIM.

Simulator Description

The RACESIM will be the backend to a Graphical Users Interface and Event Simulator named UTMOST developed by another of Dr. Chow's students, Heidi McClure. The UTMOST GUI is shown below.



The output of the GUI will be two data files: one describing the network topology and the other describing the users and events.

The Topology File will consist of information about a set of antennas in the wireless network. For each antenna will be listed, its location, the cell to which it belongs, its direction and power level. The cells will be hexagonal with three antennas located at the center. Each antenna will be responsible for 120 degrees of the area.

The Event File will consist of a list of discrete events in chronological order. For each event will be listed the user id, the location of the user, the speed of the user, the direction of the user, the time of the event and the type of event.

RACESIM will use the NETSIM libraries to handle the queuing of events. As the Event File is read in, the events will cause other events. These are all pushed on the event queue in chronological order. When all the events are pushed on the queue, RACESIM will begin to pull events from the head of the queue and perform actions based on the events. RACESIM finishes when the event queue is empty.

RACESIM will model the behavior of the base station and Mobile Telephone Switching Office (MTSO). Each as a simulated entity. As events are popped off of the queue, the event record indicates the simulated entity that should process this event. The time in the event record is checked against the current time of the simulated entities. If the event time is greater than the local time of the simulated entities, the local time is updated. However if the simulator time is well past the event time, the simulated entity may decide to discard the event, corresponding the processing a stale message under heavy system load. This could cause a call to be disconnected. RACESIM will model two hand-off procedures, basic and soft hand-off. In basic hand-off, a active mobile terminal is assigned to a sector antenna. When the mobile terminal crosses a cell boundary, a hand-off will occur where a new channel is assigned to the new base station, the call is routed from MSTO to the new base station. It involves several message exchange among MSTO, base stations, and the mobile terminal. In the soft hand-off scheme, two sector antennas from adjacent cells formed a antenna pair and they are assigned to serve a mobile terminal and the two channels are maintained between MTSO and the mobile terminal via two different base stations. When a mobile terminal crosses the cell boundary, it does not trigger a hand-off, only the switch in the MTSO reconnects the outgoing connection to the channels with the stronger signal. When the mobile moves further away from one of the sector antenna, it will trigger the hand-off where one of the two sector antennas will be replaced by one with stronger signal.

The are four types of events that will be handled:

- Registration message: Base station receives the registration message, updates the clients records and informs the customer's home Mobile Telephone Switching Office (MTSO).
- Call Request: The simulator must determine which antenna pair will handle the call. This implementation will use an antenna pair for each call. This uses a bit more bandwidth but will eliminate the need for hard switches thereby reducing call hand-off time dramatically.
- Incoming Call Request: The simulator must locate the user based on last registration message and locate a pair of available antennas to handle the call.
- Call Data: The simulator will receive call data for the same call from a pair of antennas. The strength of these two signals will determine when a boundary crossing occurs, and when the call will be handed off. When the signal from the primary antenna becomes weaker than that of the secondary, their roles will switch and the simulator will look for a new secondary antenna.

RACESIM will keep track of certain statistics such as the number of calls blocked, the number of calls dropped, the number of cell boundary crossings and the system resource utilization By varying the cell size, bandwidth and power level, and verifying the point at which dropped calls, bandwidth, and power level are minimal. When the cell size is fixed, it should be possible to determine the optimal settings for the values of other wireless network parameters.

Deliverables

The deliverables for this project will include a working prototype of RACESIM and a report that documents the design and implementation of the RACEWIN Simulator and the analysis of the simulation results on a few test networks.