## A 60GHz Indoor Wireless TDMA Network

This model of a prototype indoor TDMA-system operating at 60GHz. The system is located on on floor of a building subdivided into offices. Base stations are distributed throughout the floor area to provide coverage for all offices and hallways. Users periodically use mobile stations to access a base station and make a call.

The model demonstrates dependence of the resulting interferences on the parameter frequency reuse factor, traffic load, and a possible time offset of frame starts in different cells. The average outage probability of all connections is calculated and can be observed during run-time. A Tcl animation script visually demonstrates network behavior.



Figure 1: Top-level block diagram

The model is fairly simple. Most of the blocks are primitives (designated by a blue upper right corner. The blocks use particles to pass values rather than data structures.

The model consists of eight main blocks: a Handy (user) pool, a mobile atation block, a position generator (pos generator) block, a manager block, an interference generator block (CIR\_uld#1), a block to calculate path loss (propag.uld#1), an animation block (WiNeS\_Tcl\_Animation#1) that demonstrates network operations, and an evaluation block that generates statistics documenting network operations.





Figure 2: Handy pool

The handy pool block defines the pool of wireless phones. Parameters control the number of phones in the system, the mean arrival time and the mean time-in-service.

The Mobile Stations block receives the demands for creating a new mobile station from the activation. It checks the position and places the mobile in the right cell. If the the received position is not inside of one of the rooms, it demands a new position rather than dropping that mobile away.

The pos\_generator block generates positions for the mobile stations generated by the mobile stations block. Positions are uniformly distributed in the area (x\_min, y\_min) (x\_max, y\_max). The position is returned as a complex value, where x is the real part and y is the imaginary part of the complex value.

The CIR\_uldl block calculates inter fences by calling the appropriate methods in the propagation-block. This block is called each time a mobile station appears in the environment or one mobile station vanishes from the environment. Both events of that kind cause a new interference situation which is then calculated. Information and data are given out to animation and data analysis blocks.

The propag\_uldl block implements a path loss model. A specific environment is read in from a AutoCad-file. All obstacles which are in a path are searched for and their penetration loss is added to the path loss caused by free space propagation. The resulting path loss is given out.

The rrmanager\_uldl block holds a linked list for all mobile stations. Each time a mobile station is created or deleted, the list is updated. Each event which changes the list's contents causes a new calculation of the interference situation.

The WiNeS\_Tcl\_Animation block is an animation block. A tcl-script is read in and data containing positions of mobile stations, information about connections to the base stations as well as information about existing interferences come to this block from CIR. Each time anything happens in the network the animation will depict it. All mobile sta-



tions are shown at their position; all connections are denoted by yellow arrows. Orange arrows show interferences which are caused by other mobile stations, while red arrows show interferences which are caused by transmissions from other base stations. All interferences are measured in the uplink, so the receiving station is always the base station. This animation can be used for debugging and demonstration reasons.



**Figure 3: Evaluation block** 

The evaluation block collects data and generates two graphs showing the probability of outage for the network—a dynamic graph (TcXYPlot.X) that displays while the simulation is executing and a summary graph (XYgraph#1) that displays when the simulation is completed.

## Outputs

The animation is shown below. In operation, the mobile stations appear, make connections with base stations (and generate interferences that are displayed on the map) and then disappear when their calls are completed. At the instant this animation was cpatured one station is connected to a base station (connection shown in yellow) and interference (red lines) is coming from three adjoining base stations.





**Figure 4: Animation of network operations** 

In addition to the animation, the model generates a dynamic report showing the probability of outage as shown below.



Figure 5: Dynamic report on probability of outage



The summary outage report is shown below.



Figure 6: Probability of outage (summary)

Note: This models was developed as a case study for a "Wireless Network Simulator (WiNeS)", a joint research project of the Center for Mobile Communications Systems at Dresden University of Technology and Mannesmann Mobilfunk, a German cellular network operator.

