Random Users and moving UE Submenu

Until now the user has already set the Manhattan Environment, the Topology Parameters, the User Parameters and the static UEs coordinates. This case assumes that all UEs but one are static and have their own coordinates. It also assumes that one UE is moving. The moving UE's route is predefined. The "Random Users and moving UE submenu" (Figure 1) gives the user the possibility to watch some graphics (results) with the selected topology and parameters.

Figure 1: Random Users and moving UE submenu

Examined BS total Power

By clicking the first button of the "Random Users and moving UE submenu", the user can see the Examined BS total power. The Examined BS is the BS in the centre of the circle depicted in Figure 2. Three new figures appear. The first, called "Manhattan Grid Environment", presents the topology, the points where the static UEs have been placed and the moving UE's route.

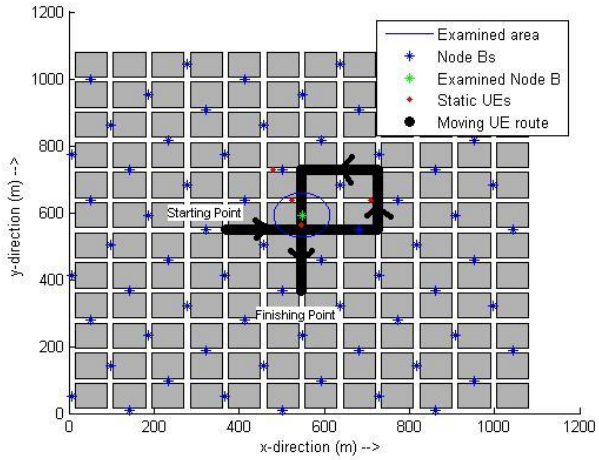

Figure 2: Manhattan Grid Environment (Node Bs, static UEs, moving UE's route and Examined Node B)

The second figure (Figure 3), called "Examined BS total transmission power vs moving UEs", examines how the total transmission power of the Examined Node B changes with time, while the moving UE passes through the examined area. The x-axis of the figure shows the time in secs, while the y-axis shows the corresponding total transmission power of the Examined Node B in Watts.

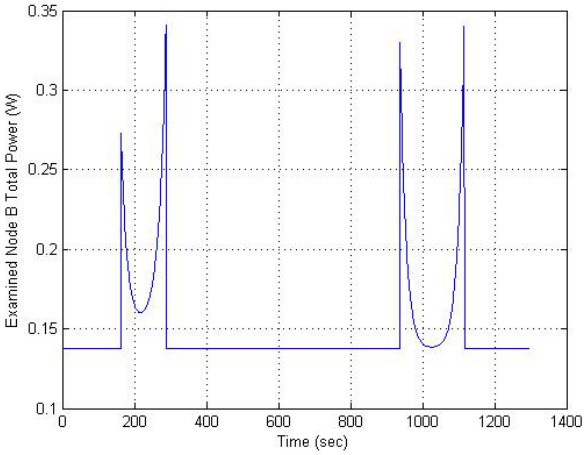

Figure 3: Examined BS total transmission power vs moving UEs

The third figure, called “Parameters Display”, is a message box that shows the values of all parameters that the user has selected.

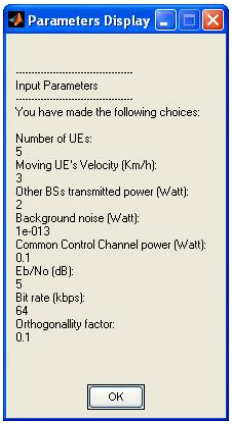

Figure 4: Parameters Display

The above figure appears every time a button from the “Random Users and moving UE submenu” is clicked, so we won’t go over it again.

Moving UE’s Active BS total power

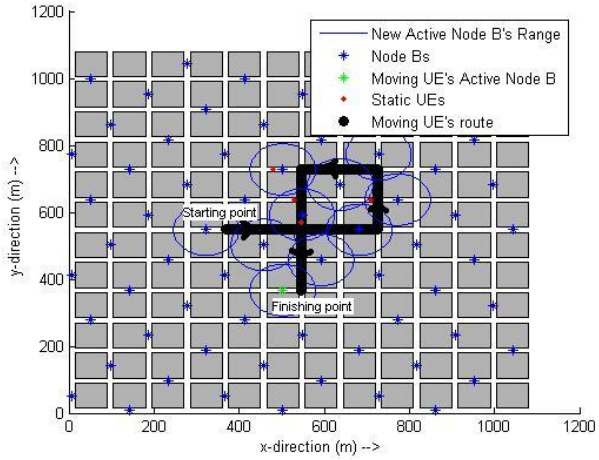

Figure 5: Manhattan Grid Environment (Node Bs, static UEs, moving UE’s route and Active Node Bs)

By clicking the second button of the “Random Users and moving UE submenu” (Figure 1), the user can see the Moving UE’s Active BS total power*. Three new figures appear. The first (Figure 5), called “Manhattan Grid Environment”, presents the topology, the points where the static UEs have been placed and the BSs that served the moving UE during its route.

The second figure (Figure 6), called “Moving UE’s Active BS total power”, examines how the total transmission power of the Moving UE’s Active BS total power changes with time. The x-axis of the figure shows the time in secs, while the y-axis shows the Moving UE’s Active BS total power in Watts (the Moving UE’s Active BS is not constant, but changes depending on the moving UE’s position).

The third figure, called “Parameters Display”, is a message box that shows the values of all parameters that the user has selected (same as Figure 4).

* As the particular UE moves, it is served by different Node Bs. This phenomenon is known as soft handover. As it can be seen from Figure 5, it would be impossible one Node B to serve the moving UE during its whole route. In that case the serving Node B would spent a large amount of its power just to serve the moving UE (mainly when it was far), increasing in that way the intercell interference. That is the reason why the soft handover is very important.

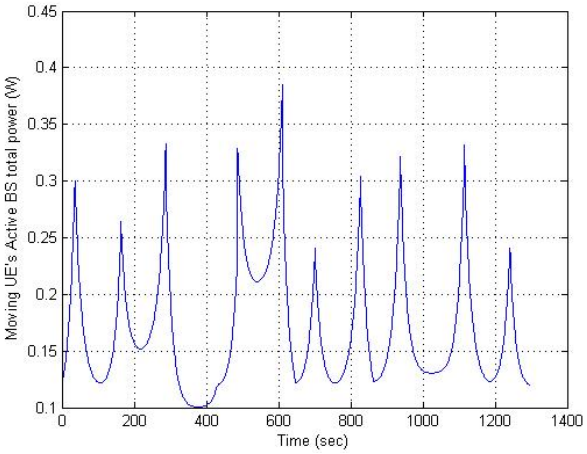

Figure 6: Moving UE's Active BS total power

Video Creation for Specified Topology

By clicking the third button of the "Random Users and moving UE submenu" (Figure 1), a new window appears, titled "Video Creation". The user can create a video with the specified topology. Note that the creation of this video is a time-consuming process.

Figure 7: Video Creation

The user has just to select a name for the video (only *.avi is allowed) and wait until the process finishes. The video will be saved in the current directory.

Help (Adobe Acrobat required)

Clicking this button opens this manual.

Close Submenu

Clicking this button closes the "Random Users and moving UE submenu" and returns to "UE Topology submenu".

Figures and Results Explanation*

The program calculates the Node B's total transmission power, when a number of n MBMS users who are residing in the above mentioned Node B use DCH. In that case the Node B's total transmission power is calculated as follows:

$$P_T = \frac{P_P + \sum_{i=1}^{n} \frac{(P_N + x_i)}{\frac{W}{(E_b/N_o)_i R_{b,i}} + p} L_{p,i}}{1 - \sum_{i=1}^{n} \frac{p}{\frac{W}{(E_b/N_o)_i R_{b,i}} + p}} \qquad \textbf{Eq. 1}$$

* Footnote: The following results have been calculated assuming: *n*=5, *Pp*=0.1W, *p*=0.1, *Pn*=1e-13W, *Eb/No*=5dB, *Rb*=64Kbps, *W*=3.84Mcps, *static UE x,y-coordinate* from the topology, *moving UEs velocity*=3Km/h, *moving UE route* predefined. The program calculates Eq. 1 every second.

where P_T is the total transmission power for all the DCH users in the cell, P_P is the power devoted to common control channels, $L_{p,i}$ refers to the path loss for user *i*, $R_{b,i}$ the bit rate for user *i*, *W* the bandwidth, P_N the background noise, *p* the orthogonality factor and $(E_b/N_o)_i$ is the signal energy per bit divided by noise spectral density. Parameter x_i is the intercell interference observed by user *i* given as a function of the transmitted power by the neighbouring cells P_{Tj}, *j*=1,…K and the path loss from this user to the *j*th cell L_{ij}. More specifically:

$$x_i = \sum_{j=1}^{K} \frac{P_{Tj}}{L_{ij}} \qquad \textbf{Eq. 2}$$

From the above equations it is observed that Node B's transmission power, for the PTP case, increases when the distance between the Node B and the UEs increases. The same occurs when the bit rate of the MBMS service increases. Objective of present program is to simulate a Microcell environment (Manhattan grid environment) taking into consideration moving and non moving users. Using Eq. 1 the program calculates the transmitted power from the Node Bs that serve a number of MBMS users. By changing one of the user Parameters in Eq. 1 we examine how the total transmission power of the examined Node B changes. In the Random Users and moving UE case (all UEs static and one moving UE) user can examine two different cases:

- Total transmission power of the examined Node B (all other parameters constant)
- Moving UE's Active BS total transmission power (all other parameters constant)

Examined BS total Power

The first figure (Figure 8), called "Manhattan Grid Environment", is a graphic representation of the topology the user has created. Some notes have been added on the original figure in order to help the user understand the results.

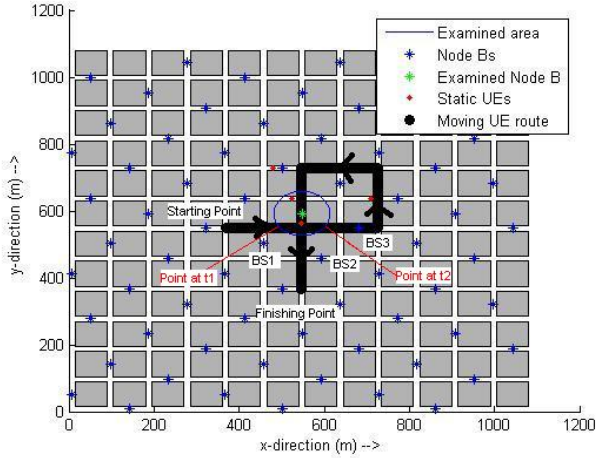

Figure 8: Manhattan Grid Environment (Node Bs, static UEs, moving UE's route and Examined Node B)

The second figure (Figure 9), called "Examined BS total transmission power vs moving UEs", examines how the total transmission power of the Examined Node B changes with time, while the moving UE passes through the examined area. The x-axis of the figure shows the time in secs, while the y-axis shows the corresponding total transmission power of the Examined Node B in Watts. From Figure 8, it can be seen that the examined Node B is predefined. If the user hasn't placed any static UE inside the examined area (the area that is served by the examined Node B), Figure 9 only shows how the moving UE affects the examined Node B's power. In our example, two static UEs have been placed inside the examined area.

Several inferences can be extracted by examining Figure 9. With regard to the time (x-axis):

- From 0 to t1: The examined Node B serves only the two static UEs,
- From t1 to t2: The examined Node B serves the two static UEs and the moving UE,
- From t2 to t3: The examined Node B serves only the two static UEs,
- From t3 to t4: The examined Node B serves the two static UEs and the moving UE,

- From t4 to t_tot: The examined Node B serves only the two static UEs.

As it can be seen from Figure 8 the moving UE passes through the examined area two times, which agrees with the exported results.

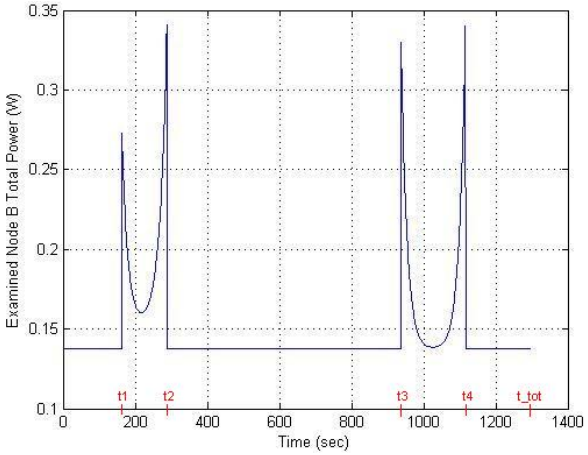

Figure 9: Examined BS total transmission power vs moving UEs

With regard to the examined Node B's power (y-axis):

- From 0 to t1, the examined Node B's power is constant. That is because during this period the examined Node B serves only the two static UEs, whose parameters are constant (see Eq. 1). The same occurs during the periods t2 to t3 and t4 to t_tot. Note that if the user hasn't placed any static UE inside the examined area, the examined Node B's power during these periods would be equal to the *Pp* power (see Eq. 1), which in our example is 0.1 Watt (see the Footnote at page 3).
- From t1 to t2 the examined Node B serves the two static UEs and the moving UE. That is why its power is not constant. When the moving UE enters the examined area (for first time) at time t1, as it can be seen from Figure 8, the moving UE is at the cell's edge. Consequently, the examined Node B has to consume a large amount of its power to serve the particular UE. The same occurs when the moving UE exits the examined area at time t2. The above remarks, explain the two maximum values of the examined Node B's power (at t1 and t2 respectively). The same occurs during the period t3 to t4.
- While the moving UE moves through the examined area (period t1 to t2), its distance from the Examined Node B initially decreases, at one point is minimised, and from that point increases (see Figure 8). The examined Node B's power is changing in a similar way. The above remarks, explain the shape of the figure during the period t1 to t2. The same occurs during the period t3 to t4.
- The difference between the two maximum values of the examined Node B's power (at t1 and t2 respectively) can be explained after noticing the asymmetry in the topology. When the moving UE enters the examined area (at t1), it only has one neighbour Node B really close to it (BS1, see Figure 8), while, when the moving UE exits the examined area (at t2), it has two neighbour Node Bs really close to it (BS2 and BS3). In the first case the intercell interference at Eq. 1 is smaller than that of the second case (exiting the examined area), requiring in that way less power from the examined Node B.

It is worth mentioning that the above values may change if one of the parameters in Eq. 1 changes (see the Footnote at page 3). However, in order to change one of the parameters the user has to return to a previous submenu ("Manhattan Environment Simulation menu" or "UEs Topology submenu").

The third figure (Figure 4), called "Parameters And Results Display", is a message box that shows the values of all parameters that the user has selected.

Moving UE's Active BS total power

The first (Figure 10), called "Manhattan Grid Environment", presents the topology, the points where the static UEs have been placed and the BSs that served the moving UE during its route. For facilitation, we have numbered the BSs that served the moving UE during its route.

The second figure (Figure 11), called "Moving UE's Active BS total power", examines how the total transmission power of the Moving UE's Active BS total power changes with time. The x-axis of the figure shows the time in secs, while the y-axis shows the Moving UE's Active BS total power in Watts (the Moving UE's Active BS is not constant, but changes depending on the moving UE's position).

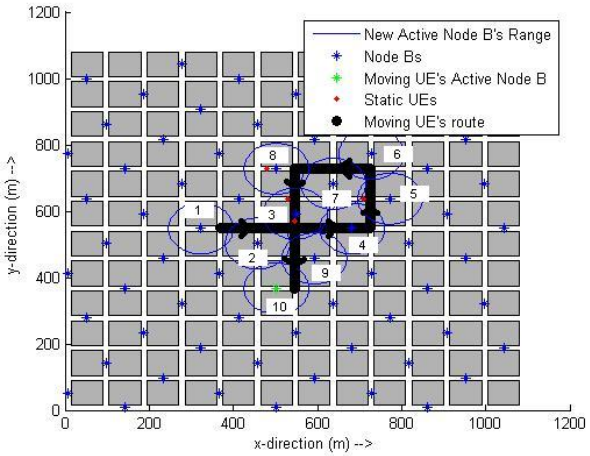

Figure 10: Manhattan Grid Environment (Node Bs, static UEs, moving UE's route and Active Node Bs)

Several inferences can be extracted by examining Figure 11. With regard to the time (x-axis):

- From 0 to t1: The moving UE is served by BS1,
- From t1 to t2: The moving UE is served by BS2,
- From t2 to t3: The moving UE and two static UEs are served by BS3 (see Figure 10),
- From t3 to t4: The moving UE is served by BS4,
- From t4 to t5: The moving UE and one static UEs are served by BS5 (see Figure 10),
- From t5 to t6: The moving UE is served by BS6,
- From t6 to t7: The moving UE is served by BS7,
- From t7 to t8: The moving UE and one static UEs are served by BS8 (see Figure 10),
- From t8 to t9: The moving UE and two static UEs are served by BS3 (see Figure 10),
- From t9 to t10: The moving UE is served by BS9,
- From t10 to t_tot: The moving UE is served by BS10.

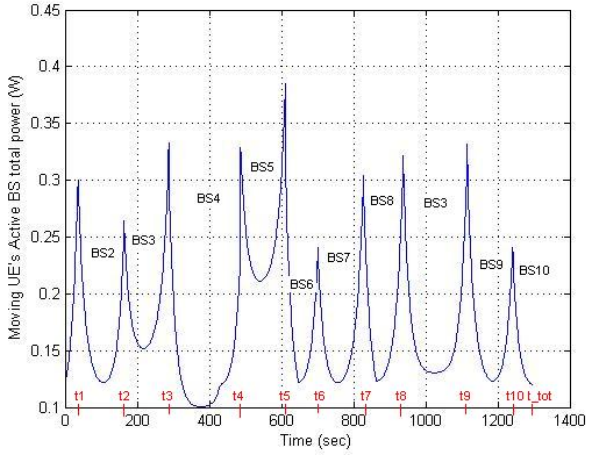

Figure 11: Moving UE's Active BS total power

With regard to the Moving UE's Active BS total power (y-axis):

- From t1 to t2 the BS2 serves the moving UE. That is why its power is not constant. When the moving UE enters the area that is served by BS2 at time t1, as it can be seen from Figure 10, the moving UE is at the cell's edge. Consequently, BS2 has to consume a large amount of its power to serve the moving UE. The same occurs when the moving UE exits the BS2's area at time t2. The above remarks, explain the two maximum values of BS2's power (at t1 and t2 respectively). The same occurs during the other periods of time.
- While the moving UE moves through an area that is served by a Node B (eg. BS2 for the period t1 to t2), its distance from the particular Node B initially decreases, at one point is minimised, and from that point increases (see Figure 10). The Node B's power is changing in a similar way. The above remarks, explain the shape of the figure during the different periods of time (eg. t1 to t2).
- The difference between the two maximum values of the examined Node B's power (eg. at t1 and t2 respectively) can be explained after noticing the asymmetry in the topology. When the

moving UE enters a Node B's area (eg. BS2 at t1), it may have one or two neighbour Node Bs really close to it, while, when the moving UE exits the same Node B's area (eg. BS2 at t2), it may have two or one neighbour Node B really close to it respectively. In both cases the intercell interference at Eq. 1 differs while entering or exiting the Node B's area, requiring in that way less or more power from the Node B respectively.

It is worth mentioning that the above values may change if one of the parameters in Eq. 1 changes (see the Footnote at page 3). However, in order to change one of the parameters the user has to return to a previous submenu ("Manhattan Environment Simulation menu" or "UEs Topology submenu").

The third figure (Figure 4), called "Parameters And Results Display", is a message box that shows the values of all parameters that the user has selected.