Help

Abstract

Universal Mobile Telecommunications System (UMTS) constitutes the third generation (3G) of cellular wireless networks which aims to provide high-speed data access along with real time voice and video calls. Wireless data is one of the major boosters of wireless communications and one of the main motivations of the next generation standards.

At first, UMTS offered tele-services (e.g voice and SMS) and Bearer Services for point-to-point (PTP) transmission using the Unicast technology. Later, with the introduction of new services, such as IP Video Conferencing, Streaming Video and others, there was an increasing need for communication between one sender and many receivers, leading to the need of point-to-multipoint (PTM) transmission. One efficient way to implement this type of transmission is the use of broadcast and multicast technologies [1]. The 3rd Generation Partnership Project realized the need for broadcasting and multicasting in UMTS and proposed some enhancements on the UMTS Release 6 architecture that led to the definition of the Multimedia Broadcast Multicast Service (MBMS) framework. MBMS is a point-to-multipoint service in which data is transmitted from a single source entity to multiple destinations, allowing the networks resources to be shared [2], [3].

Power control is one of the most important aspects in MBMS due to the fact that Node B's transmission power is a limited resource and must be shared among all MBMS users in a cell. The main purpose of power control is to minimize the transmitted power, thus avoiding unnecessary high power levels and eliminating inter-cell interference. Moreover, with the introduction of MBMS Services in UMTS networks, the Radio Network Controller (RNC) for radio efficiency reasons, can use either Dedicated resources (one Dedicated Channel (DCH) for each User Equipment (UE) in the cell) or Common resources (one Forward Access Channel (FACH) shared by all the UEs in a cell) to distribute the same content in a cell.

The choice of the most efficient transport channel in terms of power consumption is a key point for the MBMS, since a wrong transport channel selection for the transmission of the MBMS data could result to a significant decrease in the total capacity of the system.

Several studies and simulations have been carried out focusing on the threshold for switching between dedicated and common resources in terms of transmission power. In [4] is claimed that for a FACH with transmission power set to 4W, the threshold for switching from dedicated to common resources is around 7 UEs per cell, while in [5] the threshold is 5 UEs. However, only the information on the number of users in a cell may be not sufficient so as to select the appropriate radio bearer (PTP or PTM) for the specific cell. The decision has to take into account the total power required for the transmission of the multicast data in the PTP and PTM case. An interesting study under this assumption is presented in [6] where the authors propose a switching point (based on power consumption) of 5 UEs between dedicated and common resources. Finally, the above switching points are expected to increase with the use of HSDPA on PTM links [7].

DCH is the main radio bearer that is used for the PTP case and supports fast power control. Transmission power allocated for dedicated resources is variable and mainly depends on the number of UEs, the location of users in the cell, the required bit rate of the MBMS service and the Eb/No for each user. When only few users are receiving the same MBMS service it could be more efficient to use DCHs for each user in order to minimize the total transmitted power and reduce system interference. However, only the information on the number of users in a cell may not be sufficient so as to select the appropriate radio bearer for the specific cell. The decision has to take into account the total power required for the transmission of the multicast data in the PTP and PTM case.

In the case of DCHs the total transmission power from Node B to a number of n MBMS users who are residing in the above mentioned Node B is calculated as follows [8]:

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

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, [8]:

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

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 [9]) 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.

The program examines three different cases. The first case (“Group of UEs in the same spot”) assumes that all UEs are static and are placed at the same spot. The second case (“UEs with random coordinates”) assumes that all UEs are static and each UE has its own coordinates. Finally, the third case (“UEs with random coordinates and moving UE”) assumes that all UEs but one are static and have their own coordinates. It also assumes that one UE is moving.

Program

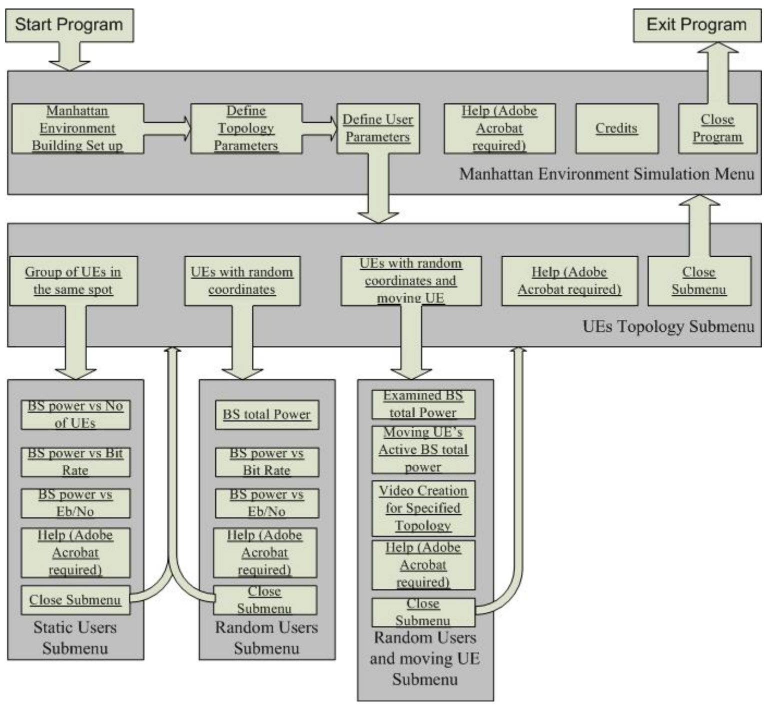

Figure 1: Program diagram

For the implementation of the particular program the Matlab release 7.0.1 was used. It is very likely, if older releases are used, (eg. release 5.3 or even release 6.1) that certain errors while running the program may occur, deterring in this way the export of results. For this, we will consider as a fact that the release of Matlab that is used is the 7.0.1, or a more recent release.

Manhattan Environment Simulation Menu

The user can start the program by typing “Manhattan_Grid_Simulation” in the Command Window (after having set the directory where the program is found as Current Directory), and a “menu window” appears, named “Manhattan Environment Simulation” (Figure 2).

Figure 2: Manhattan Environment Simulation Menu

This menu gives the user the possibility to create the Manhattan grid environment. The user can select between six (6) different buttons:

1. Manhattan Environment Building Set up: This button gives the possibility to specify the number of buildings in x and y direction. However, pressing this button in not obligatory. It can be omitted and the number of buildings in x and y-direction take the predefined value. The predefiined number of buildings in x and y-direction is 12 [9]. The only restraint is that the number of buildings must be multiplicate of 4. The buildings width is 75m and the road width 15m [9]. The rest of the program takes into account the topology that the user has created.
2. Define Topology Parameters: This button gives the user the possibility to set the topology parameters. Such parameters are: Other BSs transmitted power, Background noise, Common Control Channel power and the Orthogonallity factor (see Eq. 1 and Eq. 2). Setting these parameters is important in order to evaluate the total transmission power from the examined Node B, using Eq. 1. This button cannot be omitted. The user has to press this button and define the topology parameters.
3. Define User Parameters: This button gives the user the possibility to set the UEs' parameters. When referring to UEs' parameters, we mean the total number of UEs in the topology (static and moving), the signal energy per bit divided by noise spectral density (Eb/No) and bit rate Rb. The user is in position to change each value. All the UEs (specified by the number of UEs) are assumed to have the same Eb/No and Rb. *By setting the UEs parameters (clicking OK to the corresponding window), the "UEs Topology Submenu" appears.*
4. Help (Adobe Acrobat required): Clicking this button opens this corresponding help file.
5. Credits:
6. Close Program: Clicking this button exits the program.

UEs Topology Submenu

As mentioned above by setting the UEs parameters (ie. clicking OK to the corresponding window), the "UE Topology submenu" appears (Figure 3). Until now the user has already set the Manhattan Environment, the Topology Parameters and the User Parameters (with "Manhattan Environment Simulation Menu"). The next step is to place the UEs in the environment. The "UE Topology submenu" gives the user that possibility.

Figure 3: UE Topology Submenu

The user can select between five (5) different buttons:

1. Group of UEs in the same spot: With this button the user can interactively enter the group of UEs coordinates. The "Group of UEs in the same spot" case assumes that all UEs are static and are placed at the same spot, so the group coordinates must be inserted just one time. It is on the user's hand to place the group wherever he wants. *By defining the group coordinates (clicking OK to the corresponding window), the "Static Users Submenu" appears.*
2. UEs with random coordinates: With this button the user can interactively enter the UE's coordinates. The "UEs with random coordinates" case assumes that all UEs are static and each

UE has its own coordinates, so the UE coordinates must be inserted one time for every UE. It is on the user's hand to place the UEs wherever he wants. *By defining the UEs coordinates (clicking OK to the corresponding window), the "Random Users Submenu" appears.*

3. UEs with random coordinates and moving UE: With this button the user can interactively enter the static UE's coordinates. The "UEs with random coordinates and moving UE" case assumes that all UEs but one are static and have their own coordinates, so the UE coordinates must be inserted one time for every static UE. The moving UE's route is predefined. It is on the user's hand to place the static UEs wherever he wants. By setting the static UEs' coordinates, a new window appears, titled "Moving UE: Paramaters Specification", where the user can define the moving UE's velocity. *After defining the velocity (clicking OK to the corresponding window), the"Random Users and moving UE Submenu" appears.*
4. Help (Adobe Acrobat required): Clicking this button opens this corresponding help file.
5. Close Submenu: Clicking this button closes the "UE Topology submenu" and returns to "Manhattan Environment Simulation Menu".

Static Users Submenu

As mentioned by setting the group coordinates (button 1 at "UEs Topology Submenu"), the "Static Users Submenu" appears (Figure 4). Until now the user has already set the Manhattan Environment, the Topology Parameters, the User Parameters (with "Manhattan Environment Simulation Menu") and the group coordinates (with "UEs Topology Submenu"). The "Static Users submenu" gives the user the possibility to watch some graphics (results) with the selected topology and parameters.

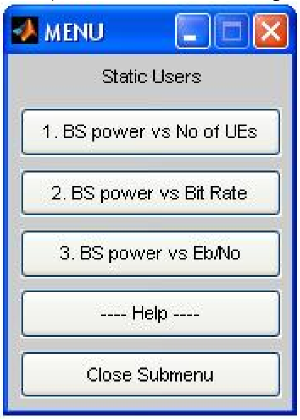

Figure 4: Static Users Submenu

The user can select between five (5) different buttons:

1. BS power vs No of UEs: By clicking this button, the user can examine how the BS total power changes with the number of UEs.
2. BS power vs Bit Rate: By clicking this button, the user can examine how the BS total power changes with different Bit Rates.
3. BS power vs Eb/No: By clicking this button, the user can examine how the BS total power changes with different Eb/No.
4. Help (Adobe Acrobat required): Clicking this button opens this corresponding help file.
5. Close Submenu: Clicking this button closes the "Static Users submenu" and returns to "UEs Topology Submenu".

Random Users Submenu

As mentioned by setting the group coordinates (button 2 at "UEs Topology Submenu"), the "Random Users Submenu" appears (Figure 5). Until now the user has already set the Manhattan Environment, the Topology Parameters, the User Parameters (with "Manhattan Environment Simulation Menu") and the UEs coordinates (with "UEs Topology Submenu"). The "Random Users Submenu" gives the user the possibility to watch some graphics (results) with the selected topology and parameters.

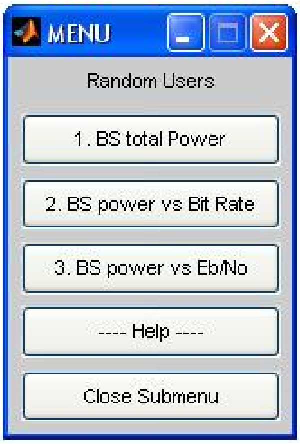

Figure 5: Random Users Submenu

The user can select between five (5) different buttons:

1. BS total Power: By clicking this button, the user can see the Examined BS total power.
2. BS power vs Bit Rate: By clicking this button, the user can examine how the BS total power changes with different Bit Rates.
3. BS power vs Eb/No: By clicking this button, the user can examine how the BS total power changes with different Eb/No.
4. Help (Adobe Acrobat required): Clicking this button opens this corresponding help file.
5. Close Submenu: Clicking this button closes the "Random Users Submenu" and returns to "UEs Topology Submenu".

Random Users and moving UE Submenu

As mentioned by setting the group coordinates (button 3 at "UEs Topology Submenu"), the "Random Users and moving UE Submenu" appears (Figure 6). Until now the user has already set the Manhattan Environment, the Topology Parameters, the User Parameters (with "Manhattan Environment Simulation Menu") and the static UEs coordinates (with "UEs Topology Submenu"). The "Random Users and moving UE submenu" gives the user the possibility to watch some graphics (results) with the selected topology and parameters.

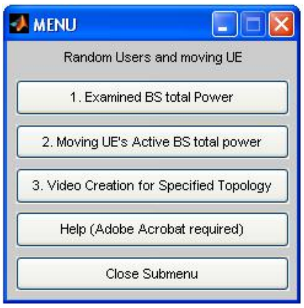

Figure 6: Random Users and moving UE submenu

The user can select between five (5) different buttons:

1. Examined BS total Power: By clicking this button, the user can examine how the total transmission power of the Examined Node B changes with time.
2. Moving UE's Active BS total power: By clicking this button, the user can examine how the total transmission power of the Moving UE's Active BS total power changes with time.
3. Video Creation for Specified Topology: By clicking this button, the user can can create a video with the specified topology.
4. Help (Adobe Acrobat required): Clicking this button opens this corresponding help file.
5. Close Submenu: Clicking this button closes the "Random Users and moving UE submenu" and returns to "UEs Topology Submenu".

References

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