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Research Article

ABCDecision: A Simulation Platform for Access Selection Algorithms in Heterogeneous Wireless Networks

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We present a simulation platform for access selection algorithms in heterogeneous wireless networks, called "ABCDecision". The simulator implements the different parts of an Always Best Connected (ABC) system, including Access Technology Selector (ATS), Radio Access Networks (RANs), and users. After describing the architecture of the simulator, we show an overview of the existing decision algorithms for access selection. Then we propose a new selection algorithm in heterogeneous networks and we run a set of simulations to evaluate the performance of the proposed algorithm in comparison with the existing ones. The performance results, in terms of the occupancy rate, show that our algorithm achieves a load balancing distribution between networks by taking into consideration the capacities of the available cells.

1. Introduction

Next generation of mobile systems is evolving towards a heterogeneous wireless access network consisting of diverse radio technologies, able to host multiinterface wireless terminals, each of them capable of alternatively operating in the various radio technologies (e.g., Wireless Local Aera Networks (WLANs), cellular networks, etc.). These available radio technologies will encompass cooperating components and will be interconnected by a backbone (e.g., IP-based fixed network) [1].

In this context, there are three possible options to study the network performance and Quality of Service (QoS) and to help developers to realize better efficiency and fully exploit the deployed infrastructure. First, analytical models have been put forward to study heterogeneous networks in generic environments and for simplified mobility or traffic models. However, these models usually necessitate realism, and in practice, the complexity of wireless networks makes their results subject to prudence and avoids their use especially when specific characteristics in a given environment are required. Second, the developed concepts can be implemented and deployed on actual hardware (testbed implementation). While testbeds might yield the most accurate results, there are several problems. One, hardware must be obtained, which can be expensive considering the fact that realistic networks might consist of hundreds of nodes. Two, implementation to specific hardware often brings about special issues and pitfalls which are only applicable for that particular hardware. Hence, testbed implementations will generally be an option only for smaller number of nodes and during the later stages of the implementation phase when considerable changes in the code base are not to be expected.

A Third option to test network performance is simulation. This avoids the problems with testbed implementations outlined above, and the inflexibility of analytical models. On the other hand, models can capture reality only to a limited scope, which implies that simulation results will generally not be as precise as real implementations. Still, simulations are the option of choice in many situations where limited accuracy can be accepted.

A simulation also has the advantage compared with the analytical approach because the model can be more detailed (i.e., with less proposition of simplification) and therefore the simulation results are nearer to the reality. Simulations are also a good option when modeling the dynamics of a system based on stochastic process: each user of the system is modeled as a random process that demands a service and moves in space and time, and at each interval of time, we can examine the contribution of other users to the performance of the whole network, which is difficult to model using only the analytical techniques. Simulation can also be used to validate analytical models used in network analysis.

For network simulation, a number of simulation tools are available. However, many of them (including the most popular ones like Opnet [2], OMNeT++ [3], J-Sim [4], and ns-2 [5]) were originally developed for wired networks. Only later they were extended to also support wireless networks. Also, these simulators use packet level simulation to study the network performance, and are not specific to build heterogeneous networks models. The most of them permit to simulate only two types of wireless networks (WLANs and UMTS), and we have to write a very complex code to perform the desired configuration. In this paper, we present a simple, easy to use, tool called "ABCDecision" to simulate access decision algorithms in wireless heterogeneous networks that can support several wireless networks with high flexibility and extension capabilities.

ABCDecision is an applicative level simulation tool, which permits to simply implement any decision algorithm, managing network queues, reading network indicators, generating different types of users, determining users needs and preferences, then making decision to choose the convenient access network. Consequently, the main idea behind ABCDecision is to make the development and the evaluation of new access decision algorithms as instinctive and easy as possible without going away into networks details and links parameters. This is achieved through several concepts.

(1) ABCDecision is entirely based on Java, which is a well-known language, as opposed to Tcl (Tool Command Language) for J-Sim, OTcl (ns-2), Proto-C (Opnet), and so forth. Thus, the effort of learning new languages is not required.

(2) Java eliminates known programming issues associated with C or C++ (ns-2, OMNeT++, Opnet, etc.) like memory allocation and deallocation. Simulation results produce text files containing the necessary parameters, which might be used by other tools.

(3) Java is a portable language; thus Java based simulator can be running in any machine.

(4) All network components like users, traffic generators, and cells are defined as abstract superclasses. For example, to define new cells, it suffices to inherit the abstract classes and to define the needed parameters.

(5) ABCDecision has a GUI (Graphical User Interface) support, which does not require to edit configuration files manually or to change tools for different purposes. The GUI-based configuration also ensures that the input data is valid.

The rest of the paper is organized as follows: in Section 2, we present the basic elements of an Always Best Connected (ABC) system, mainly the Access Technology Selector (ATS) module. Section 3 explains the architecture of ABCDecision simulator, including the implementation of the ATS module and the other components of the simulator, and then we list the variable parameters and the performance indicators. We present the case studies in Section 4 that include a brief description of several algorithms used for access selection and implemented in ABCDecision. In Section 5, a new algorithm (load balancing distribution) is proposed and explained in detail. Further, in Section 6, we describe and simulate a radio resources allocation scenario, and then we evaluate the performance of our proposed algorithm by a comparison with the other decision algorithms simulations. Finally, Section 7 highlights our conclusion and outlines future works.

2. ABC System

The core of the next generation infrastructure is expected to be the IP-based multiservice network (IP Backbone) that provides connectivity and transport via any access technology, including legacy 2nd generation systems (2G), evolving 3rd generation systems (3G), WLAN and future access technologies. Such a multiaccess infrastructure supports services and users having a wide variety of multiaccess capable (multimode) terminals [6]. Thus, from a QoS and access selection point of view, the key elements of an ABC system include the Multiinterface Terminal (MIT), the (candidate) access networks, the Access Technology Selector (ATS) entity, and the IP backbone network, as depicted in Figure 1. Alternatively, the ATS may be a part of the network and can have direct access to important network status parameters, or it can communicate with access technology specific entities via the IP backbone network.

In The ATS module, the access selection decision algorithms must be implemented to ensure that users are indeed best connected in terms of QoS, price, and possibly other preferences. Such algorithms should optimize the combined capacity of the multiaccess network. These algorithms will be discussed in Section 3. ABCDecision implements the different parts of an ABC System, including Access Technology Selector (ATS), RANs, and users.

3. ABCDecision Simulator

3.1. Architecture. The simulator has as a role in simulating a heterogeneous environment composed of several wireless networks and an ATS. It is based on the principle of threads and is programmed in Java language; that way, it is possible to simulate true parallelism. The simulation starts by generating users, sending them to the ATS module as a selection request. Then, the selection process is accomplished by using a specific decision algorithm to choose the best network; therefore, the client is informed by the ATS choice. Finally, the client begins to send his data of a specified type to the selected network (Figure 2).

Figure 3 shows the general schema that represents the different parts of ABCDecision simulator, which we will describe in depth in the next sections. We should notice that each cell used in our model represents a different RAN, because we need to show the influence of access decision algorithms in an environment composed of heterogeneous networks (i.e., available cells must be characterized by different parameters).

This simulator permits to generate randomly threads representing users of voice, video and data services with an interval of time λ, where λ is the interarrival time of users. Then, these users are sent towards the ATS system which is composed of a simple queue and a server. The ATS has a role to select the suitable cell and to assign it to a user. It is characterized by its time of service μ (very small value). Before the beginning of the selection process, the ATS collects needed information from the available RANs, to use them in the decision phase.

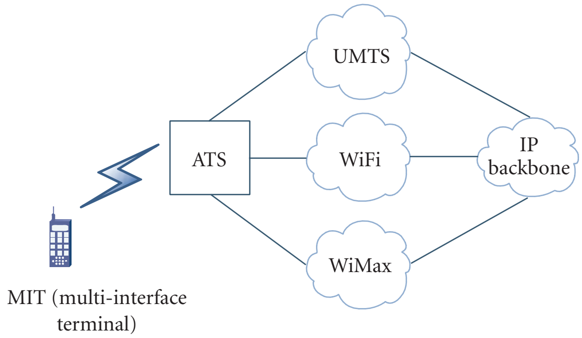


Figure 1: Key elements of an ABC system.

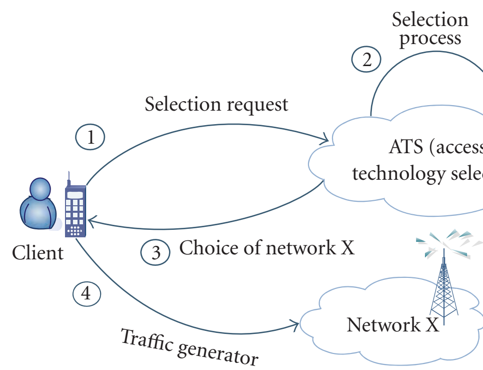


Figure 2: Selection steps implemented in the simulator.

3.2. Access Technology Selector (ATS). A user demands a service which can be voice, video, or data. His request is transferred to the ATS to select the appropriate RAN. The ATS treats the user request, determines the service needed, and indicates the QoS requirements. On the other hand, the ATS prepares a list of the current available RANs, determines the free resources reserved to the needed service in each RAN, and begins the selection process. This one is terminated by assigning the user to the suitable RAN or by rejecting the request as shown in Figure 4.

In the ATS system, we can implement any selection algorithm in a manner that the used algorithm must take into consideration, during the selection of a network, the sufficiency of the available resources in this network for the new user. Moreover, this system can read several parameters of the different available networks, such as: the occupancy rate, the maximal capacity of the cell, the size of its queue, the latency (queuing delay), and the jitter. According to these parameters, the ATS makes the selection of an access network and redirects the user towards the selected network. It is implemented by an M/M/1 model, with a mean service time (μ) expressed in seconds and distributed according to poisson law. This service time is chosen to be very small compared to the interarrival of users. The objects, representing the users, and which are creating by the users' generator, were placed in the ATS queue. The ATS treats them according to the desired QoS, and the bandwidth demanded by the generated traffic.

3.3. Users' Generator. We model the generation of the users as being a Poisson process with a determined mean ($1/\lambda$) expressed in seconds. The service type of each user is an integer value generated randomly between 1 and 3 (1 for the voice, 2 for the video, and 3 for the data).

3.4. Cell Model. Each cell is modeled by a queue and a server, and is characterized by several parameters such as: the total capacity, the type of the cell, the size of the queue, and the service time μ. The arrival of a user to a cell carries out a thread representing a traffic generator having the same type of the service required by the user. What interests us in our simulator is to notice the effects of the various selection algorithms on the change of delay and on the total capacity of the system composed by different cells of several access networks. A cell is modeled by M/M/1 model, and characterized by the following elements.

(i) The maximum number of acceptable users. Each cell has a maximum capacity which can be measured by the number of radio resources in this cell. The service types consume different radio resources, for example, in a WCDMA cell; the relative estimated consumption of radio resources for the voice = 1/150 and for the data Web (www) = 1/80. Thus, we specified for each cell a given value representing the maximum number of acceptable users. At the time of the arrival of a user, the number of available resources is decreased according to the service type of this user.

(ii) The time of service. It is a relative value which depends on the maximum bandwidth supported by the cell and precisely by the access network. The time of service has an average (μ), which is a value expressed in milliseconds and distributed according Poisson's Law.

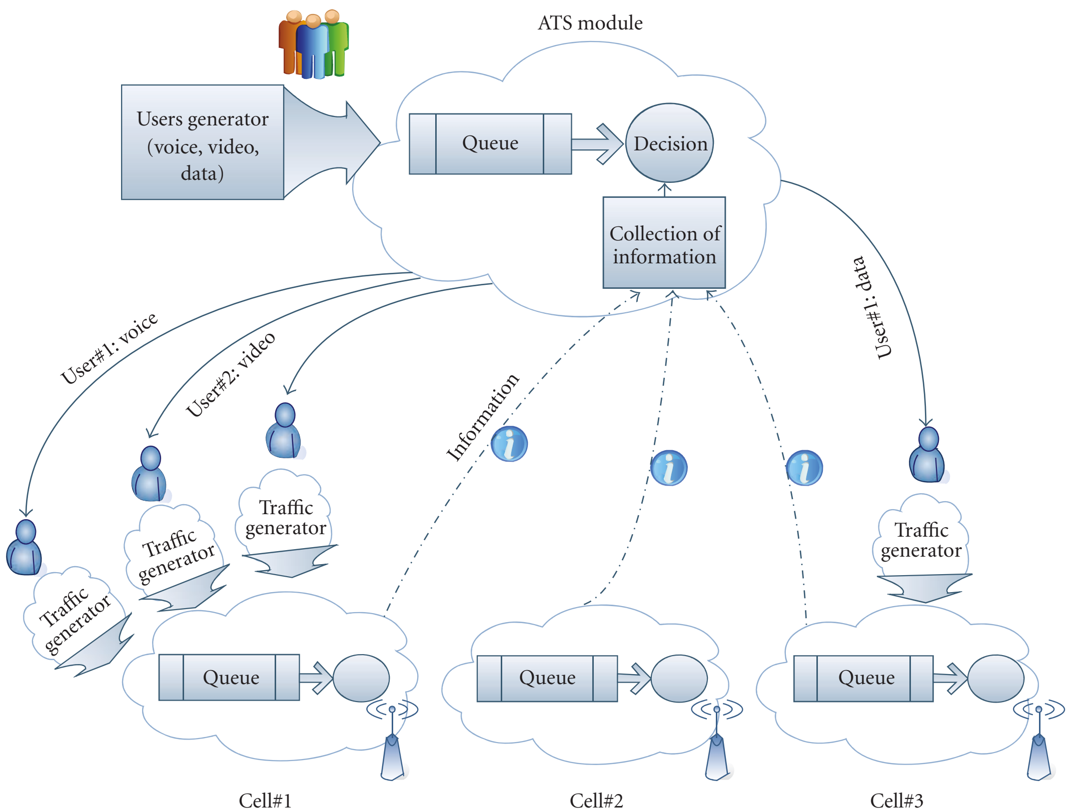


Figure 3: General schema representing the different parts of the simulator.

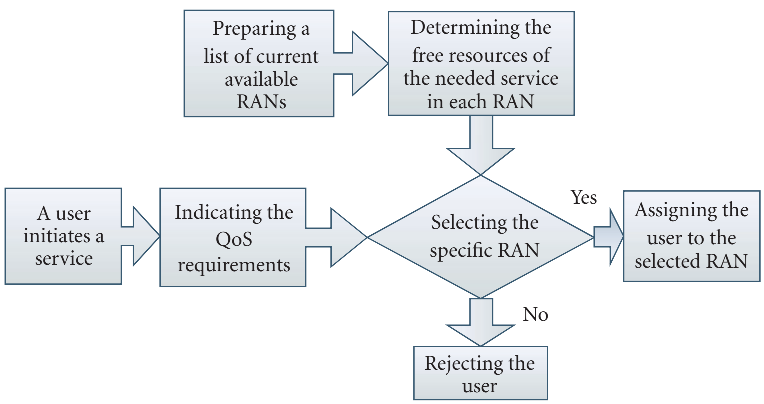


Figure 4: Assigning the user to the suitable RAN.

As for other performance indicator, the delay and the jitter are calculated as explained in the standard of the RTP protocol [7]. The delay indicates the time between the moment when information is sent and that when it is received; there are several types of delay in networks, which interests us in our simulator is the queuing delay. The jitter is an estimate of the statistical variance of the interarrival time of the packets, measured in timestamp units and expressed as an unsigned integer. The interarrival jitter **J** is defined to be the mean deviation (smoothed absolute value) of the difference **D** in packet spacing at the receiver compared to the sender for a pair of packets.

3.5. Traffic Classes Generator. A traffic generator represents a user sending data through a cell and must be of the same type of the user service type; thus, 3 types of generators are presented:

(i) voice traffic generator,

(ii) video traffic generator,

(iii) data traffic generator.

Each generator is characterized by many parameters related to the type of service concerned, including the execution time and the generation interval λ of the packets. Each generator represents a traffic class, which is modeled as follows:

3.5.1. Voice Traffic. The voice traffic at source level is characterized by an active period (talk spurt) followed by an inactive period (silence). During the ON period, the source sends packets according to the regular intervals of length T (Packetization time). The duration of the active and inactive periods is generally estimated by independent exponential laws, with parameters α and β, respectively, (Figure 5). A source of voice traffic is modeled as a Markovian ON-OFF model with three parameters [8].

(1) The mean duration of ON period: $T_{\mathrm{ON}} = 1/\alpha$, with α being the parameter of the exponential law of the ON active period.

(2) The mean duration of the OFF period: $T_{\mathrm{OFF}} = 1/\beta$, with β being the parameter of the exponential law of the OFF inactive period.

(3) The constant packet transmission rate during the ON period: $\lambda = 1/T$.

We can calculate the mean rate of the source E in packets per second on all states by

$$E = \frac{T_{\mathrm{on}}}{(T_{\mathrm{on}} + T_{\mathrm{off}}) \cdot T} = \frac{\beta}{(\beta + \alpha) \cdot T}. \qquad (1)$$

The mean duration of call is 3 minutes distributed exponentially. The packets are transported by UDP protocol. The size of packet and the interarrivals depend on the CODEC used for the voice encapsulation.

The voice traffic generator implemented in our simulator is G.729 Codec, but simply we can change the parameters as described in [9] to use another codec.

3.5.2. Video Traffic. For video traffic, we used a simple model where interarrivals are distributed according to poisson law, with a mean $\lambda = 40$ and each packet has a size of 1000 bytes. The mean duration of a video session is 30 minutes distributed exponentially.

3.5.3. Data Traffic. For data traffic, we used a simple model where interarrivals are distributed according to poisson law, with a mean of $\lambda = 22$, and each packet has as size of 1460 bytes. The mean duration of a data transfer session is 5 minutes distributed exponentially.

3.6. Variable Parameters and Performance Indicators. The parameters used in the simulator and which can be configured by the user are.

(i) duration of simulation (in minutes),

(ii) the maximum number of acceptable users per cell,

(iii) the type of generated traffic (voice, video and/or data),

(iv) the interval of arrival ($1/\lambda$) of the users or the number of the users generated in one minute,

(v) the time of service of the selection server of the ATS,

(vi) the time of service of each network,

(vii) the interval of arrival of the generators of video and data traffic.

And the performance indicators provided at the end of simulation are:

(i) the occupancy rate of the cell,

(ii) the number of the users (or asks of a service) blocked for each service type,

(iii) the number of the users, who are in service for each service type,

(iv) the number of the users been useful for each service type,

(v) the average value of the delay and the jitter,

(vi) the maximum value of the delay and the jitter.

The simulator enables us to make simulations for various algorithms of access networks selection and to obtain the parameters of which we want to use them in the comparison between these algorithms. We can improve the simulator and add new modules necessary to the operation of a network.

4. Case Studies

Most of the existing and proposed access selection methods formulate the objective such that the user is best connected with respect to the QoS requirements. While this requirement is nontrivial on its own, we recognize that from the access provider's point of view it is important that the overall capacity is maximized. References [10–12] indicated that in multiaccess networking, for a given set of QoS requirements, there is a significant potential for capacity gain if overall resource management is coordinated. In this section, we present a list of implemented access selection algorithms that can be used for selecting the appropriate RAN based on different criteria.

Algorithm 1. It is a reference access selection algorithm; it does not take into account the type of service needed by the user or the capacity of the RAN (Radio Access Network). User u_i is simply assigned to RAN_j with a probability:

$$\boxed{\Pr\left[u_i = \mathrm{RAN}_j\right] = \frac{1}{n},} \qquad (2)$$

where n is the number of radio access networks available.This assignment method requires no input information, and results in equal expected service mixes in all RANs.

Algorithm 2. In this algorithm, we choose a RAN in a random and equivalent way among all the available cells. If the selected cell serves the needs of the user in request, then the cell is assigned to the user. If not, the following cell is selected in a Round Robin manner until obtaining a cell which accepts the request of the user.

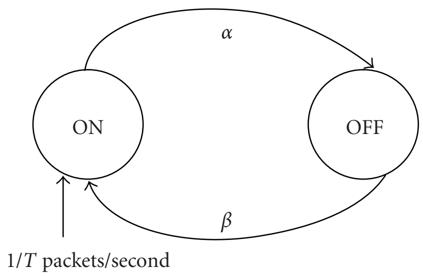


Figure 5: Voice over IP (VoIP) Model.

Algorithm 3. For this algorithm, the cell selected for the user is the one which can accept him and have the smallest number of available resources. Obviously, this algorithm requires the knowledge of the situation of the system (occupation of each cell).

Algorithm 4. Contrary to the previous algorithm, this algorithm chooses among the cells which can serve the user, that having the greatest number of radio resources available. This algorithm requires the knowledge of the situation of the system.

Algorithm 5. In this algorithm, we will considered the service type during the selection, for that the user is directed towards the cell which presents the minimum delay.

Algorithm 6. Multi-Constraint Dynamic Access Selection is an optimization method used by [13], wherein a sequence of un-predetermined flows starts at discrete time points and an access network is selected for each of them upon arrival.

They model the Multi-Constraint Dynamic Access Selection (MCDAS) problem as a variant of the bin packing problem, which is NP-hard. The basic bin packing problem is as follows: given a list of items with sizes less than 1 and a set of bins with capacity 1, find the packing of these items into the bins without violating the capacity limit, so that the minimum number of bins is used. A bin packing problem is called on-line if every item is packed without information on subsequent items, while an offline problem allows decisions to be made with full knowledge of all the items [14]. Thus the maximum bandwidth of an access is analogous to the capacity of a bin, which varies from one access to another. The bandwidth requirement of a traffic flow is mapped to the size of an item. Other constraints are added to the basic problem, such as delay constraints and access preferences. If the accesses are sorted in increasing power cost order before allocation, seeking minimum total power is similar to finding minimum number of bins.

5. Proposed Algorithm (Load Balancing Distribution)

In this section, we propose a network access selection algorithm which can be implemented in the ATS module. The algorithm is based on a general strategy characterized by distributing the traffic to the different available RANs to achieve a load balancing between RANs according to the adopted criteria. This distribution uses a priority manner dependant on the number of radio resources reserved to each type of service in each RAN (e.g., the reservation can be based on the service cost).

The pseudo code of the algorithm used in the selection process is mentioned in Figure 6.

We define MaxCap(i) as the maximal capacity of the cell i, which can be measured as the number of radio resources in this cell, as explained in Section 3.4.

We assume that the capacity of a cell can be different from the capacity of another cell: MaxCap$(i) \neq$ MaxCap(j) if $i \neq j$.

Cap(j, i): the capacity available for the type of service j in cell i. Then,

$$\text{MaxCap}(i) = \sum_{j=1}^{n} \text{Cap}(j, i), \tag{3}$$

where n is the number of types of services used.

Needed (a, i) is the bandwidth or the number of resources needed by the application (*user*) a in cell i.

The number of available resources in the cell i:

$$\text{MaxCap}(i) - \sum_{a=1}^{m} \text{Needed}(a, i), \tag{4}$$

where m is the number of applications currently using the cell i.

The number of resources available for the type of service j in cell i: Free(j, i).

We define Threshold (j, i) as equaling 80% of the capacity available of the type of service j in cell i.

After the definition of the terms and parameters used in our algorithm, we list the decision steps as follows.

(i) The user is assigned to the RAN that gives higher priority (i.e., higher capacity) for the type of service demanded by the user taking into consideration that the free resource available in this RAN is sufficient and the RAN meets the delay requirements for the user.

(ii) If the capacity provided for the type of service in the first RAN is not enough, then the next RAN is tested, and so on.

(iii) If the capacities provided for the type of service in all RANs exceed the convenient Threshold, the selected RAN would be that provides the highest free resources.

(iv) If no RAN meets the requirements mentioned above, the user is rejected.

The important point provided by this algorithm is the equitability between the different services and the different cells to avoid the saturation of a cell, while the other cells are still empty.

```
FUNCTION Assign (a)
meets_Delay = true;
FOR RANs sorted in decreasing Cap(j,i) order
    Used = Cap(j,i) − Free (j,i)
    IF ((Needed(a, i) < Free(j, i)) THEN
        IF (Used < Threshold (j, i))) THEN
            IF RANj meets delay requirements of a THEN
                Assign j to a;
                RETURN true;
            ELSE meets_Delay = False;
            END IF
        END IF
    END IF
END FOR
IF (meets_Delay == False) THEN
    RETURN false;
END IF
FOR RANs sorted in decreasing (Free(j,i)) order
    IF (Needed(a, i) < Free(j, i)) THEN
            IF RANj meets delay requirements of a THEN
                assign j to a;
                RETURN True;
        END IF
    END IF
END FOR
RETURN False;
END FUNCTION
```

Figure 6: Pseudo code of the proposed algorithm.

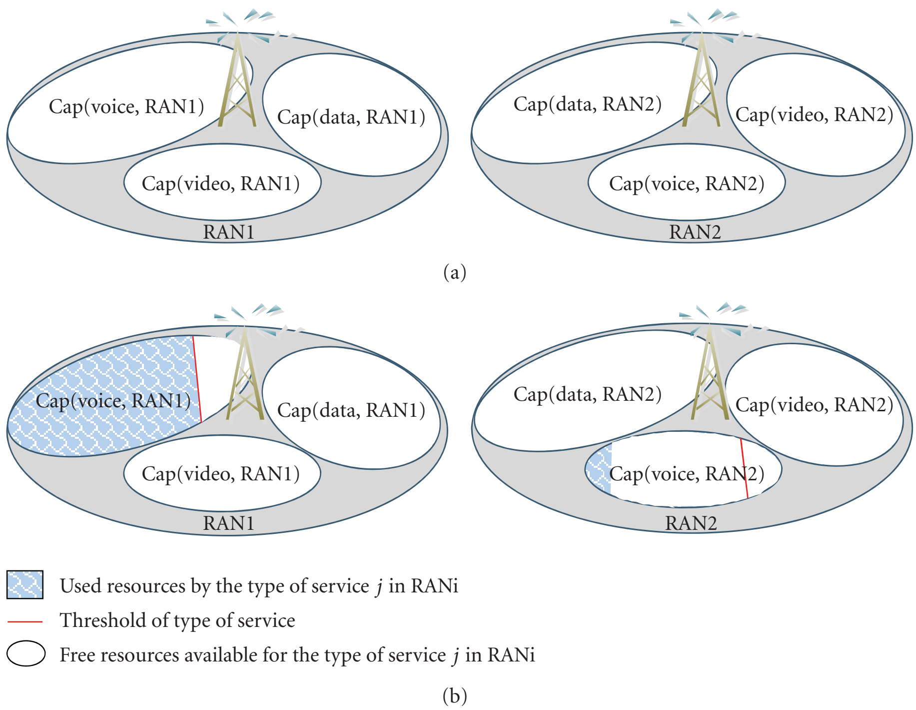


Figure 7: (a) Example of the distribution of radio resources on the type of services in two different RANs. (b) When the capacity of "Voice" service exceeds the specified threshold in RAN1, the voice traffic is directed to RAN2.

6. Performance Results

In this section, we show through a set of simulations the behavior of our proposed algorithm then we compare it with the existing one.

6.1. Radio Resources Allocation. We consider a scenario with a heterogeneous wireless environment that contains only two cells of different technologies, RAN1 and RAN2. We assume that RAN1 has the higher allocated radio resources for voice service between the available RANs (Figure 7(a)).

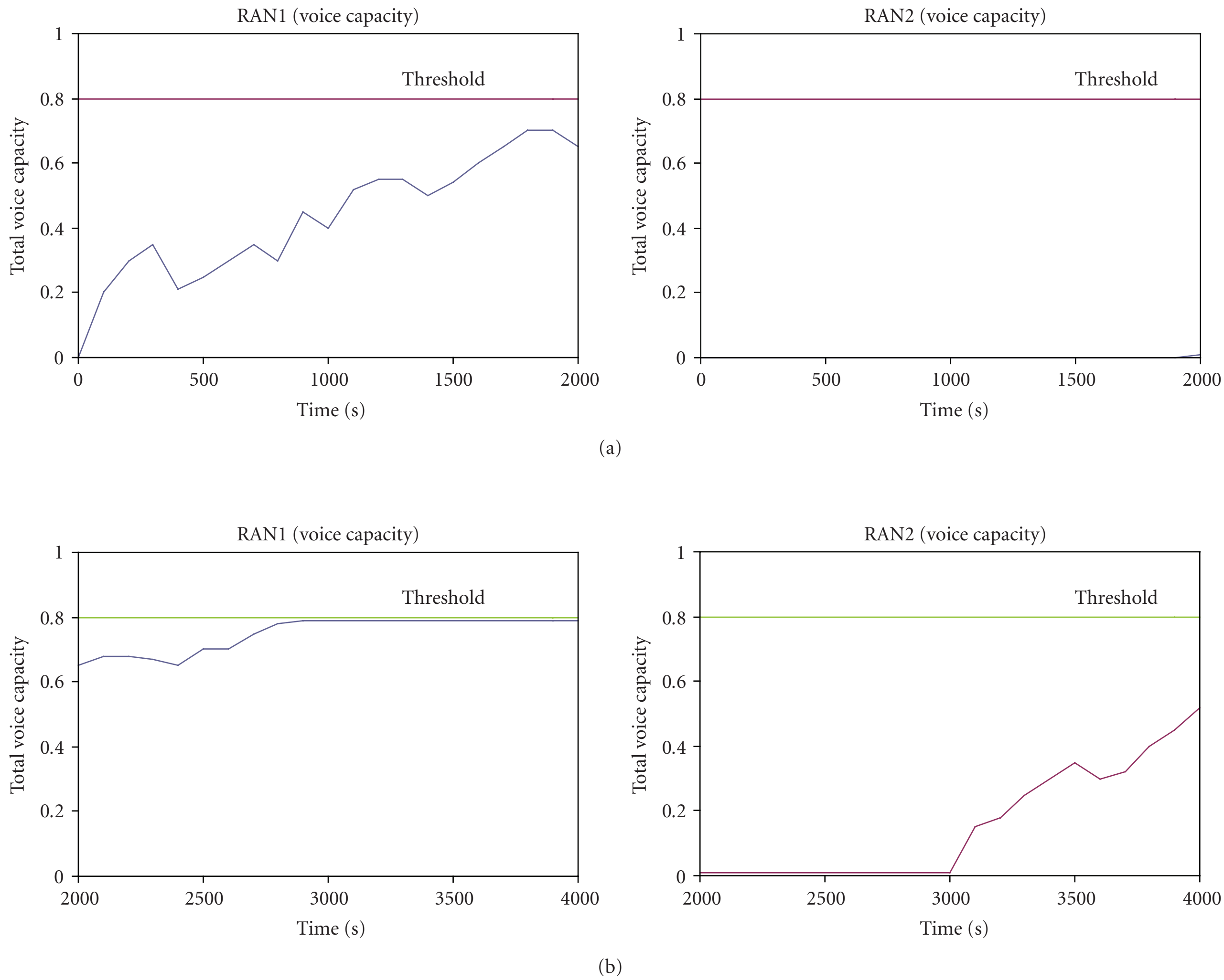


Figure 8: Voice traffic distribution between the two RANs.

We treat only the case of voice traffic.We consider a number of users that initiate consecutively voice calls; their requests are treated by the ATS system to make the decision and select the appropriate RAN, according to the algorithm explained above. The ATS redirects firstly the voice users to RAN1. A predefined threshold is set in RAN1 so that the resources allocated to voice traffic remain below or equal to this threshold. When a new voice user arrives and the resources allocated to voice traffic will exceed the threshold in RAN1, the ATS sends the user to the RAN that provides the maximal allocated free resources to voice traffic which is in our case RAN2 (Figure 7(b)).

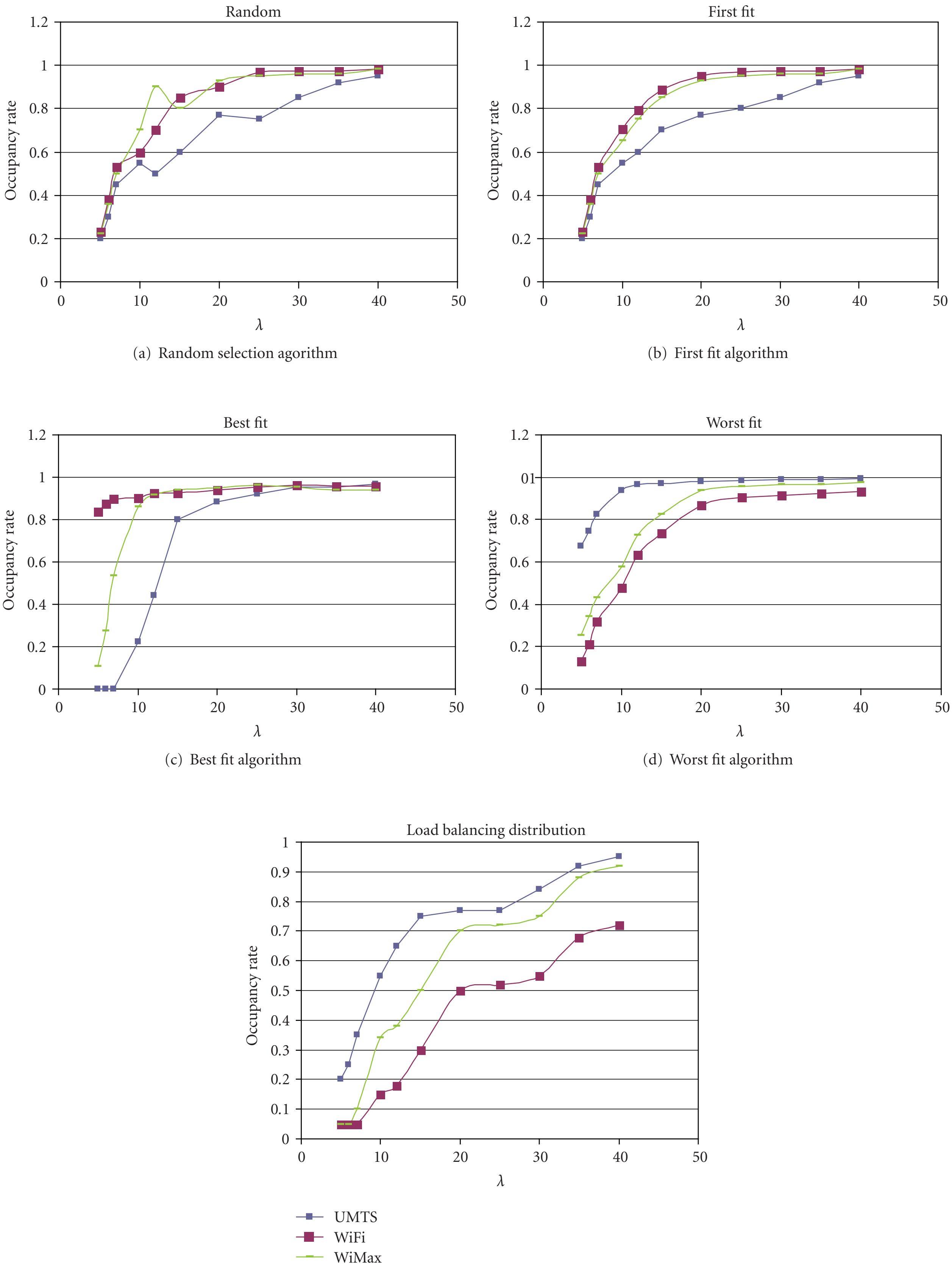
Figure 8 illustrates the distribution of voice traffic between the two RANs, in different time intervals. Figure 8(a) shows that between 0 and 2000 s, the voice traffic is directed to RAN1, because it provided the largest radio resources for voice traffic. Figure 8(b) shows that at 3000 s, the used radio resources allocated to voice traffic in RAN1 exceed the predefined threshold (in our case 0.8); therefore, the traffic is directed to RAN2.

6.2. Comparison between Algorithms

6.2.1. Simulation Setup. We assume that three radio access networks are available. RAN1 represents a UMTS cell, RAN2 a WiFi cell, while RAN3 is intended to represent WiMax cell. Without loss of generality, the maximal capacity of each RAN is shown below in Table 1.

We consider a dynamic scenario in which voice calls will be supported in the network. Thus, the maximal capacity of each RAN in our scenario represents the maximal number of resources that can be allocated for voice traffic.

We model the arrival and departure of calls as a Poisson Process with an arrival rate (lambda) representing the number of arriving users per minute. By definition, with higher arrival rate, users arrive faster than they leave the subsystems, causing the access networks to be more crowded. Arrival rate has a strong impact on the performance of access selection algorithms, as will be seen in simulation results. In our experiments, eleven arrival rate values were simulated; these values are listed in Table 2.



(a) Random selection agorithm

(b) First fit algorithm

(c) Best fit algorithm

(d) Worst fit algorithm

(e) Load balancing distribution algorithm

Figure 9: Simulation results showing the occupancy rate versus arrival rate.

Table 1: Maximal capacities of used RANs.

RAN	Maximal number of resources
RAN1 (UMTS)	22
RAN2 (WiFi)	14
RAN3 (WiMax)	16

Table 2: Arrival rates values used in the simulations.

Simulation	1	2	3	4	5	6	7	8	9	10	11
Arrival rate (users/min)	5	6	7	10	12	15	20	25	30	35	40

The main metric used to evaluate the functionality of our simulator and the basic performance of different algorithms is the occupancy rate, which shows the level to which traffic flows on different RANs are balanced, with respect to the QoS constraints.

6.2.2. Simulation Results. Figure 9 illustrates the basic simulation results of access decision algorithms (Random, First Fit, Worst Fit, Best Fit and Load Balancing) that demonstrate their impact on the occupancy rate of the three used RANs.

The simulation results of Random algorithm show that the occupancy rate in the three RANs varies depending on the random selection manner of the cells, that is, the traffic is directed to the cells without applying any defined rule and regardless of the cells capacities. As shown in Figure 9(a), for lambda approximately in the 10 to 13 interval, UMTS has the highest occupancy rate, while this is not necessarily the case for other lambda values, since as mentioned, this depends on the random selection manner of the cells.

First Fit algorithm distributed the traffic in equal manner between cells without taking into consideration the capacity of each cell. Thus, the cell having the highest capacity (UMTS) receives the same number of voice calls as the one having the lowest capacity (WiFi). For this reason, UMTS cell has the smallest occupancy rate (Figure 9(b)).

Figure 9(c) shows that WiFi cell is occupied to the maximum (higher occupancy rate) before the other cells begin to receive traffic, because by using Best Fit algorithm, the traffic is directed to the RAN having the lowest number of available resources. So, as lambda increases, the available resources in WiFi cell decrease to null and the traffic is directed to the cell having the new lowest number of available resources (WiMax then UMTS).

Contrary to Best Fit, worst Fit algorithm sends the traffic to the RAN having the highest number of available resources which is UMTS cell. Consequently, its occupancy rate reaches the maximal limit even though lambda has small values (Figure 9(d)). Hence, as lambda increases, the available resources in UMTS cell decrease and the traffic is directed to the cell having the new highest number of available resources (WiMax then WiFi).

Figure 9(e) illustrates the simulation results of our proposed algorithm (load balancing). The traffic is sent to the RAN having the highest free resources allocated for voice traffic (UMTS). As lambda increases, the used radio resources exceed the predefined threshold; therefore, the traffic is directed to the next larger RAN in terms of available radio resources (WiMax). UMTS has not been occupied to the maximum to satisfy QoS requirements. The same scenario is repeated with WiMax and WiFi. We can conclude that the occupancy rate in the three RANs increases progressively by taking into consideration the capacities of the available cells and the QoS requirements.

7. Conclusion

In this paper, we presented ABCDecision, a multisystem RAN simulator allowing the evaluation of access decision algorithms in heterogeneous wireless networks, and we proposed a novel strategy in access selection. The main focus of the simulator is on ease of use without entering inside networks complexity. The object oriented architecture of this simulator makes it extensible and gives the user the possibility to build easily new models. The fact that ABCDecision is based on a well-known language like Java notably reduces the learning curve. The proposed algorithm for access selection is based on the distribution of the traffic on the available cells of different technologies that belong to the same operator, taking into consideration the QoS parameters and the needs of the user, precisely the demanded bandwidth to each type of service. Our initial results showed a good distribution of the traffic of the different type of services to the available cells and the occupancy rates of cells of different capacities are equilibrated.

Our future works will focus on the improvement of the visualization support of the simulator by adding new graphical user interfaces, and providing more build-in models and access decision algorithms.

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