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Improving the Quality of Experience by Optimization of Access Selection and Priority Scheduling (OASPS) In Heterogeneous Wireless Access Networks

Abstract*:*The IEEE 802.16j standard for WiMAX has recently received considerable attention. The IEEE 802.16j amendment is fully compatible with the 802.16e standard and enhances IEEE 802.16e by incorporating relay technology . A typical IEEE 802.16j network consists of base stations (BSs), relay stations (RSs) and subscriber stations (SSs). The radio links between BSs and RSs are called relay links, while the links between BSs and SSs or between RSs and SSs are called access links. According to the channel qualities of these links, BSs and RSs can dynamically adapt the downlink modulation and coding schemes (MCSs) for data transmission. We design an ANS mechanism that takes into account all aspects of the trade-off between the quality of the connections, the preferences of the end users and the cost. To improve the quality of experience, priority scheduling is established between various call patterns. To highlight the benefits of our approach from the perspectives of both end users and network operators, we have implemented and tested the solution in a multitechnology simulator. Results show that the proposed solution outperforms mainstream approaches. We propose a modified priority algorithm for the uplink scheduler of Mobile WiMAX. The proposed algorithm guarantees the delay property of the real-time traffic by imposing a threshold to the bandwidth request messages of the non real-time Polling Service (nrtPS). Each service class is serviced exhaustively (until empty) to overcome on the starving of lower priority service class which is the Best Effort (BE). The threshold value can be adjusted according to the load demand of the networks. Simulation results, found at the end of this study show that the proposed algorithm is fairer and delivers higher throughput of the BE service class.

Index Terms: Cellular networks, fourth-generation (4G) mobile, mobile radio mobility management, utility theory, modified priority algorithm, QoS, scheduling algorithm, Worldwide Interoperability for Microwave Access (WiMAX).

I.INTRODUCTION

The ability to provide services in a cost-effective manner is one of the most important building blocks of competitive modern cellular systems. Usually, an operator would like to have a maximal utilization of the installed equipment, that is, to maximize the number of satisfied customers at any given point in time. This paper addresses one of the basic problems in this domain, the cell selection mechanism. This mechanism determines the base station (or base stations) that provides the service to a mobile station—a process that is performed when a mobile station joins the network (called cell selection) or when a mobile station is on the move in idle mode (called cell reselection, or cell change, in HSPA). In our work, the automatic network selection (ANS) mechanism, which is a key mechanism that needs to be implemented in multimode terminals, is primordial. In traditional homogeneous networks, network selection is only based on signal quality from serving and neighboring access nodes, such as received signal strength (RSS) or signal-to-interference-plus noise ratio and it is fully controlled by the network in the case of cellular systems. In heterogeneous networks and universal access facilities, ANS is a multidimensional decision-making problem that involves a set of network and terminal parameters and a complex trade-off between possibly heterogeneous criteria (e.g., performance or cost) that could be defined by the end user. Satisfying all criteria at the same time is proven to be difficult as some criteria may be in conflict. The problem of wireless access network selection and the vertical handover (VHO) have been previously addressed in several contributions. The common goal of all approaches was to maintain the MT connection during the mobility of the user across heterogeneous and/or multi-operator access networks (e.g., walking, using a car or traveling in a train). To ensure a seamless handover, several mechanisms have been proposed and can be classified in three different categories, depending on the entity that controls the handover: terminal-controlled handover (TCH), network-controlled handover (NCH) and hybrid controlled handover (HCH).In this paper, We propose a modified priority algorithm aimed at improving the throughput and fairness of the lower priority classes. Then, to evaluate the network performance from a theoretical point of view and later from a more realistic point of view, we provide both numerical and network simulations. The latter have been achieved by setting up a complete simulation platform that is able to simulate the coexistence of all the technologies considered in this work. We present the most important criteria that will be considered in the ANS mechanism. Link quality, Monetary cost. Battery lifetime, MT velocity ,Network load using the mechanism of ANS, the above criteria are analysed and for call maturing process, priority scheduling is established based on the type of calls such as audio and video calls. Effective channel based priority scheduling is implemented in the framework to improvise the overall quality of experience of the system. The approach aims at adjusting the threshold value which represents the number of bandwidth request message in the nrtPS service class. The scheduling scheme starts with the scheduler visits to rtPS. The rtPS is serviced until no more bandwidth request message is available. Before continuing the service to nrtPS, the scheduler will check on the amount of bandwidth request available in the nrtPS service class.

II.LITERATURE REVIEW

L. Harju and J. Nurmi,
“A baseband receiver architecture for UMTS-WLAN interworking applications,”
2004, vol. 2, pp. 678–685.

This paper presents a programmable hardware platform for dual-mode WCDMA/OFDM receive implementations. The platform is targeted for mobile terminals capable of operating in tight coupling UMTS-WLAN interworking systems. The proposed platform comprises a RISC core and three coprocessors that are used for the most intensive computation kernels. The receiver algorithms needed inWCDMA and OFDM receivers are
overviewed and the needed computation resources are specified based on the analysis. The high-level architecture of the dual-mode receiver is also presented. A software development model is specified for the platform.

H. J. Wang, R. H. Katz, and J. Giese,
“Policy-enabled handoffs across heterogeneous wireless networks,”
1999, pp. 51–60

“Access is the killer app” is the vision of the Daedalus project at UC Berkeley. Being able to be connected seamlessly anytime anywhere to the best network still remains an unfulfilled goal. Often, even determining the “best” network is a challenging task because of the widespread deployment of overlapping wireless networks. We describe a policy-enabled handoff system that allows users to express policies on what is the “best” wireless system at any moment, and make tradeoffs among network characteristics and dynamics such as cost, performance and power consumption. We designed a performance reporting scheme estimating current network conditions, which serves as input to the policy specification. A primary goal of this work is to make it possible to balance the bandwidth load across networks with comparable performance. To avoid the problem of handoff instability, i.e., many mobile hosts making the same handoff decision at essentially the same time, we designed randomization into our mechanism. Given the current “best” network, our system determines whether the handoff is worthwhile based on the handoff overhead and potential network usage duration

E. Adamopoulo, K. Demestichas, A. Koutsorodi, and M. Theologou,
“In-telligent access network selection in heterogeneous networks—simulation results,” , 2005, pp. 279–283.

This paper presents mobile terminal for devices operating in heterogeneous environments, which incorporates intelligence for supporting mobility and roaming across legacy access networks. It focuses on the structure and functionality of the proposed schemethat supportsterminalinitiated and terminalcontrolled access network selection in heterogeneous networks. It discusses the decomposition of the proposed terminal management system into separate modules, responsible for retrieving link-layer measurements from the attachment points in the terminal's neighborhood, for handling the user's profile and for performing intelligent access network selection. This latter function aims at independently determining the optimal local interface and attachment point through which applications can be obtained as efficiently as possible, by taking into account network status and resource availability, user preferences and service requirements

O. Ormond, G. Muntean, and J. Murphy,
"Utility-based intelligent net-work selection in beyond 3G systems,"
2006, pp. 1831–1836

Development in wireless access technologies and multi homed personal user devices is driving the way towards a heterogeneous wireless access network environment. Success in this arena will be reliant on the ability to offer an enhanced user experience. Users will plan to take advantage of the competition and always connect to the network which can best service their preferences for the current application. They will rely on intelligent network selection decision strategies to aid them in their choice. The contribution of this paper is to propose an intelligent utility-based strategy for network selection in this multi-access network scenario. A number of utility functions are examined which explore different user attitudes to risk for money and delay preferences related to their current application. For example we show that risk takers who are willing to pay more money get a better service.

O. Ormond, G. Muntean, and J. Murphy,
"Economic model for cost effective network selection strategy in service oriented heterogeneous wireless network environment,"
2006, pp. 1–4

This paper describes and formalizes the service oriented heterogeneous wireless network environment (SOHWNE), the future service provision and delivery environment that supports ubiquitous user access anywhere at any time from diverse devices to a broad range of services. These services can be offered by third parties and can be accessed via one of many available networks. This paper also proposes and describes a novel algorithm for intelligent cost-oriented and performance-aware selection between available networks. This user-centric strategy focuses on the maximization of consumer surplus when selecting the best available connection for transferring non real-time data, with user

M. Xiao, N. Shroff, and E. Chong,
"A utility-based power-control scheme in wireless cellular systems,"
vol. 11, no. 2, pp. 210–221, Apr. 2003.

Distributed power-control algorithms for systems with hard signal-to-interference ratio (SIR) constraints may diverge when infeasibility arises. We present a power-control framework called utility-based power control (UBPC) by reformulating the problem using a softened SIR requirement (utility) and adding a penalty on power consumption (cost). Under this framework, the goal is to maximize the net utility, defined as utility minus cost. Although UBPC is still non cooperative and distributed in nature, some degree of cooperation emerges: a user will automatically decrease its target SIR (and may even turn off transmission) when it senses that traffic congestion is building up. This framework enables us to improve system convergence and to satisfy heterogeneous service requirements (such as delay and bit error rate) for integrated networks with both voice users and data users. Fairness, adaptiveness, and a high degree of flexibility can be achieved by properly tuning parameters in UBPC.

H. Lin, M. Chatterjee, S. Das, and K. Basu,
"ARC: An integrated ad-mission and rate control framework for competitive wireless CDMA data networks using non cooperative games,"
vol. 4, no. 3, pp. 243–258, May/Jun. 2005

The competition among wireless data service providers brings in an option for the unsatisfied customers to switch their providers, which is called churning. The implementation of Wireless Local Number Portability (WLNP) is expected to further increase the churn rate (the probability of users switching the provider). However, the existing resource management algorithms for wireless networks fail to fully capture the far-reaching impact of this unforeseen competitiveness. From this perspective, we first formulate non cooperative games between the service providers and the users. A user's decision to leave or join a provider is based on a finite set of strategies. A service provider can also construct its game strategy set so as to maximize their utility (revenue) considering the churn rate. Based on the game theoretic framework, we propose an integrated admission and rate control (ARC) framework for CDMA-based wireless data networks. The admission control is at the session (macro) level while the rate control is at the link layer packet (micro) level. Two admission control modes are considered - one-by-one mode and batch processing mode, in which multiple users are admitted at a time. We show that: 1) for the one-by-one mode, the Nash equilibrium using pure strategy can be established for both under-loaded and fully-loaded systems and 2) for batch processing mode, there is either an equilibrium in pure strategy or a dominant strategy exists for the service provider. Therefore, the providers have clearly defined admission criteria as outcome of the game. Users are categorized into multiple classes and offered differentiated services based on the price they pay and the service degradation they can tolerate. We show that the proposed ARC framework significantly increases the provider's revenue and also successfully offers differentiated QoS to the users.

III.PROPOSED METHODOLOGY

In our work, the automatic network selection (ANS) mechanism, which is a key mechanism that needs to be implemented in multimode terminals, is primordial. In traditional homogeneous networks, network selection is only based on signal quality from serving and neighboring access nodes, such as received signal strength (RSS) or signal-to-interference-plus noise ratio and it is fully controlled by the network in the case of cellular systems. In heterogeneous networks and universal access facilities, ANS is a multidimensional decision-making problem that involves a set of network and terminal parameters and a complex trade-off between possibly heterogeneous criteria (e.g., performance or cost) that could be defined by the end user. Satisfying all criteria at the same time is proven to be difficult as some criteria may be in conflict. The problem of wireless access network selection and the vertical handover (VHO) have been previously addressed in several contributions. The common goal of all approaches was to maintain the MT connection during the mobility of the user across heterogeneous and/or multi-operator access networks (e.g., walking, using a car, or traveling in a train). To ensure seamless handover, several mechanisms have been proposed and can be classified in three different categories, depending on the entity that controls the handover: terminal-controlled handover (TCH), network-controlled handover (NCH), and hybrid controlled handover (HCH).

The approach aims at adjusting the threshold value which represents the number of bandwidth request message in the nrtPS service class. The scheduling scheme starts with the scheduler visits to rtPS. The rtPS is serviced until no more bandwidth request message is available. Before continuing the service to nrtPS, the scheduler will check on the amount of bandwidth request available in the nrtPS service class. If the amount of bandwidth request exceeds the threshold assigned, then the scheduler will carry out the service to nrtPS and subsequently the BE. On the other hand, the scheduler will return to service rtPS if the amount of the bandwidth request is less than the threshold assigned.

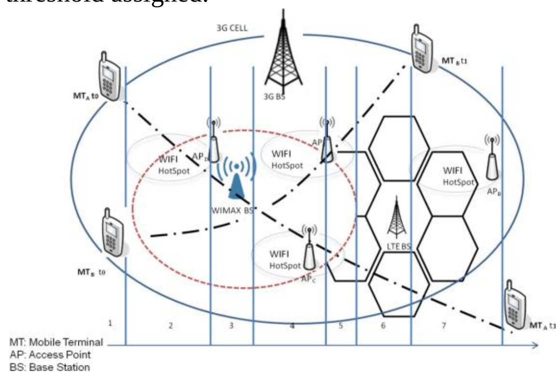


Fig.1: Heterogeneous wireless network diversity.

IV.FLOW CHART

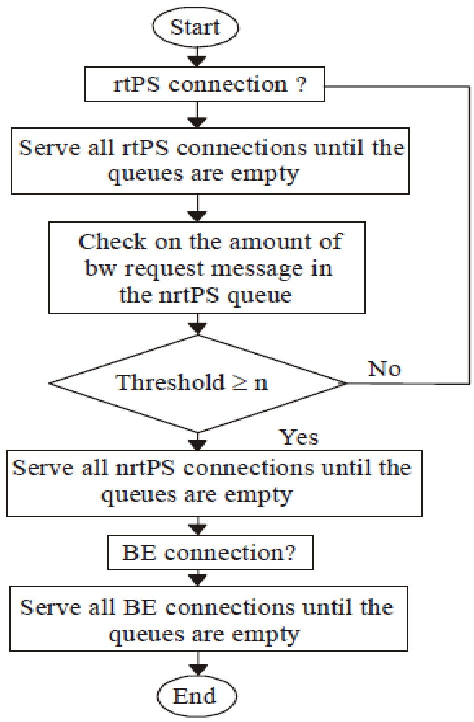


Fig. 3: Modified priority algorithm flowchart

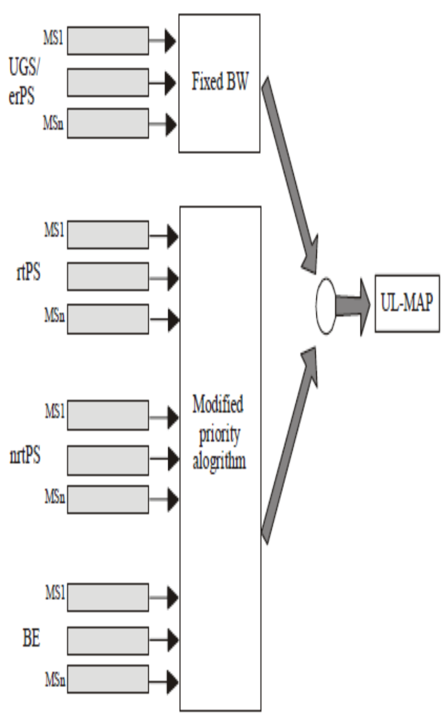


Fig2: The architecture of the uplink scheduler

The simulation is conducted in two phases:

1) initial efficient resource allocation (*offline phase*);
2) connection management and revenue calculation (*online phase*).

a) Phase 1: Efficient resource-allocation evaluation:

The first phase is executed offline and is aimed at calculating the best resource-allocation vector **b_**. The input is the total number of subscribers and their service profile (gold or silver). Let *Ng* and *Ns* be the respective number of end users subscribing for gold and silver contracts, and suppose that the network capacity in term of bandwidth *C*BW and the users' preferences are known. The proposed Algorithm 1 aims to compute the best allocation vector that maximizes RE(**b_**, *ps*, *pg*). To find the best **b_**, the algorithm relies on a heuristic approach that consists of a random walk in the search space of acceptable resource distribution vectors **b**. The algorithm
improves at each stage the allocation vector, similar to a Monte Carlo method. The number of evaluation loops that are required to reach an optimal value for the vector depends on both the dimension of the search space and the walking step. In our case, after numerous tests, we have set this value *N*loop 106.

a) Phase 2: Users connections management and reward evaluation:

We now describe the second step of the simulations done in real time. At each connection request initiated by an MT to any access network (WiMAX/Wi-Fi/UMTS/LTE), the information contained in the message (e.g., node ID, requested band width, etc.) is extracted by the corresponding access network and added to a set of vectors called resource request vectors Req. Among all the information provided, we denote by **b**(Req)the requested bandwidth. Note that **b**(Req)*k* = [*b*(Req)1 . . *b*(Req) *N*max], where *b*(Req) *k* = 0 if the *k*th user makes no service request.

V.ALGORITHM

Algorithm 1 Efficient resource-allocation evaluation:

Input: N_s, N_g (with $N_s + N_g = N_{\max}$), C_{BW}, and user preferences.

Output: $\mathrm{b}^\star$: $\arg\max_{\mathrm{b}} ER(\mathrm{b}, p_s, p_g)$ s.t. $\sum_k b_k^\star \leq C_{\mathrm{BW}}$

Init: $\mathrm{b}^\star = [\,]$, $\mathrm{ER}(\mathrm{b}^\star, p_s, p_g) = 0$.

for $l = 1 \to N_{\mathrm{loop}}$ **do**

randomly generate b^l

if $\sum_{k=1}^{N_{\max}} b_k^l \leq C_{\mathrm{BW}} \wedge \mathrm{ER}(\mathrm{b}^l, p_s, p_g) > ER(\mathrm{b}^\star, p_s, p_g)$

then

$\mathrm{b}^\star := \mathrm{b}^l$

end if

end for

Algorithm 2 Users' connection management and reward evaluation:

Input: $\mathrm{b}^\star$, N_g, $N_s(N_s + N_g = N_{\max})$ $\mathrm{b}^{(\mathrm{Req})} = [b_1^{(\mathrm{Req})}, \ldots, b_{N_{\max}}^{(\mathrm{Req})}]$ and user preferences.

Output: accepted/rejected users, and REI.

for $k = 1 \to N_{\max}$ **do**

if $0 < b_k^{(\mathrm{Req})} \leq b_k^\star$ **then**

Accept user connection

end if

end for

$R = \sum_{k=1}^{N_s} p_s \theta(k) + \sum_{k=N_s+1}^{N_{\max}} p_g \theta(k)$

$\mathrm{REI} = R/B$

where $\theta_g(k) = 1$ if the kth user is a gold one, or $\theta_g(k) = 0$ if otherwise;

and $\theta_s(k) = 1$ if the kth user is a silver one, or $\theta_g(k) = 0$ if otherwise.

Simulation Analysis:

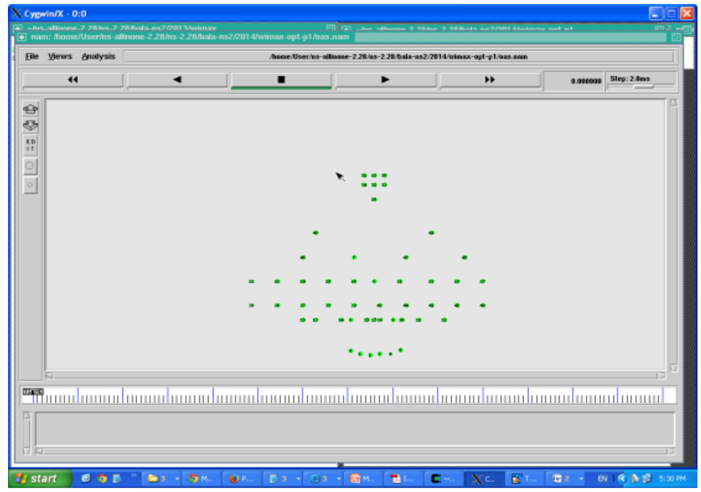


Figure 4. Number of NODES in WAN

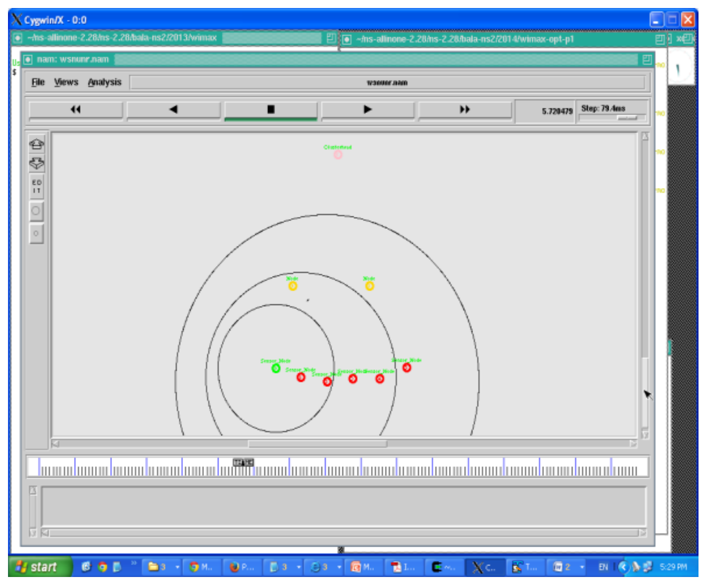


Figure 5. Data flow in WAN Architecture

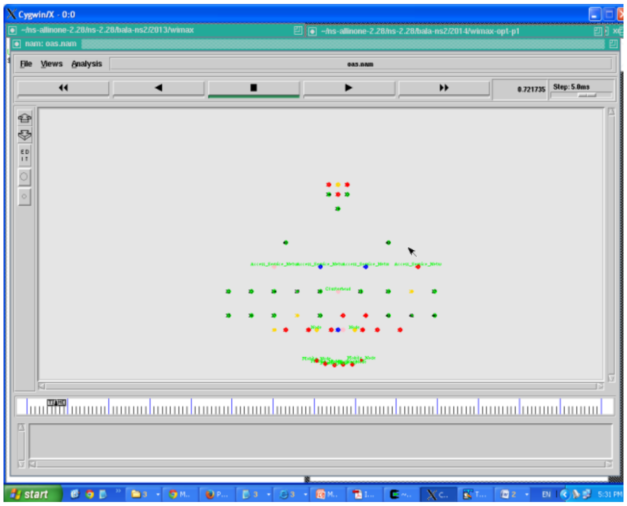


Figure 6. Data flow of WAN in layered architecture

In Nomal N/W ---------- (RED)

In OAS N/W ---------- (GREEN)

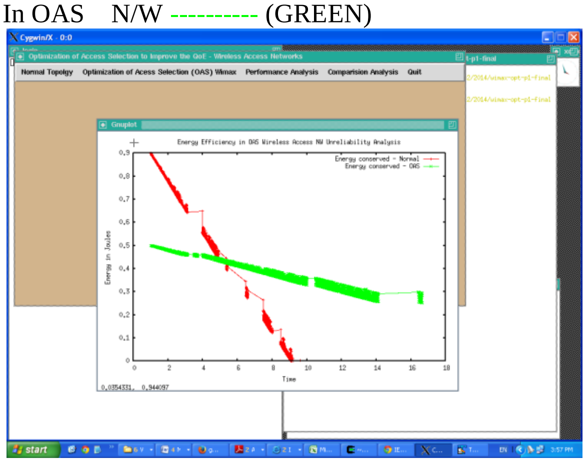
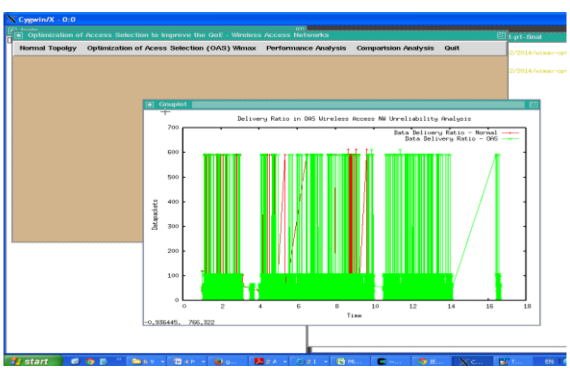


Figure 7. Energy Efficiency in OAS WAN unreliability Analysis

The figure7. shows that the optimized wimax network quality of experience in terms of energy efficiency which is compard with existing methodology. The amount of energy consumed is reduced, so the MT's battery life is increased in time.Thus proposed system is more efficient.



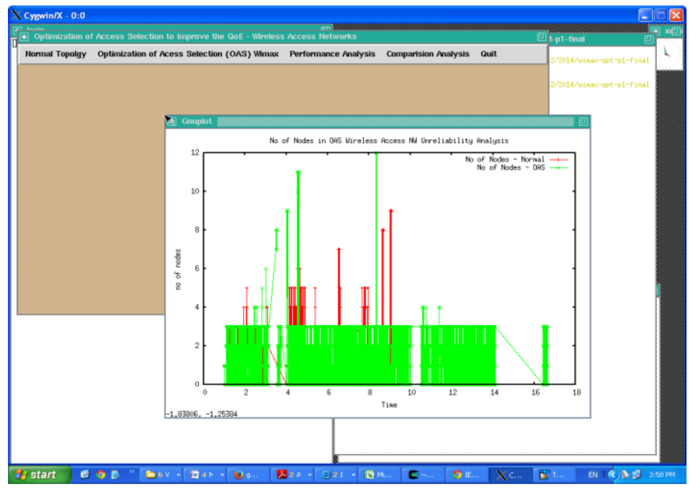


Figure 8. No of Nodes in OAS WAN unreliability Analysis

The figure8. shows that the number of live nodes are taken and compared with existing system. It shows that the energy drained between number of live nodes is reduced. Hence the battery life period of MT's is increased in our proposed methodology.

Figure 9. Delivary Ratio in OAS WAN unreliability Analysis

The figure9. shows that the delivary ratio of packets transmitted between source and destination in OAS wireless access network which reveals that throughput of proposed methodology is high compared with existing system. Hence the proposed system is more efficient than the existing system.

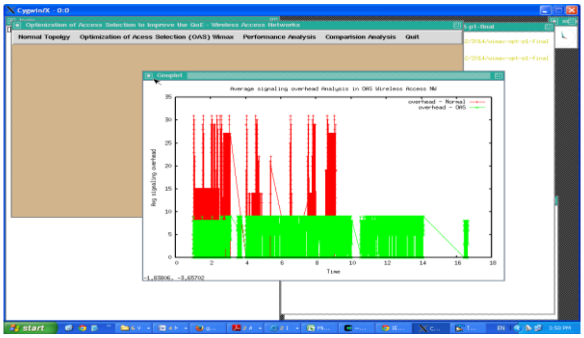


Figure10.Average signalling Overhead Analysis in OAS WAN

The figure10. shows that as the average signaling overhead is reduced in the proposed method, the performance is optimized in terms of decreased delay.

So the quality of experience is optimized for OAS wimax network in terms of following parameters .

a. Energy efficiency
a. Delivery ratio
b. Number of live nodes.
c. Latency

VI.CONCLUSION

We have shown the importance of achieving this selection in an efficient way for both perspectives, i.e., the end user and the network operators. Given the end user preferences, which can be numerous and possibly in conflict, we have proposed a multi-criteria utility unction that satisfies all the properties to maximize the quality of experience of the end user. We have also demonstrated that the proposed function can be used as an acceptance probability for the network operators' radio resource management. The suitability and the effectiveness of the proposed functions have been analyzed using numerical analysis and using a new multi-technology network simulation platform. A modified priority algorithm for an uplink scheduler in Mobile WiMAX is proposed to improve the throughput and fairness of the BE. Results from the simulation show that the algorithm outperforms the algorithm is 58% and has been observed to be fairer.

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