INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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VERTICAL HANDOVER BETWEEN 4G AND WI-MAX SYSTEMS BASED ON COMMON RADIO RESOURCE MANAGEMENT IN HETEROGENEOUS NETWORK

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Accepted Date: 15/03/2016; Published Date: 01/05/2016

Abstract: In telecommunications, just like any other field of human endeavor, fashions come and fashions go. No sooner is one technology safely out of the laboratory than attention turns to the next new innovation. Over the last few years, 4G has been slowly taking shape as the next big development in wireless communication 4G will be a convergence platform providing clear advantages in terms of coverage, bandwidth and power consumption. 4G will ensure the seamless mobility and global roaming among various access technologies such as cellular networks, WiFi, WiMAX, satellite, Digital Video Broadcasting -Handheld . 4G services will be end-to-end QoS, high security, available at anytime, anywhere with seamless mobility, affordable cost, one billing, and fully personalized. 4G is about convergence of networks, of technologies, of applications and of services, to offer a personalized and pervasive network to the users. Result show joint management of radio resources and bandwidth adaptation reduce call blocking or dropping probability in heterogeneous cellular networks.

Keywords: AC, CRRRM, RAT, RRM, HC, QOS etc.

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How to Cite This Article:

Neha Paliwal, IJPRET, 2016; Volume 4 (9): 31-42

PAPER-QR CODE

INTRODUCTION

Technological advances and market developments in the wireless communications area have been see the last decade they were mainly driven by the successful deployment of GSM (Global System for Mobile communications) networks from the European perspective. GSM currently evolves towards GPRS, a process much more complex and challenging than forecasted a few years ago. In an increasingly interconnected world, consumers demand high speed communication, ease of access and flexibility. This has spawned off next generation networking technologies that offer anytime, anywhere, any device access to web/data and provide better communication capabilities. In fact, digital convergence, an outcome of this technology evolution, is revolutionizing the way data is delivered and consumed. However, the challenge here is to track evolving consumer demands and meet the expectations for faster and more sophisticated capabilities. Fourth Generation (4G) wireless networks are set to transform the telecom sector with their promise of providing greater speed and handling higher volumes – a priority for most enterprises today. Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX) are the two wireless broadband technologies poised to dominate next generation networks. These technologies were developed in response to market demand for interoperability across networks and integration of earlier wireless network technologies. Earlier perceived as competing technologies, LTE and WiMAX are increasingly viewed as capable of complementing each other. Therefore, an appropriate question today is how much and how soon they will converge. This paper explores the need for convergence of LTE and WiMAX, factors driving it, stakeholder efforts underway to actualize it and the best strategy operators can adopt to capitalize on this union. Today, different types of cellular networks are actively working on the radio links. For instance, the Global System for Mobile Communication (GSM) is being used in nearly two hundred countries and currently it has around two and half billion users all over the world. Universal Mobile Telecommunication System (UMTS) is currently deployed in many countries and it is providing increased data rates, coverage and mobility as compared to GSM. Wireless Local Area Networks (WLAN) are very famous when we have a small area and none real time services. Worldwide Interoperability for Microwave Access (WiMAX) is a new technology and it is in deployment phase. In all these cellular technologies, we have very limited recourses and we have to make best use of them by proper management. Radio Resource Management (RRM) is a control mechanism for the overall system which is being used to manage radio resources in the air interface inside a cellular network. The main objective is to utilize the available spectral resources as efficiently as possible. Our aim is to use them in the best possible way to maximize the performance and spectral efficiency in such a way that we have maximum number of users in our network and

Quality of Service (QoS) is up to the mark. In a cellular communication system, a service area or a geographical region is divided into a number of cells and each cell is served by an infrastructure element called the base station which works through a radio interface. The frequency license fees, real estate, distribution network and maintenance are the issues which dominates the cost for deploying a cellular network. Management of radio related resources is a critical design component in cellular communications. In RRM, we control parameters like Radio Frequency (RF) planning, link budgeting, modulation schemes, channel access schemes etc. RF planning includes cell planning, coverage of the network and capacity of the network. Our main focus in this thesis will be on cell planning and link budgeting and we will discuss them in context of a WiMAX network.

- **RELATED WORK**

LITERATURE SURVEY

Radio Resource Management

Radio Resource Management (RRM) is a control mechanism for the overall system which is used to manage radio resources in the air interface within a cellular network. The main objective of our study of RRM is to analyze and determine a way to utilize the available spectral resources as efficiently as possible. The frequency license fees, real estate cost, distribution network and maintenance are the issues which dominates the cost of deploying a cellular network. Hence, the limitation of spectral recourses is being faced due to the above mentioned factors regarding their cost effectiveness. The core objective of this research is to serve the purpose of maximization of the performance along with spectral efficiency enabling maximum number of users in our network and to bring QoS up to the mark.

RRM involves techniques and algorithms for controlling parameters which are as follows:

• Frequency Band Allocation

• Cell Planning

• Link Budget

• Call Admission Control

• Modulation Schemes

• Multiple Access Schemes

AIM

The 4G network will be an umbrella of multitude of technologies. The glue is likely to be seamless mobility over heterogeneous wireless networks. Inter-system mobility, mainly between 4G LTE and WiMAX.

NEED

- High demand for wireless multimedia services such as data, voice and video has ensured widespread growth of broadband wireless networks. This is further spurred by advancements in standards and technologies. The growth of wireless broadband networks is expected to gradually outpace Asymmetric Digital Subscriber Line (ADSL) connections.
- Mobile operators today are addressing exponential growth in traffic with the help of packet evaluation for Third Generation (3G) and all Internet Protocol (IP) from 4G.

MOTIVATION

4G mobile networks do not consist of only one access technology but multiple ones. It is needed to have a mechanism that enables seamless mobility among different systems. The motivation behind the heterogeneous networks comes from the fact that there is no technology that could offer ubiquitous coverage. No technology can provide simultaneously the high bandwidth, low latency, high mobility and wide-area data service to a large number of users. As all these systems have their own advantages and shortcomings, no single technology merits enough to replace all other existing technologies up to now, even pre-4G technologies.

PROBLEM STATEMENT

The coexistence of different cellular networks in the same and different geographical area necessary Common radio resource management for enhanced quality of service provisioning and efficient radio resource utilization. The concept of CRRM arises in order to efficiently manage the common pool services radio resources that are available in each of the existing radio access technologies RAT. In heterogeneous cellular networks, the radio resource consists of resources that are available in a set of cells under the control of a radio network controller and a base station controller.

A new wireless networks are used radio resource management algorithms are responsible for efficient and effective utilization of the air interface resources in order to integrated guarantee

of quality services maintain the planned coverage area, and offer high capacitive. In distributed cellular networks, radio resource can be independently managed as shown in Figure 1

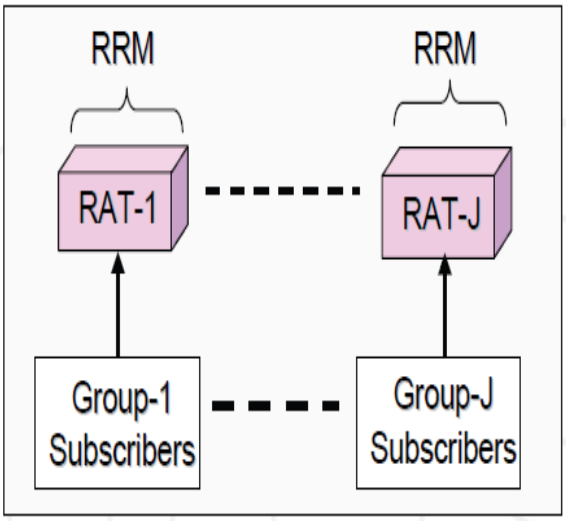

Fig. 1. Independent RRM in heterogeneous wireless networks.

Jointly managed as shown in Figure 2.Joint management of radio resources enhances quality of service and improves overall radio resource utilization in heterogeneous cellular networks. With joint radio resource management in heterogeneous cellular networks, mobile users will be able to communicate through any of the available radio access technologies (RATs) and roam from one RAT to another, using multi-mode terminals.

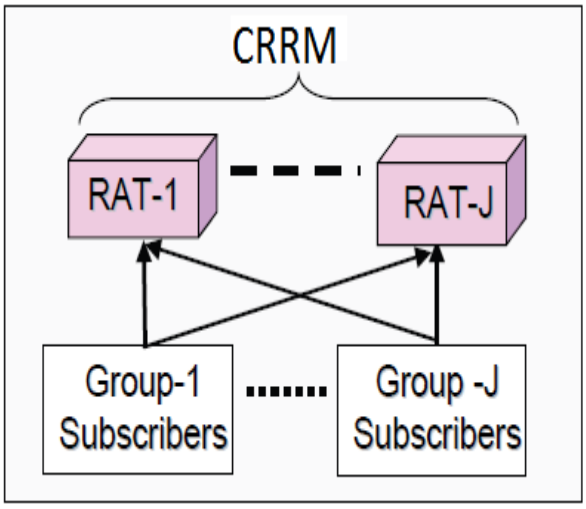

Fig. 2. Common RRM in heterogeneous wireless networks

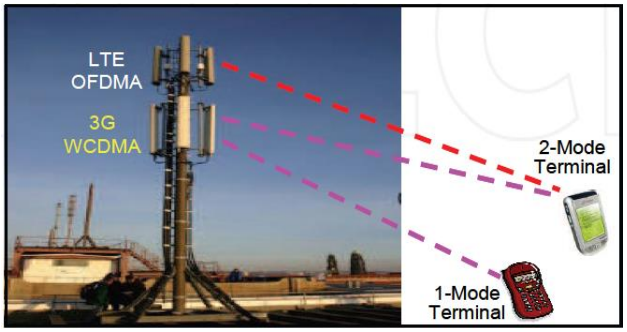

Fig. 3. A typical two-RAT heterogeneous cellular network with co-located cells.

Availability of multi-mode terminals is very crucial for efficient radio resource management in heterogeneous wireless networks. A mobile terminal can be single-mode or multi-mode. A single-mode terminal has just a single RAT interface, and therefore can be connected to only one RAT in the heterogeneous wireless network. A multi-mode terminal has more than one RAT interface, and therefore can be connected to any of two or more RATs in the heterogeneous wireless network. As show in Figure 3, a subscriber using a two-mode terminal will be able to access network services through either of the two RATs. However, a subscriber using a single-mode terminal will be confined to a single RAT, and cannot benefit from joint radio resource management in the heterogeneous wireless network.In heterogeneous cellular networks, radio resources are managed by using algorithms such as joint call admission control algorithms, joint scheduling algorithms, joint power control algorithms, load balancing algorithms, etc. This paper focuses on joint call admission control (JCAC) algorithms in heterogeneous cellular networks

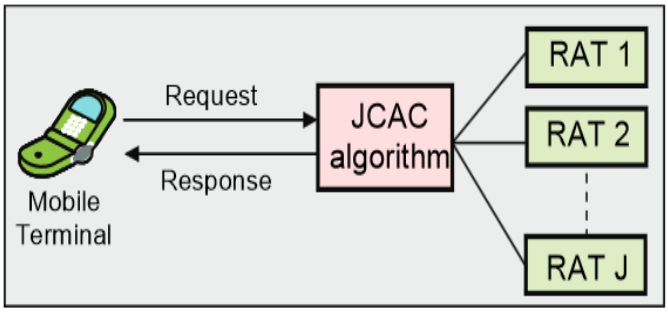

Fig 4 Joint call control algorithm

A multi-mode mobile terminal wanting to make a call will send a service request to the JCAC algorithm. The JCAC scheme, which executes the JCAC algorithm, will then select the most suitable RAT for the incoming call.

Generally, the objectives of call admission control algorithm in heterogeneous cellular networks are:

1. Guarantee the QoS requirements (data rate, delay, jitter, and packet loss) of accepted calls.
2. Minimize number vertical handoffs,
3. Uniformly distribute network load as much as possible,
4. Minimize call blocking/dropping probability,
5. Maximize operators' revenue,
6. Maximize radio resource utilization

All the above objectives cannot be simultaneously realized by a single JCAC algorithm. Thus, there are tradeoffs among the various objectives.

Movement from Cell to Cell

In a cellular system, as the distributed mobile transceivers move from cell to cell during an ongoing continuous communication, switching from one cell frequency to a different cell frequency is done electronically without interruption and without

a base station operator or manual switching. This is called the handover or handover. Typically, a new channel is automatically selected for the mobile unit on the new base station which will serve it. The mobile unit then automatically switches from the current channel to the new channel and communication continues. The exact details of the mobile system's move from one base station to the other varies considerably from system to system. A service provider usually has limited coverage. Neighboring service providers can provide extended coverage through a roaming contract, enabling to have access to communication and to be reached where there is no coverage from its home service provider.

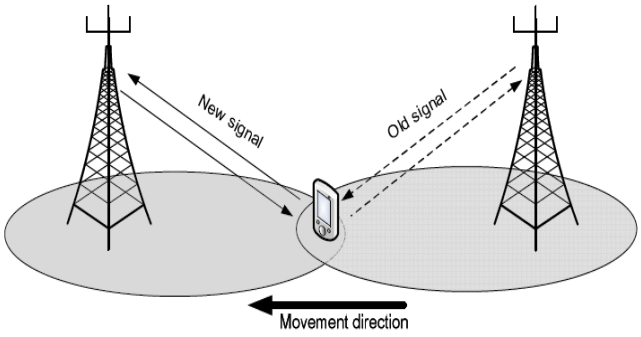

Figure 5: Handover direction

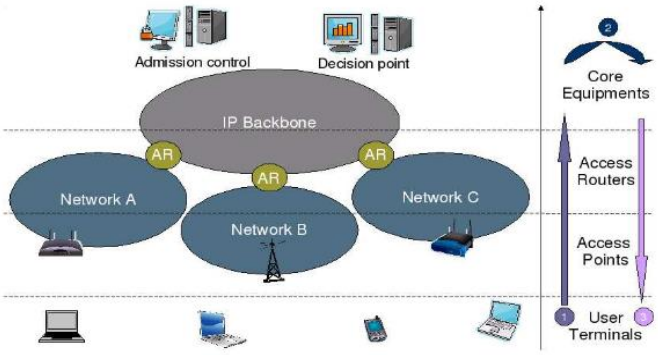

Figure 6: Resource management in mobile heterogeneous network

Radio resource management in mobile heterogeneous network consists of 3 steps: information harvesting, decision making and decision enforcement. Figure 2 illustrates the levels where these steps are taking place. We explain each step as follow:

1. Information harvesting: at this stage, information about user and network are gathered, this information is important factor for making decision.

First users' information should be collected at user terminals level then It should be propagated up through access points (AP) and access routers (AR) levels for having more information about cell condition and network conditions respectively.

2 Decision making: at this stage, decisions are made. It can be noticed that later in this report we also show another place than core network where decision can also be made. For example, decision can be made at user terminals in case they have possibility to choose their point of attachment or at access routers for controlling local networks. Therefore, the decision point depends essentially on where the control has been plant decision making location again in

section 4 as architectural aspect. Furthermore, since decision making is the most important part in resource management.

3. Decision enforcement: at this stage, decisions are enforced. Several mechanisms can be used to ensure that decisions made in step 2 are respected.

4 Admission control is one of the enforcement mechanisms; it can be used to filter access according to the decision. In some case, it can be adopted in decision making (step 2) to screen candidate networks by comparing required service and availability on the present networks.

CRRM FUNCTIONALITIES

CRRM is designed to coordinately manage resources pools over the heterogeneous air interface in an efficient way. This efficiency depends on how to construct its functionalities. There exist a range of possibilities for the set of functionalities that CRRM entity may undertake, which mainly depend on the following two factors:

1) RRM or CRRM entity is the master to make radio resource management decisions.

2) The degree of interactions between RRM and CRRM entities

The RRM functionalities arising in the context of a single RAN are:

1) Admission control

2) Congestion control

3) Horizontal (intra-system) handover

4) Packet scheduling

5) Power control

COMPARISON

- **Release and Deployment**

WiMAX was developed which is much earlier than LTE, which was released in 2009. Currently there are 592 WiMAX networks in 149 countries [22]. On the other hand, the commercial use of LTE just has started in 2009 and thus it is not much widespread yet [4]. This is a huge advantage over LTE's deployment, which has recently started leading to a wider spread of WiMAX.

B. **Transfer rates**

WiMAX reaches peak transfer rates of 46 Mbps in the downlink and up to 4 Mbps in the uplink, whereas LTE offers up to 300 Mbps in the downlink and 75 Mbps in the uplink. LTE is definitely supperior to WiMAX in this case. It also supports a bigger range of channel bandwidths from 1.4 MHz to 20 MHz than WiMAX with 3.5 MHz to 10 MHz.

C**. Mobility**

WiMAX and LTE are mobile telecommunication networks, so they have to offer good mobility features. The coverage of cells and the power efficiency of the devices are some of the most important factors.

D. **Coverage:**

WiMAX signals can reach up to 50 km but this is only acquirable with much loss in signal quality. WiMAX is more optimized for shorter distances like 1.5 to 5 km. LTE, on the other hand, can cover up to 100 km, which is twice as much as WiMAX' coverage. LTE also offers connectivity with speeds up to 350 kmph. So, it's even possible to be connected on a LTE-network when sitting in a high speed train. On the other hand, WiMAX supports speeds up to 120 kmph, because of its optimization for nomadic speeds.

Power efficiency: Both LTE and WiMAX offer power saving mechanisms. They can be both sent into an off-state where less or even no power is needed. LTE can even turn the transmitter off while having a call when there are longer breaks. Also LTE uses SC-FDMA in the uplink, which is more power efficient than OFDMA. This makes mobile devices use less power, which increases their battery life.

E**. Quality of service**

WiMAX and LTE use both reservation-based access to achieve quality of service, which allows services like video telephony and VoIP. A WiMAX frame is seperated in a downlink and an uplink sub frame that allocates resources for different users. LTE frames don't seperate their frames in uplink and downlink sub frames. Each frame contains 10 sub frames and only 2 of them are always reserved for the downlink. The other 8 sub frames can either be uplink, downlink or switch point. LTE frames are more dynamic, so they reach smaller delays.

F. **Security**

Concerning security aspects both, LTE and WiMAX, are on the same level. They both offer techniques and use protocols, which ensure safe connections. All in all, Long-Term Evolution is superior to WiMAX when it comes to the technology. But there are also downsides. LTE was released several years after WiMAX, so that many telecommunication companies already invested in

WiMAX and already offer commercial services. For some telecommunication companies it is not rentable to switch from WiMAX and invest into a new technology.

CONCLUSION

Now a day's coexistence of multiple cellular networks in the same geographical area has enabled more efficient utilization of radio resources and enhanced quality services and provide through joint radio resource management. Joint call admission control in heterogeneous and distributed cellular networks has been given in this paper. Different approaches for selecting RATs in heterogeneous cellular networks name as: random selection, network load, service-class, path loss, layer, terminal modality, computational intelligence or non-computational intelligence techniques have been proposed to solve this problem. Considering new four different simulation results are obtained and compared. Proposed results show that joint management of radio resources and bandwidth reduce call blocking/dropping probability in heterogeneous cellular networks.

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