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An Effective Review on Relaying In LTE-Advanced and WiMAX Networks

Priyanka Rani[1], Ms. Renu Singla[2]

M-Tech Student, Department of CSE, Shri Ram College of Engg. & Mgmt, Palwal, Haryana, India[1]

Assistant Professor, Department of CSE, Shri Ram College of Engg. & Mgmt. Palwal, Haryana, India[2]

Abstract: LTE is a latest cellular system, it is standardized by 3rd Generation partnership project (3GPP), and it is employed to satisfy increasing customer demand for high speed services also to fulfil demand for user experience with full mobility. With the ever growing demand of data applications, traditional cellular networks face the challenges of providing enhanced system capacity, extended cell coverage, and improved minimum throughput in a cost-effective manner. Wireless relay stations, especially when operating in a half duplex operation; make it possible without incurring high site acquisition. Design of wireless relay stations faces the many challenges of providing backward compatibility, minimizing complexity, and maximizing efficiency. In this review paper we provide an overview of relaying mechanism in LTE-Advanced and WiMAX and than explain relaying handover mechanism over LTE-Advanced and WiMAX.

Keywords: E-UTRAN, LTE, UMTS, WiMAX.

I. INTRODUCTION

LTE-Advanced is taken to be next big dive in the broadband mobile communications world, objective to arrive and go outside the International Telecommunications Union (ITU) needs for International Mobile Telecommunications-Advanced (IMT-Advanced) [1]. LTE-Advanced should share the frequency bands with the existing versions of LTE and should be backward compatible.LTE supports higher peak data rates through wider bandwidth, it provides low latency and overhead .LTE supports mobility speed of up to 350 km/h to 500 km/h under consideration. LTE network has three main parts, user equipment (UE), the Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) and the Evolved Packet Core (EPC) network [2]. UE is actually a mobile equipment has mobile termination to handle communication and terminal equipment to terminate data streams [1]. E-UTRAN is an access network and handles radio communication between the EPC and mobile.

In LTE-A the two main entries are Base station (BS) and Subscriber station (SS) where BS is the service provider it exchanges control messages ,SS subscribes to the BS for the service .Relay Station enhances the capacity ,throughput and coverage area of base station in technologies like LTE and WiMAX. RS has capacity of boosting the signal. LTE–A relay stations are positioned either at cell edge to extend coverage area or within the cell to relay the BS signal into coverage holes. RS benefits as it provides a cost effective and easy to install solution for coverage area .Worldwide Interoperability for microwave access (WiMAX) also known as IEEE 802.16 ,it uses microwaves for transfer of data wirelessly .The need of WiMAX is to extend the range of Wifi like services .WiMAX combines the cellular range with the Wifi speed. 3GPP LTE Advanced and IEEE 802.16m (next generation WiMAX networks) are viewed to be the top candidates for fulfilling needs and in some particular situations, even increasing the IMT-Advanced needs. Both techniques consider advanced characteristics i.e. coordinated multipoint processing (CoMP), carrier aggregation, and relays as potential solutions towards obtaining IMT Advanced needs. With cell sizes decreasing drastically owing to the requirement for higher spectral reutilization, the no. of femtocells and picocells base stations that are deployed is increasing very high thus growing the costs of deployments. Relays, which have wireless backhaul connections to the core network through Base Stations can importantly decrease the costs of deployments while offering coverage and capacity comparable to femto and pico BSs (IEEE) 802.16 standards, makes capable wireless broadband access anytime anywhere and on any device virtually [11].

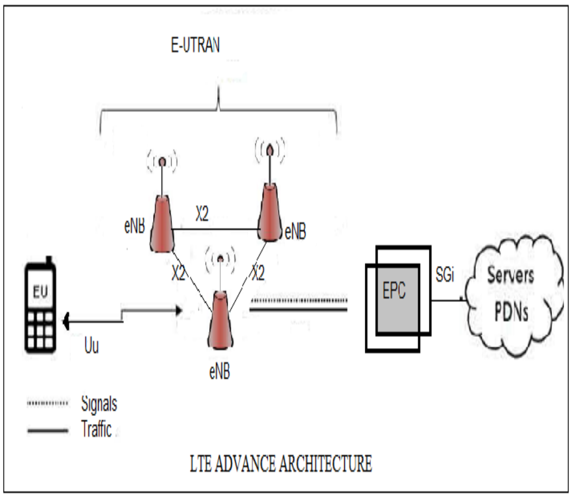

Figure 1: LTE Advanced Architecture

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WiMAX is a best technology for backhaul applications because it removed costly fibre alternative or leased line. It can offer broadband access to places in worlds rural and evolving regions where broadband is currently not available. WiMAX has multiple benefits, i.e. enhanced robustness and performance, secure mobility, end to end internet protocol (IP) based networks and broadband speeds for data, voice and video. It is a wireless metropolitan area networks (WMAN) technique that offers interoperable broadband wireless link to static, portable, and nomadic subscribers within 50 km of service region. It permits the subscriber to obtain broadband connectivity without the requirement of direct line of sight communication to the BS and offers total data rate up to 75 Mbps, with the enough bandwidth to support hundreds of business and residential business areas with a single BS simultaneously. WiMAX is a term coined to explain interoperable and standard implementation of IEEE 802.16 wireless networks in a manner same as Wi-Fi being interoperable of the 802.11 WLAN standards. Since, the WiMAX working is very different from Wi-Fi [1][2]. The network architecture contains a base station in the city centre, with the BS interacting with all the access points or users. Every sector can offer broadband connectivity to hundreds of homes and dozens of businesses. The several parameters of IEEE 802.16 standard in WiMAX are linked to the PHY and MAC layers. Several researchers have provided techniques for transporting information with Light WiMAX. Mostly works concentrate on IEEE 802.16 bandwidth allocation algorithms. The LWX contribution is in the area primarily concentrated on OFDMA, QoS and multi hop relay. LWX also show a technique for dynamic binding for subscriber to plug and play different algorithms without correcting it and recompiling those algorithms which examine bandwidth assignment. Relay station is one of the significant research field regarded to this area which is examined here. IEEE 802.16j is an improvement to prior IEEE 802.16 standards to offer support for relays, hence offering for increased coverage and/or capacity, based on the scenario [3]. The standard does not allow modifications to SSs, thus the changes proposed by the standard concentrate on communications between new RSs and (enhanced) BS.

II. RELAYING

Relay is one of the main characteristic being thought for IMT-Advanced systems. The relay architectures described in 3GPP LTE-Advanced and IEEE 802.16m are examined only for non mobile relay, such as the Relay Station is linked to a designated BS and becomes a part of the static access network.

2.1. RELAYING IN WIMAX: Relay Station IEEE 802.16j is an enhancement to latest 802.16 standards to offer support for relays, hence offering for increased coverage and/or competence, based on the scenario. The standard does not allow modifications to SSs, thus the changes proposed by the standard concentrate on communications between the new RSs and (improved) BS. One issue which raises in this point of view is how to move toward network designing a multi-hop radio access network provides rise to new issues which have not been introduced in earlier radio planning methods. Here, it is introduced how RS provides advantage to a set of SSs and BSs. In this work, the advantage of utilizing RS in a network of SS and BS has been expected Relay based networks has low outlay relays, small form factor linked with BSs. Three main advantages offered from relay based architecture over single hop architecture are coverage enlargement, throughput enhancement and operational cost. It is desired to enhance system capacity by deploying RSs in a way that enables more aggressive spatial reutilization. The relay technique is desired to increase the coverage reliability in geographic regions that are seriously shadowed from the BS and/or to enlarge the BS range. Relay based systems have been to provide cost gains over conventional single hop wireless access systems. Utilizing RSs, an operator could deploy a network with broad coverage at a lesser cost as compared to utilizing only (more) costly BSs to offer good system capacity and coverage.

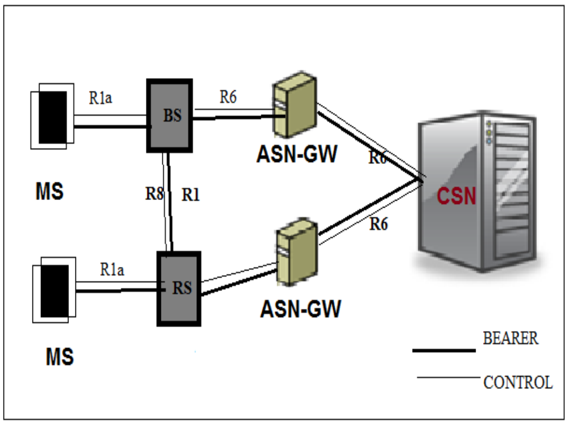

Figure 2: IEEE 802.16m Interface Architecture for Relay Station

2.2 RELAYING IN LTE: Relay technology is a candidate for increasing the coverage or improving the next-generation cellular systems throughput.

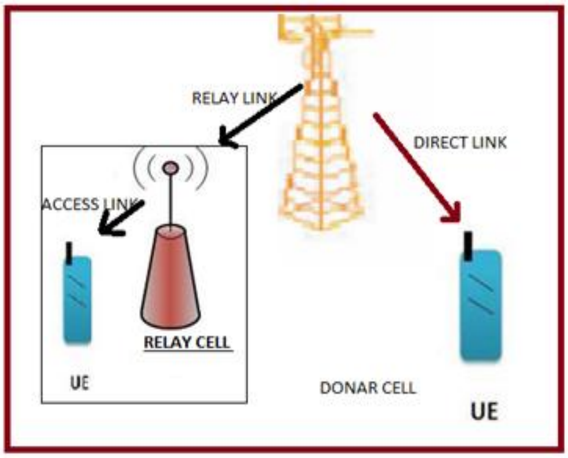

Figure 3: LTE Interface Architecture for Relay Station

The 3GPP standard describes two kinds of RNs in LTE-A networks:

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A *Type-I* RN acts like a BS and transmits its own common reference signal, physical cell identity (ID) and scheduling information. UE informs their channel quality information (CQI) to the *Type-I* RN and obtain the hybrid automatic repeat request (HARQ) feedback and scheduling information directly from the RN. A *Type-II* RN behaves as a repeater. The UE cannot determine the existence of a *Type-II* RN because the RN does not transmit common reference signal and does not have a cell ID. *Where* a relay station (RS) should be located in a cell for (1) Optimizing efficiency of network efficiency and (2) Maximizing mobile stations throughputs (MSs) that creates traffic flows at random locations and at random time instants in the network.

In the downlink of a Long Term Evolution Advanced (LTE-A) relay network, a relay node (RN) generally reserves a Small buffer for every subscriber equipment(UE) such that the RN can reduce the no. of sending packets at the time of UE handover. RELAY technology is a predicting technology introduced to obtain throughput and coverage improvements for next generation cellular systems

LTE-A uplink scheduling have to use resource blocks (RBs) utilization in such a way for maximizing the total capacity and throughput, and ensuring the needed Quality of Service (QoS) for real time applications and voice calls. Several different Uplink-scheduling algorithms are shown by vendors; the simplest Algorithm among all of them is channel-unaware Round Robin i.e. Fair Work Conserving (FWC) and the Fair Fixed Assignment (FFA).

Uplink relaying: the total uplink system capacity and throughput is inquired. It was presented that the RS located at 75% of the cell radius (counted from the centre towards the cell edge) offers the maximum total uplink throughput, and thus also offers the maximum system capacity. The mean file transfer time for every segment and for various arrival rates and RS positions was inquired. So, under the assumptions and conditions utilized in this study, it can be drawn that the best place to position an RS is at 75% close to the cell edge.

III. RELAY STATION HANDOVER MECHANISM

The handover mechanism for the mobile relay between the target and serving ABSs. For simplicity, we only assume intra-ASN handover in this paper. The handover technique is shown in Figure 4. the network re-entry and handover process flow for ARS is as described below:

1) Achieve Network configuration and neighbour ABS parameters
2) Start ARS handover to target ABS (either ABS or ARS initiated)
3) Perform network re-entry at target ABS
4) Configure Operational Parameters

Exclude the final step, where the ARS requires to achieve the configuration to offer PMP link to the AMSs, the ARS handover framework nearly resembles the handover mechanism for a regular MS. The handover and network re-entry process happens in two phases -

A) Handover Initiation and Preparation Phase
B) Handover Execution and Network Re-entry Phase

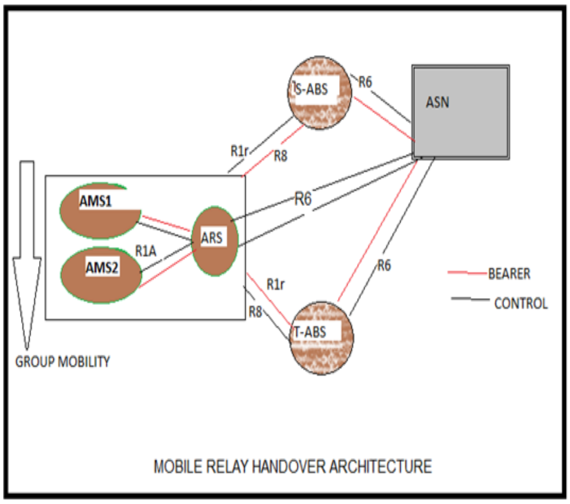

Figure 4: The handover technique

A) Handover Initiation and Preparation Phase:

- The ARS forwards a Handover Request Message with a list of suitable target BSs to the serving ABS.
- The serving ABS, in proper order, forwards an R8 Handover Request message to the target ABS(s).
- The target ABS(s) gets AK Context and starts data path pre-registration for the ARS with the ASN-GW overR6. The target ABS also categorizes the Handover Request message to detect that handover is needed for a relay station.
- If ARS handover is accepted, the target ABS must forward an R8 Handover Response message to the serving ABS. But the target ABS requires the tunnel mapping information to do GRE Tunnel ID ⇔ARFEH mapping to determine the per-AMS ASN tunnels and their corresponding parameters of QOS. Thus, the target ABS should piggyback a Tunnel Mapping Context Request message requesting the tunnel mapping table and per tunnel QOS over the Handover Response message.
- The serving ABS forwards a Handover Command message over the relay connection to the ARS to report the ARS about the decision of handover.
- The ARS initiates ranging at the target ABS to start the network re-entry process. For optimization, if the HORe entry- Mode is adjusted to 1 in the Handover Command message forwarded to ARS, the serving ABS can confirm that data route is existed for the ARS regarded AMSs until the ARS ends network re-entry at the target BS.

B) Handover Execution and Network Re-entry Phase:

- The ARS begins the Ranging Request/Response message exchange with the T-ABS
- A Handover Confirmation message is obtained by the target ABS from the serving ABS. This message

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involves the piggybacked Tunnel Mapping Context Response message so that the target ABS can show data path preregistration with the ASN-GW over R6. The ASN-GW may either establish a brand novel tunnel with the target ABS for the corresponding service flow and break the GRE tunnel with the serving ABS; or it may reutilize the similar GRE tunnel for the service flow and manage its Tunnel sending port to be the target BS. The later situation is straight forward where the ARS can set-up data route directly with ARS at the time of its re-entry. In the earlier situation, the target ABS requires to do Data Path Reg/Update with the ARS over R8 for the ARS to manage the novel tunnel mapping context. The data path registration mechanism completes when the target ABS obtains a Path Registration Reply message from the ARS.

- For the ARS to provide support to relay operation at the novel serving ABS, a Layer-3 control route from the ASN-GW to the ARS is also formulated to manage configuration from the OAM (Administration, Operations and Maintenance) server.
- The serving ABS, after forwarding the Handover Confirmation message may drop all links resource information (ARS and related AMSs) involving all outstanding buffered PDUs and the MAC state machine.
- The Handover Complete message from the target ABS shows the Network Re-entry completion which reminds the serving ABS to release all MAC PDUs and MAC context linked with ARS. Following this, the serving ABS begins Data route De-registration with the ASN-GW.

IV. RELATED WORKS

There are several research studies conducted on the topic of LTE and WiMAX relaying

[1] Here author performed analysis of RS in WiMAX networks by using bandwidth allocation algorithm (BWA). Light WiMAX simulator (LWX) is used for simulation purpose. This paper focuses on wireless access as it is flexible and cost effective .RS are used in order to extend the range of base stations for long distances .Various simulation parameters such as routing protocol (AODV),transmission protocol(TCP) ,simulation time (300sec) etc are taken in order to analyze the performance of RS.

[2] In this paper LTE-A multi hop networks are used to satisfy the requirements of coverage and capacity in minimum cost. Resource blocks (RB), adaptive modulation and coding (AMC) schemes are used for zero multi-hop links overflow and for maximizing network throughput with low bit error rate respectively. This paper mainly focuses on position of RS in LTE-A cell and for improving network performance and minimizes asymmetric multi hop links data overflow.

[3] In this paper author introduced LTE-A and its various standards and technical aspects. It is a radio platform technology .carrier aggregation scheme is employed to fully utilize the wider bandwidth of up to 100 MHz .Antenna system and relaying are also used to enhance the performance of radio communication and LTE.LTE-A works on providing various worldwide functionality such as roaming effects ,interworking, service of compatibility etc .

[4] Here author uses DRX mechanism (or discontinuous receive) for energy efficient relay selection scheme. Relay energy efficiency metric is used .Two relay selection schemes SNR-based and random selection are employed in Discrete Time Markov Chain (DMTC) model of DRX .This paper shows high energy efficiency is achieved with tolerable delay .

[5] Resource Blocks (RBs) proposed scheduling scheme is considered for zero multi-hop links overflow in Uplink LTE-Advanced. Then based on this scheduling scheme and other network assumptions the best Relay Station (RS) placement in the cell was estimated in order to improve LTE-A Uplink performance. The total LTE-A uplink Throughput, average throughput per user, and Mean File Transfer Time (MFTT) in the LTE-A network are considered as performance measures.

[6] the total uplink throughput and system capacity is investigated. It was shown that the RS placed at 75% of the cell radius (counted from the centre towards the cell edge) provides the highest total uplink throughput, and therefore also provides the highest system capacity.

V. CONCLUSION

In 3GPP LTE, Wireless relay stations especially operating in half-duplex operation, make it possible to achieve, extended cell coverage, improved minimum throughput and enhanced system capacity. Several of relays and relaying techniques have been discussed as part of the LTE-Advanced and WiMAX. In the cellular networks half-duplex relays are fully backward compatible, and are deemed an efficient, effective, and practical means to complement.

In 3GPP LTE, Non-transparent half-duplex relaying operation in imposes great design challenges stemming from the support of legacy LTE UEs, and maximizing the reuse of the existing LTE physical layer, MAC layer, and upper layer standards. Detailed solutions for LTE relaying operation are provided in this article. Simulations show promising gains in certain relay scenarios, most notably when the RNs are placed close to the UE in a hotspot fashion. The key to relay gains is a significant increase of the quality of the access and backhaul links compared to the direct link, especially when proper deployment of relays is possible and sophisticated cell selection is used.

Finally, we have touched upon possible areas of future research and standardization for enhanced relaying operation in LTE.

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