MLB OUTLINE: UNDER LTE NETWORKS

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Abstract
Day by day the use of communication devices like Smartphone, tablets etc is increasing at a very fast pace. This resulted in increased traffic on the networks. These networks face degraded performance which also affects the quality of service of the networks. In order to prevent the network degradation the excess traffic can be handled by transferring it from one loaded cell to least loaded cell in neighborhood. MLB is key function in SON (Self Organizing Networks) which measures the load on the cells and takes appropriate actions to resolve the load issue. In this paper the load balancing in long term evolution networks is reviewed.

Index Terms: Load Balancing, MLB, SON Networks

I. INTRODUCTION

Long term evolutions networks are purely flat IP based networks designed particularly in order to reduce the latency and to improve the quality of networks. A number of nation contributing in the development of LTE networks. Initially NTT DoCoMo Japan proposed the idea of LTE in 2004. It is a registered trademark of ETSI (European telecommunications Standard Institute). The LTE network supports peak rates of 300 Mbit/s in downlink and 75 Mbit/s in uplink with managing quality of services with latency of less than 5 ms. LTE is developed by 3GPP (Third Generation Partnership Project) specified it in their first 3GPP release 2008. LTE has scalable carrier bandwidth from 1.4 MHz to 20 MHz. It supports both FDD (Frequency Division Duplexing) and TDD (Time Division Multiplexing). The motivation behind the introduction of LTE is to replace the existing complex and costlier GPRS (General Packet Radio Services) architecture. One of the main advantage of opting for these networks is these are cost effective and consuming less time during up gradation of these networks time to time. Two different approaches implemented to increase the speed of networks OFDMA (Orthogonal Frequency Division Multiplexing Access)
In case of downlink and SC-FDMA (Single Carrier Frequency Division Multiple Access) in case of uplink [1][2][3].

II. LTE ARCHITECTURE

A. LTE Architecture

E-UTRAN (Evolved Universal Terrestrial Radio Access Network includes UE (User Equipment) which is a smart phone or other LTE enabled devices that communicates with other communication devices through the LTE network, eNode (Evolved Node) which is termed as base station in earlier networks, these eNodes provides access to the network and also known as radio access interfaces. These eNodes are also connected to each other by using X2 interface and exchange information to each other for taking some important decisions like handover, load transfer etc.

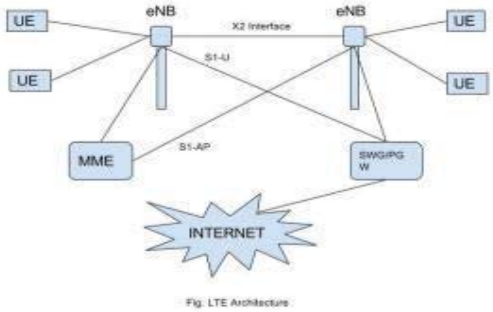

Fig. LTE Architecture

EPC: - (Evolved Packet Core) is connected to E-UTRAN by using S1 interface that includes MME, S-GW, P-GW, and HSS etc. Some of the basic or important functionalities of these entities are:-

MME: - (Mobility Management Entity): - provide access to S-GW which is Serving Gateway, by using S11 interface and to eNode's by using S1-MME interface. MME performs S-GW selection, Handover, Ciphering, Paging, Security Key Management, NAS signaling, Allocation of temporary ID's to UE's, mobility between 3gpp and non-3gpp networks, operations with HSS (Home Subscriber Server)

SGW: - Serving gateway serves the user packets with S1-U interface.

PDN GW: - Packet Gateway Network provides connectivity to others non 3gpp networks [4] [5] [6].

B. LTE/LTE-A Networks

There are LTE-A networks introduced followed by LTE in order to include enhanced inter-cell interference coordination (eICIC), self-optimizing networks (SON) and the deployment of heterogeneous network (HetNet). LTE-A also includes Device to Device communication (D2D). D2D communication can be established using licensed spectrum or using unlicensed spectrum results in efficient utilization of network resources. Some more LTE-A networks features of transmit power control, peer discovery, physical resource blocks (PRBs) assignment and interference management [7].

C. SON Networks

Manual deployment, configuration and management of Long term evolution networks results in wastage of time, money and manpower so the concept of Self Organized Networks (SON) was also introduced in 3gpp Long term evolution networks. The feature is SON is self-configuration, self healing and self-diagnostics. It results in savage of operational cost, time and power as well [8]. There are three types of SON networks are there in cellular networks.

1. Centralized SON: - In this type of architecture the SON algorithms are executed on network management level which is a central unit that take parameters and values from all of the entities together and take decision based on that. Central management unit may cause slow response in networks because it takes time to gather information from all the entities in the network.
2. Distributed SON: - The algorithms are executed directly by the eNBs and these eNB's communicate to each other eNB via messages and exchanges the information to each other and based on that information eNB's takes various decisions related to the handover or other actions.
3. Hybrid SON: - This architecture takes advantage of both the Centralized SON and Distributed SON. It comprises of both node level execution of algorithms and as well as network management level execution of algorithms [9].

III. LOAD BALANCING IN LTE NETWORKS

As smart phone, tablets and mobile users are increasing at very fast rate there is also an increase in traffic on networks, but the resources are limited. Base stations in LTE terminology called eNod. When traffic of some eNode is more it will degrade its performance. There might be some neighbor eNode may have spare resources. So by transferring this load to the neighbor eNode, the load on a particular cell can be reduced. This improves the network performance. SON networks having the special feature to perform this activity are MLB (Mobility Load Balancing). Release 9 includes functions for self-optimization contains optimization of coverage, capacity, handover and interference. Mobility load balancing (MLB) is a function where cells heaving excess load can transfer load to other cells, which have enough available resources. MLB performs load reporting between eNBs to exchange information about load level and available capacity.

A Hanover is used in Load Balancing Is the process of transferring of a User Equipment (UE) from one eNode to its neighbour eNode by modifying the handover parameters. So that a successful or with a less handover failure rate , handover happens.

The eNBs estimates how much the cell border needs to be shifted. Mobility robustness optimization (MRO) is a solution for automatic detection and correction of errors in the mobility

configuration. In Release 9 the focus is on errors causing Radio link failure (RLF) due to too late or early handover, or handover to an incorrect cell.[10].

Recent studies classified load balancing in two categories:-

1. Borrowing resources.
2. Transferring to resources.

As per first category the source eNB when suffers from the excess load it tries to borrow network resources from its neighbor eNB's that are having enough available resources. Some methods were proposed related to learning, optimization, robustness and fault tolerance. Some of them are based on neural networks and fuzzy logics. And in second category the source eNB transfers the load to its least loaded neighbor in order to reduce its load. This process is achieved by adjusting the handover parameters like hysteresis, time to trigger, cell coverage techniques etc. in literature new power control algorithms have been proposed. One method based on co-weighted satisfaction factor also proposed in literature. In this method a eNB having highest utilization ratio is selected source cell and a eNB having lowest utilization ration is selected as target cell [11][12][13][14][15][16][17][18][19].

A. Mobility Load Balancing

Hanover is the process opted to transfer one UE from one eNB to another eNB is commonly used in cellular networks. It is not necessary that a UE is always keeps stable in network, many of the times the Users are keep on moving while communicating. So during their travels they need to change their eNB time to time, when the existing cell becomes far from the devices and starts losing its signal strength, the handover take place [20]. Handover process is triggered based on some events.

These are:-

Event A1: Serving becomes better than absolute threshold.

Event A2: Serving becomes worse than absolute threshold.

Event A3: Neighbor becomes amount of offset better than present Cell.

Event A4: Neighbor becomes better than absolute threshold. Event A5: Serving becomes worse than threshold 1 AND neighbor becomes better than threshold 2.

Handover Process Properties:-

UE_Reports:- UE sends measurement reports to the connected eNB's. Both RSRP and RSRQ are always reported. eNB_Control:- The source eNodeB and the target eNodeB decides when to trigger the handover and oversees its execution.

Handover Algorithms: - some of the common algorithms implemented in [21] are:-

A2-A4-RSRQ handover algorithm:- This algorithm is based on the reference signal received quality measurements received by Event2 and Event 4 measurements. Firstly UE sends measurement reports to the eNB's and then eNB checks for that whether the source RSRQ is less than or equal to the threshold or not. If it is true than it looks for the neighbor cells who are having best RSRQ. If the difference between the best neighbor RSRQ and Source cell RSRQ is greater than or equal to neighbor cell offset, the handover is triggered otherwise eNB's again start getting reports. The process is repeated iteratively.

Strongest Cell handover algorithm: - This algorithm is based on a3 event. The main idea behind this algorithm is whenever a best cell is available just handover the UE to that best cell. Hysteresis delays the handover in terms of RSRP but time to trigger delays handover in terms of time [21].

MLB is the special part of SON networks. MLB is applied to get improve performance and increased satisfied users. The basic or main step of MLB process is the collection of load values. MLB works on the basis of cell load values and whenever these cell load values meet certain condition the MLB is triggered. This condition may be the cell load values become higher than the threshold or some cell may have cell load values less than the threshold in order to tell the neighbor cells that it have enough resources or low load so that the load can be transferred to the cell. One of the methods of MLB is shrinking or expanding the coverage. Based on the cell load values MLB performs shrinking or expanding of the coverage or by increasing or decreasing the transmit power of the cell [22].

Mohamed E. at al. proposed two Mobility Load Balancing Algorithms in [22]. MLB takes place when the following two conditions satisfy:-

Source cell load exceeds the predefined threshold.
The target cell has enough available resources to accept the new traffic.
Authors proposed two MLB algorithms alg_MLB1 and alg_MLB2 based on the dynamic updating of handover parameters like hysteresis values, time to trigger etc. these algorithms accept RSRP (reference signal received power) and use the A3 event of 3gpp specification [11] to take handover decision. These algorithms update Handover parameters as a function of the network load. Authors concerned with the three conditions in these algorithms.

Condition1:
available_resources/totalresources<predefined_thresold.
If this condition is verified MLB is triggered.
Condition 2:
available_resources/totalresources>post_thresold.
MLB transfers some load to the best neighbor and this condition is used to stop the MLB, because it may be the case that now the available resources are enough to satisfy the current traffic demand.
Condition 3:
available_resources/totalresources>thresold_to_accept.
This condition is for the target cell to check whether the target cell is able to satisfy the resource demand of UEs, which are being transferred or not .The simulation results shows that the algorithms results in improved global throughput for different loads but not much significant for high loads. These algorithms provides better throughput than the algorithms without MLB in different UE densities [22].

d) Some the works found in literature are shown in Table

Sr.	Details		
	Author	Algorithm	Year
1.	R. Nasri, Z. Altman, H. Dubreil	Macro diversity Algorithm	2006
2.	R. Nasri, Z. Altman	Auto-Tuning	2007
3.	C. Xue, J.Luo, R. Halfmann, E. Schulz,C. Hartmann	GW Load Balancing process	2009
4.	A.LobingerS.Stefanskiki, T. Jansen, I. Balan	Handover load balancing	2010
5.	R.Kwan, R. Arnott, R. Paterson, R. Trivisonno	Load balancing using handover	2010
6.	Z. Liu, P. Hong, K. Xue, M. Peng,	Novel Load Balancing	2010
7.	H. Wang, L Ding P Wu, Z. Pan, N. Liu and X.You	Multi-Objective Hybrid Scheduling	2010
8.	H. Wang, L Ding P Wu, Z. Pan, N. Liu and X.You	Heaviest First Load Balancing Algorithm	2010
9.	D.Woon Lee, G. Tae Gil and D. Hoi Kim	CBLB (Cost-Based Load Balancing) Algorithm	2010
10.	J. Suga, Y. Kojima, M. Okuda	MLB (Mobility Load Balancing)	2011
11.	Aderemi A. Atayero and Matthew K. Luka	Adaptive Neuro-Fuzzy Inference system	2012
12.	Y. Yang, P. Li, X. Chen, W. Wang	Mobility Load Balancing	2012
13.	W. Bo, S. You, Z. Lv, J. Wang	Ant Colony Based Load Balancing	2012
14.	Omar Altrad, Sami Muhaidat	CLB (Clustered Load Balancing)	2014
15.	Mohamed Escheikh, Hana Jouini and Kamel Barkaoui	Alg_MLB1 and Alg_MLB2	2016

Table: Literature of Load Balancing in mobile networks.

IV. CONCLUSION

Traffic handling definitely affects the performance of quality of networks. The quality of a network can be improved by applying such strategies that can achieve load balance between heavily loaded cells and least loaded cells. In this paper, recent works regarding load balancing and load balancing itself are reviewed. There is a need to opt for new load balancing techniques or

methods in order to achieve load balance on the network cells. Some methods are based on cell coverage optimization and some are based on dynamic adaptation of handover parameters. A lot of work is being done.

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