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A Load Balancing in LTE Heterogeneous Networks: A Review

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Abstract: In present Data traffic demand in cellular networks is increasing at an exponential rate. Third Generation Partnership Project (3GPP) Long Term Evolution/ System Architecture Evolution (LTE/SAE) is the next generation radio access system that carries future end-user requisite. With the rapid use of the cellular network, operators have to give over momentous manual efforts to network management. Manual configuration and management of networks is a time-consuming, costly and error prone due to exponentially growing rate of mobile users and nodes. This shows the way to a preamble of self-organizing capabilities for network management with minimum human enthusiasm. A Load balancing as a part of self organized network solution has become one of the most active and emerging fields of research in Cellular Network. This paper is an attempt to review the various load balancing techniques presently used in mobile networks with special prominence on techniques that are appropriate for self optimization feature in future cellular networks.

Keywords: LTE, Load Balancing, SON, eNB, EPC.

I. INTRODUCTION

It has been observed that during the past few decades wireless technology has rapidly seen a remarkable growth. Mobile data traffic is growing day by day. Every mobile user needs high data rates with cheaper rates. The mobile users have become much more mature and the challenge of the mobile operator companies are increasing day by day to satisfy them with higher capacity, better coverage, and Quality of service (QoS).It is inevitable that the mobile operator companies will have to make extra efforts to overcome the future coverage and capacity requirements. Mobile users and the resulting data usage are random, time varying, and often unbalanced, this makes unequal load scenario for neighbor cells; consequently one cell may be overloaded while others have much fewer users and in this way the resources are not fully utilized. On the other hand overloaded cell faces resource shortage, which affects access to new users and impacts the QoS of active users. This load imbalance declines the overall performance of the cellular network in a fatal way due to ineffective utilization of resources. This problem can be resolved by load balancing techniques. Load balancing involves distinguishing network load imbalance by sporadically exchanging information between neighboring eNBs to compare the cells load and then, Load balancing optimization feature automatically change the network parameters to manage the unpredicted loading conditions produced due to the sudden rise in data usage [1].

The rest of the paper contains four sections in which section II briefly provides the background information while section III highlights the detailed discussion on Load Balancing in cellular networks. In Section IV efforts have been made with special emphasis on the Load Balancing techniques suitable for self organized cellular networks, and Section V is the conclusion of the overall assessment of the topic.

II. OVERVIEW

Conventionally, various kinds of networks namely fixed/cellular telephone networks, data networks etc. were available for the users to support numerous services. Next Generation Network (NGN) offers are these facilities by using multiple access technologies through an IP-core network and yields better performance. It will also give better mobility and routing management thereby yields good Quality of Service (QoS).

Long Term Evolution (LTE) is the first technology to be designed explicitly for the NGN. It is basically designed to increase the capacity and speed of mobile networks. 3GPP standards introduce the LTE technology. LTE is the first standard that is fully IP-based that support data rates up to 150 Mbps. Fig.:1, shows that LTE network elements EPC (evolved packet core) is a direct replacement for the packet switched domain of Global System for Mobile Communication (GSM) and Universal Mobile Telecommunication System (UMTS). EPC distributes all types of information to a user, voice and data by using the packet switching technologies. During mobility of the users, it gives interference free services through Internet Protocol (IP) connectivity between UE (User Equipment) and PDN (Packet data Network) [2].

E-UTRAN (evolved UMTS terrestrial radio access network) handles the EPC radio communications with the mobile. Each eNB is a base station that supervises the mobiles in one or more cells. The base station that is

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communicating with a mobile which known as its serving eNB. A System Architecture Evolution (SAE), which covered the core network and LTE, which covered the air interface, radio access network, and mobile. Officially, the whole system is known as the Evolved Packet System (EPS). Together LTE and SAE cover the Evolved Packet System (EPS) [3][4].

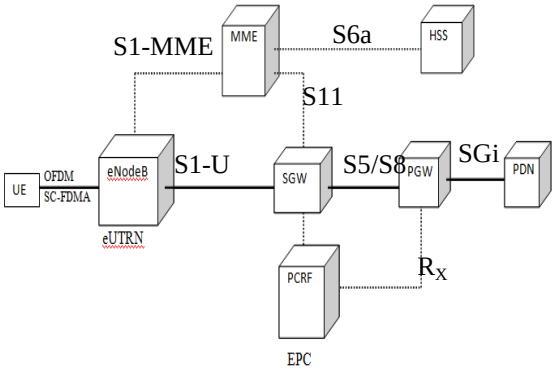

Fig1: LTE Architecture

Brief description about the components of LTE architecture (as shown in fig.1) is discussed below:

2.1 The Core Network

It is accountable for the entire control of the UE. It is the combination of E-UTRAN and EPC. The main logical nodes of the EPC are:

• S-GW (Serving Gateway)
• P-GW (PDN Gateway)
• MME (Mobility Management Entity)

Besides this EPC also contains other function and services namely PCRF (Policy Control and Charging Rules Function) and the Home Subscriber Server (HSS).

- PCRF – it is basically used for policy control decision-making and managing the flow-based charging functionalities. It also provides the QoS support.
- HSS – It consists of users' information that is connected to PDN and maintains a database and provides secure services using security keys.
- P-GW (PDN Gateway) – It does allotment of IP address for the user equipment, QoS enforcement, flow based charging and filtering of downlink IP packets from diverse owners. The PDN-Gateway implements QoS enforcement and provides the mobility support for interworking with non-3GPP technologies networks.
- S-GW – It is basically used for transferring users IP packets. It acts as a router and forward data between the base station and the PDN gateway. It also provides mobility support for interworking along with existing technologies.
- MME - Control node that route the signaling between the LTE network elements and UE using NonAccess Stratum (NAS) protocols.

III. LOAD BALANCING MEASURING IN LTE

A load balancing always requires sharing workload among the various nodes of distributed system to improve the resource utilization and for better performance of the system. In this way, it can help to avoid the situations either of heavy load or under the load of the network [5].
Load balancing algorithm is based on load status information of network which becomes able automatically to indicate optimal adjustments for network parameters. There is a problem in Network unequal load distribution and this causes overload. So, the users are not served with required quality level due to lack of resources. The following idea can resolve these reallocate part of users from overloaded cell to less loaded neighbor cell [6][7][8]. For calculating, load per user we apply throughput mapping base on the concept of a truncated Shannon mapping curve:

$$R(SINR_u) = \log_2(1+SINR_u) \quad (1)$$

A load generated by the single user is the necessary number of PRBs (Physical Resource Blocks). N_u (Number of user's) for the required throughput D_u and transmission bandwidth of one PRB is denoted as:

$$N_u = \frac{Du}{R(SINR\,u).BW} \quad (2)$$

D_u: is an average data rate requirement per user u.

Virtual Load: The condition of virtual load arises when the total required number of PRBs N_u may exceed the amount of the total existing resources in one cell M_{PRB}. Virtual cell load can be stated as the sum of the required resources N of all users u connected to cell c by connection function X(u) which gives the serving cell c for user u.

$$\rho_c = \frac{1}{M_{PRB}} \cdot \sum_{u|X(u)=c} N_u \quad (3)$$

M_{PRB}: is a number of available PRBs (depend on operating bandwidth)
– All users in a cell are satisfied as long as $\rho_c \leq 1$.In a cell with $\rho_c > 1$, we will have a fraction of $\frac{1}{\hat{\rho}_c}$ satisfied users.

There are the numbers of unsatisfied users due to the limitation of the resources. The total numbers of unsatisfied users in the whole network (which is the sum of unsatisfied users per cell, where the number of users in cell c is represented by Mc).

$$z = \sum_{\forall c} \max\left(0, M_c \cdot \left(1 - \frac{1}{\hat{\rho}_c}\right)\right) \quad (4)$$

LB performance evaluation by 'z' metric
Load Balancing (LB) is included within the SON LTE framework and its responsibility is to optimally distribute

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traffic among the different layers [7] by exploiting mobility management and load knowledge of the neighboring cells. In such a manner, overloaded cells can identify potential under-utilized nearby eNBs and attempt to shift part of their traffic towards them by adjusting handover parameters. However, such an approach might interrupt mobility management as users are forced to stay connected longer too low loaded cells at a cost of lower spectral efficiency.

There are various goals of load balancing as follow:
- Improve the performance.
- Maintain system stability.
- Built fault tolerance system.
- Accommodate future modification.

IV. LOAD BALANCING OPTIMIZATION TECHNIQUES

There are several load balancing techniques adopted for the better network to the users and to avoid the imbalance load. They are as follow: Mobility based load balancing, QoS based load balancing, Energy efficient based load balancing, Distributed dynamic load balancing, and Combined metric based load balancing. With the help of mobility load balancing, optimization of cell reselection/handover parameters the unequal traffic load can be managed in a better way and to minimize the number of handovers and reroute needed to get the load balancing [9].

Self-optimisation contains two types of Parameters intra-LTE and inter-RAT mobility which manage load in the cell and they also improve the neighboring cell system capacity compared to static/non-optimised cell reselection/handover parameters. These types of optimization can also minimize human intervention to cater the needs of network management and optimization tasks. The load balancing will not affect the user QoS in a negative way in spite of what a user experiences at common mobility without load-balancing. In order to handle the service competency of RAT efforts must be done keeping in view the solution of network deployments with the overlay of high-capacity and low-capacity layers in which high-capacity layer has spotty coverage. [10] [11][12] Load balancing can be maintained in following circumstances:
- Intra-LTE load balancing
- Inter-RAT load balancing

Most of these above-mentioned load balancing techniques have been designed for cellular networks with users without any quality-of-service (QoS) requirements, and therefore only a few may be applicable in the LTE network, which aims to serve users with specific QoS requirements. Further in all the existing solutions, the success of LB scheme depends on the availability of low loaded adjacent neighbor cells that can easily overtake load from overloaded cells. However, in complex load scenarios observed in LTE Systems adjacent neighbor cells of an overloaded cell may not have enough available capacity. Furthermore, in LTE-A HetNets traffic load has to be balanced among cells having different size, a maximum transmits power and other differing performance metrics; consequently, new approaches need to be explored for load balancing in LTE-A networks [13].

The energy expense causes a typical critical cost for the operators. Cuts on energy expenses could be realized if the capacity offered by the network would match the needed traffic demand at any point in time as close as possible [14]. Energy savings based on enabling the possibility, for a cell providing additional capacity in a deployment where capacity boosters can be distinguished from cells providing basic coverage, to be switched off when its capacity is no longer needed and to be re-activated on a need basis. This capacity can be improved through interference reduction by switching off those cells which are not needed for traffic at some point of time, in particular home eNodeBs when the user is not at home.

Another Dynamic load balancing approach proposed in [15][16] is used to combine the conventional cellular technology and ad hoc wireless networking technology in order to provide an efficient cost solution for heavily overloaded networks. A number of ad hoc relay stations (ARSs) are used to relay signals between MHs and base stations in this way ARSs load is used to transfer the congested cell into a non-congested cell.

V. CONCLUSION

In this paper, efforts have been made to review/ survey the various load balancing techniques for LTE heterogeneous Network. The main objective of load balancing technique is the assurance for the requirement of the consumer by distributing load dynamically among the nodes and the formulation of maximum resource utilization by relocating the total load to the individual node. Self optimized load balancing mechanism is needed for improving efficiency and operation cost reduction. It will not be unreasonable to say that every resource is disseminated efficiency and uniformity. In this way, the performance of the system is increased.

REFERENCES

[1] S. Mishra and N. Mathur, "Load Balancing Optimization in LTE/LTE-A Cellular Networks: A Review," ArXiv Prepr. ArXiv14127273, 2014.
[2] 3rd Generation Partnership Project (3GPP) [online] available: https://www.3gpp.org.
[3] White Paper, "Long Term Evolution Protocol Overview", published by freescale semiconductor, 2008.
[4] White Paper "The LTE Architecture" AlcatelLucent, 2011.
[5] O. Stanze and A. Weber, "Heterogeneous networks with LTE-Advanced technologies," Bell Labs Tech. J., vol. 18, no. 1, pp. 41–58, Jun. 2013.
[6] SOCRATES, Use cases for self-organising networks, European Research Project, http://www.fp7 - socrates.eu.org.

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[7] 3GPP, Self-configuring and self-optimizing network use cases and solutions, Technical Report TR 36.902, available at http://www.3 gpp.org.
[8] Z. Li, H. Wang, Z. Pan, N. Liu, and X. You, "Joint optimization on load balancing and network load in 3GPP LTE multi-cell networks," in Wireless Communications and Signal Processing (WCSP), 2011 International Conference on, 2011, pp. 1–5.
[9] 3GPP, LTE, E-UTRA, Access Network E-UTRAN overall description, Technical Report TR 36.300, available at http://www.3 gpp.org.
[10] Jiajia Liu; Kawamoto, Y.; Nishiyama, H.; Kato, N.; Kadowaki, N., "Device-to-device communications achieve efficient load balancing in LTE-advanced networks," IEEE-Wireless Communications, vol.21, no.2, pp.57,65, April 2014.
[11] J. M. Ruiz-Aviles, M. Toril, S. Luna-Ramirez, V. Buenestado, and M. A. Regueira, "Analysis of Limitations of Mobility Load Balancing in a Live LTE System," IEEE Wirel. Commun. Lett., vol. 4, no. 4, pp. 417–420, Aug. 2015.
[12] P. Szilágyi, Z. Vincze, and C. Vulkán, "Enhanced mobility load balancing optimisation in LTE," in 2012 IEEE 23rd International Symposium on Personal, Indoor and Mobile Radio Communications-(PIMRC), 2012, pp. 997–1003.
[13] H. Wang, L. Ding, P. Wu, Z. Pan, N. Liu, and X. You, "QoS-aware load balancing in 3GPP long term evolution multi-cell networks," in 2011 IEEE International Conference on Communications (ICC), 2011, pp. 1–5.
[14] V. Monteiro, K. M. S. Huq, S. Mumtaz, C. Politis, and J. Rodriguez, "Energy efficient load balancing for future self-organized shared networks," Telecommun. Syst., vol. 59, no. 1, pp. 123–135, May 2015.
[15] H. Zhang, X. Qiu, L. Meng, and X. Zhang, "Design of distributed and autonomic load balancing for self-organization LTE," in Vehicular technology conference fall (VTC 2010-Fall), 2010 IEEE 72nd, 2010, pp. 1–5.
[16] W. Lv, W. Li, H. Zhang, and Y. Liu, "Distributed mobility load balancing with RRM in LTE," in Broadband Network and Multimedia Technology (IC-BNMT), 2010 3rd IEEE International Conference on, 2010, pp. 457–461.