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Impact of Wide Band Paging Optimization in LTE on Femtocell Network

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***Abstract*— This paper is intended to present an extensive study of wide band paging optimization in Long Term Evolution (LTE) network, to identify its impact on system performance. In this paper we will be focusing only on femtocell network and will understand the performance of system in femtocell network with this proposed extended cell global identity (E-CGI) based wideband paging optimization technique. An End-to-End real femtocell setup has been built with real User Equipment (UE), Femto-Gateway (FGW), LTE core network to capture performance of the proposed feature. A deep study has been done on system performance in femtocell network to identify system impact with the proposed technique, it has been observed that with proposed E-CGI based paging optimization technique, drastic improvement has been observed on system resource utilization.**

Keywords— Paging optimization, Femtocell, Femto- Gateway, LTE, Wideband,

I. INTRODUCTION

With Service provider trying to provide seamless LTE services to end user, femtocell network are gaining popularity as it help service provider to provide end-user good connectivity even inside buildings and other locations , where macro eNB can't provide enough coverage , as a result number of mobile user are increasing exponentially , and along with this network is increasing exponentially, with growing network mobile user tend to move between different base station and femtocell , which result in lot of paging message network in sending to page those mobile users. These paging message need resources from system.

In current TAC based paging approach whenever a particular paging message arrives for a specific user, in first attempt of paging , this paging message will be broadcast to all the cells which are associated to the particular tracking Area code (TAC) , if no response is received from the specific user which result in failing of paging attempt ,in that scenario paging will be performed to all the cells in that area, so that paging message should reach to the user and user can reply

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Problem with above mentioned Tracking area Code (TAC)[1] based paging technique is that, in this technique Femto-gateway (FGW) will page all the femtocell in that particular TAC in which user equipment (UE) was there , which is unnecessary wastage of resource , since then all the femtocell in the TAC will try to page one user equipment and UE is attached with only 1(Femtocell Access point) FAP so that FAP will be able to page that UE , rest all the FAP will waste there resource in broadcasting paging message since UE is not UE for which paging message is intended is not attached to other femtocell, with our proposed solution this wastage of resource can be reduced drastically, by making sure that Mobility management entity (MME) sends paging based E-CGI instead of performing TAC based paging.

This paper is organized as follows. In Section 2, Overview of femtocell network is captured along with information on wideband Paging optimization techniques and configuration detail. Section 3 captures details of test setup and results achieved with this technique. Conclusions are drawn in section 4.

II. SYSTEM ARCHITECTURE

A. *Femtocell Architecture:*

The Standard End-to-End Femtocell architecture shown in fig.1 shows the Network element and there standard interface mentioned in the figure, the suggested optimization technique should be implemented in Femto-gateway, Femtocell and in LTE core network , in order to enable network to perform paging based on E-CGI along with TAC based paging.

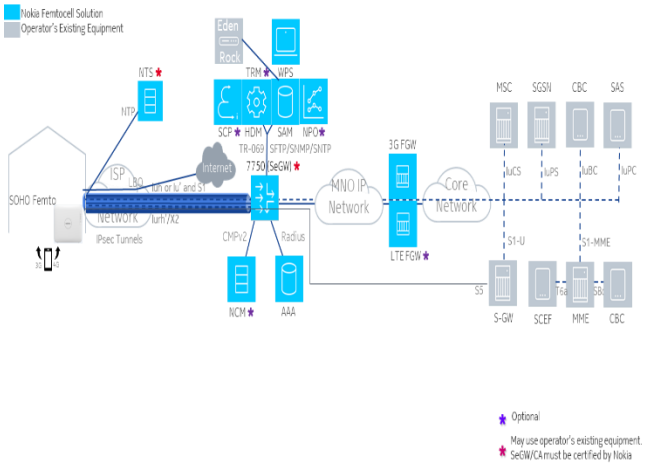

Fig. 1. Femtocell End-to-End network architecture

B. *ProblemStatement and Proposed solution*

In a femtocell n/w , which is highly dense the mobile user will be in continuous move between different Femtocell , which will intern increase the paging message core network need to send to mobile user. With earlier paging techniques for. Example tracking area code (TAC) based techniques , core will send

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paging message with tracking area Identity (TAI) in paging message to femto-gateway(FGW) , as a result FGW will perform TAC based paging and send paging message to all the femtocell in the particular TAC, once paging message received by femtocell it will page to all the user equipment (UE) in its coverage , and the UE for which this paging message is intended will reply with service request to femtocell . but during this TAC based paging a lot of resources are getting wasted, as paging message was intended to one particular UE , since core network don't know exact location of UE , in which femtocell UE is currently attached to , hence it will send paging message to all the femtocell via FGW , which is causing unnecessary wastage of resource.

In this paper we proposed a paging technique which can be used to page UE more precisely, by paging UE with the help of extended Cell global identity (E-CGI).

As a part of this proposed technique, femtocell will inform mobility management entity (MME) in LTE core network about its recommended eNB list and cell list, for which MME can send paging message.

Femtocell can include list of cell identity information along with recommended eNB information in the release message send to MME via FGW. When core wants to page the user equipment (UE) it can use the recommended cell ID and eNB info list provided by femtocell to LTE core network, in last release message for that UE, to page the UE via FGW, instead of performing whole TAC level paging.

But with this method of paging optimization there is a limitation, in scenario when after releasing from network UE perform an idle mobility which means UE moves from one femtocell to another femtocell in release mode, in that scenario UE will not be able to receive the paging message.

To overcome this problem of idle mobility scenario, we proposed a mechanism of fall back to TAC based paging, when paging message is not received by UE. To achieve this fall back we suggest a method in which LTE core network can track the number of paging attempt sent to UE in paging message by adding Paging attempt count, Intended number of Paging attempt and Next Paging area Scope in Paging Attempt Information message.

When paging message has not been received by UE in idle mobility scenario , MME will wait for some time and will send paging message again to UE , but this time paging attempt count will increase once paging attempt count value exceeded more than intended Number of paging attempts MME will send TAI based paging to FGW and FGW will perform TAI based paging for UE or after not receiving any reply from UE for paging message MME can decide to change Paging Area scope and do TAI based paging for the UE.

Thus, UE will receive paging in idle mode scenario as well.

Fig.2 demonstrate the proposed solution

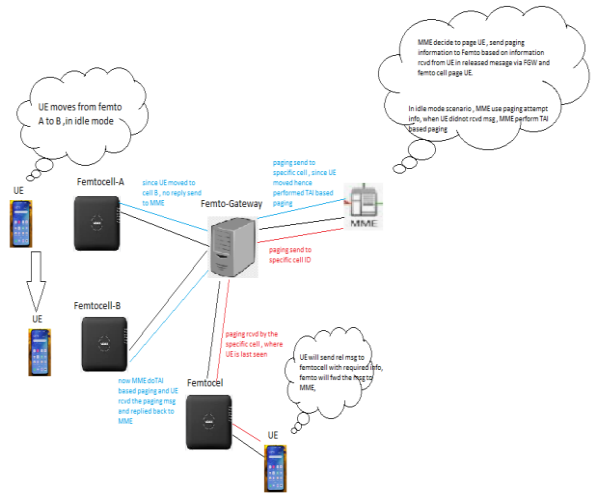

Fig. 2 Proposed solution message flow.

III. EXPERIMENTAL SETUP AND SYSTEM PERFORMANCE

In this experimental setup we have used a simulator to attach 1000 HeNB or femtocell per TAC in Femto-Gateway FGW, MME simulator to trigger paging message in the network and call load profile to generate traffic load in the network.

Parameters	Values
Number of HeNB per TAC	1000
Paging messages from MME	600 message/second
call load profile	128000 NB+WB profile used

Table 1. Test Parameters

The parameters used to perform the experiment is mentioned in table 1, we have used a network with 1000 femtocell per TAC and 128K NB+WB profile is been used to generate traffic load to observe the behavior system with call load , along with this 600 paging message per second has been send from MME simulator to network , to study the performance of suggested technique in network.

A. Simulation result:

Here we are comparing legacy tracking area code (TAC) based paging optimization with the proposed ECGI based paging optimization techniques, on system performance. To evaluate the performance of the proposed technique , we have initiated call load in our system , along with the load we have performed 600 aging messages per second to network with the help of MME simulator for 8 hours and studies impact on system performance in different Central processing Units (CPU) of system , with ECGI based paging optimization technique and with legacy TAC based paging techniques.

With the result shown in fig.3 we can clearly see that CPU utilization of system with this proposed technique is 50% less than the CPU utilization observed with legacy based techniques.

Similar results is obtained in all the 8 CPU cores in system, as shown in fig. 3 where TRUE denotes, the proposed E-CGI

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based paging technique is enabled and False denotes TAC based paging techniques is been used, with the below result we can observe considerable amount of improvement in terms of CPU utilization with this proposed optimization techniques.

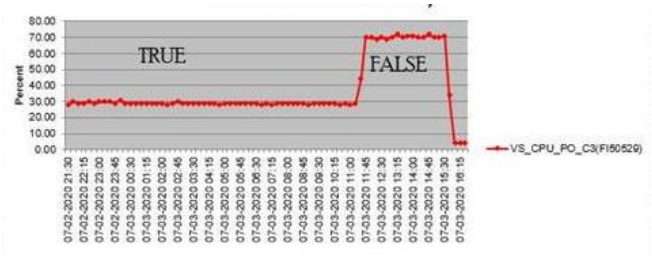

Fig 3 CPU utilization-based comparison.

In Fig 4 with the proposed paging optimization techniques, the Interrupt Request (IRQ) CPU usage is almost null and with TAC based paging the IRQ CPU usage is almost 50% for the system, hence here also we have observed significant improvement with proposed E-CGI based paging optimization techniques.

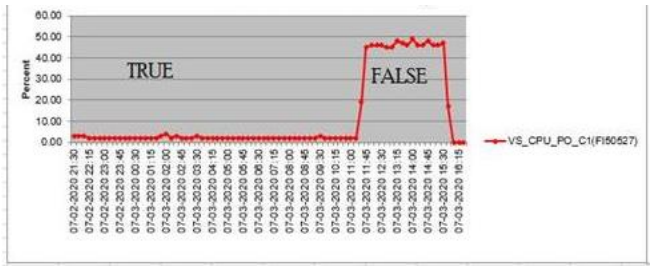

Fig. 4 IRQ CPU utilization comparison.

IV. CONCLUSION

This experimental study shows the decent enhancement in System performance with respect to CPU utilization in Network elements. Improvement of approx. 50% has been observed on application CPU utilization in Femto-Gateway.
Similarly, approximately 50% of CPU utilization enhancement has been observed with IRQ CPU utilization as compared to TAC based paging mechanism. This fundamentally will provide the wireless network operators the most competent way to accommodate more Femtocell in FGW. To make this optimization techniques more robust and achieve better paging success rate, more cell list can be added in recommended cell information message based on neighbor cell information reported by UE, so that probability of getting UE pages increase. Further study will be done to analyses the paging success rate behavior with this paging optimization techniques in future.

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