Protocol for Reduction in Network Resource Wastage for 4G Dual SIM Dual Standby User Equipment

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Abstract : A user equipment (UE) with Dual Subscriber identity- module (SIM) Dual Standby (DSDS) feature can connect to two network operators, such as, each SIM is associated with one operator and with one Protocol Software Stack (PSS) while both the SIMs share same Radio Frequency Integrated Circuit (RFIC). UE schedules SIM-1 to communicate with Operator-1 and at the same time SIM-2 remains standby and vice versa. The ongoing data session with Operator-1, through SIM-1 is interrupted while the UE's RFIC tunes away to attend a higher priority signaling through SIM-2 to Operator-2. This tune away procedure of RFIC results in allocated Physical Channel Resource (PCR) wastage at Operator-1 for SIM-1 during the tune away period. After the end of tune away at SIM-1, it further more suffers from low PCR allocation from Operator-1, because of no response from SIM-1 during tune away period. To overcome the above challenges, to the best of our knowledge, for first time this paper proposed Signaling indication from UE to network for RFIC tune away event to reduce network PCR wastage. This signaling is done by: (a) Radio Resource Control (RRC) layer (b) Medium Access Control (MAC) layer (c) Layer 1 (L1). Each of the above-mentioned signaling has particular level of latency and reliability. We propose to apply above-mentioned signaling in scenario specific manner to address all possible tune away events. Through extensive simulation derived from mathematical modelling and measurements obtained from test bed with commercial DSDS UEs, the results reveal an improvement in overall PCR utilization for an operator and increase in UE admission by up to 30% in comparison with current DSDS solutions.

Keywords—dual SIM dual standby; RFIC tune away; resource scheduling; multiple subscription; network capacity; dual LTE; dual VoLTE.

I. INTRODUCTION

In a Dual Subscriber Identity Module (SIM) Dual Standby (DSDS) User Equipment (UE), SIM-1 and SIM-2 are associated with respective operators and to save cost, one Radio Frequency Integrated Circuit (RFIC) is shared by the respective Protocol Software Stacks (PSS) catering to each SIM. Capability of DSDS UEs to connect with two operators through a single UE to avail the benefits offered by both operators makes DSDS an attractive solution.

The DSDS RFIC tune away operation happens when SIM-1 is on an active data session with Operator-1 and SIM-2 is scheduled to attend higher priority signaling with Operator-2, which eventually tunes away RFIC from SIM-1 PSS, thus moving SIM-1 PSS to a standby state. The 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) standard specification has not considered dual SIM functionality as a feature. Therefore, a decision at UE for tuning away RFIC to connect with Operator-2 will result in no response from SIM-1 towards Operator-1 for an active data session. This no response from SIM-1 will result in wastage of Physical Channel Resource (PCR) allocated to SIM-1 from Operator-1. In order to maintain fairness among the UEs, eNodeB (eNB) under Operator-1 monitors Hybrid Automatic Repeat Request (HARQ) Negative Acknowledgement (NACK) and NO Acknowledgement (ACK) for downlink (DL) data and grant utilization for uplink (UL) data on the allocated DL/UL PCR [4]. Due to unutilized allocated PCR during tune away period, the eNB under Operator-1 will scale down DL/UL PCR allocation to SIM-1 in the subsequent grant. This results a drop in average throughput at SIM-1 as well as the PCR wastage at Operator-1, which otherwise could have been granted to other UEs. This holds true for SIM-2, as well when it has an active data session, and SIM-1 needs to attend to high priority signaling. In recent literature to solve aforementioned problems, [1]leverages existing procedure and sends a Signaling Connection Release Indication (SCRI). Though this solution explicitly communicates the scheduling of DSDS RFIC tune away event with the network, it suffers from a notable delay due to Acknowledged Mode (AM) communication and reestablishment of connection. Thus, it is not suitable for short and frequent RFIC tune away duration in DSDS RFIC tune away scenarios. In [2] [3] attempts are made to optimize the RFIC tune away periods with discrete events scheduling, however, it does not address the resource wastage at the operator. As mentioned above, to the best of our knowledge all the surveyed literature has not addressed the wastage of PCR during DSDS RFIC tune away efficiently.

II. RELATED WORK

Osama M. Abusaid, et al. [9] exploits the new Quality of Service feature of Channel Quality Indicator (CQI) that LTE-A systems have introduced in order to alleviate these negative effects. Specifically, we introduce Self Organizing and Neural Network (SONN) algorithms towards providing adaptive solutions. Adaptive Resource-Block scheduling enhances downlink throughput and increases the wireless network capacity as well. Moreover, they present comparative metric performance of the developed algorithms to well-known existing algorithms under the same parameters in extensive standard simulation environment.

Weihong Fu, et al. [10] focused on the resource scheduling of Long Term Evolution - Advanced (LTE-A) with Carrier Aggregation (CA). Application of CA meets the demand of bandwidth in LTE-A by aggregating several discrete carriers together. With different fading characters, the aggregated carriers have different coverage between each other. Considering the backward compatibility, there exist both LTE-A and LTE users. In order to improve the performance of LTE users and cell edge users, an improved proportional fair (PF) scheduling algorithm suitble to multi-carrier system is proposed.

Mushtaq Al-Shuraifi, et al. [11] proposed the improvements for Max C/I Ratio method, which is used in the LTE downlink. These improvements resolve problem of the resource scheduling in the situation where some user with high SNR uses all available resources.

Rohaiza Yusoff, et al. [12] proposed an energy-efficient resource allocation scheduler with QoS aware support for LTE network. The ultimate aim is to promote and achieve the green wireless LTE network and environmental friendly. Some related works on green LTE networks are also being discussed.

Xiaoshan Liu, et al. [13] proposed a scheme which dynamically switches a mobile user's connection between different access networks. In each handoff, a user will adjust its bandwidth requirement according to the utilization of the current access network. A profitability function is established to evaluate the profits gained from a handoff and to select the target network accordingly. Through vertical handoffs, traffic load will be balanced among the access networks and radio resources will be efficiently utilized.

III. OBJECTIVE

1. Addressed the wastage of PCR during DSDS RFIC tune away efficiently.
2. Radio Resource Control (RRC), signaling from UE to network to indicate the RFIC tune away events with high reliability and high latency.
3. Medium Access Control (MAC), signaling from UE to network to indicate the RFIC tune away events which provides average latency and average reliability with respect to Layer-1 (L1) signaling.
4. Layer-1 (L1), signaling from UE to network to indicate RFIC tune away events, which can be further categorized based on availability of Physical Uplink Control Channel (PUCCH) and Physical Uplink Shared Channel (PUSCH).
5. Resource Booking using priority scheduling algorithm

IV. PROPOSED METHODOLOGY

The Proposed Signaling Protocol for DSDS RFIC Tune away Scenarios are described in bellow. RFIC tune away event at SIM-1 will send suspension explicitly, which will trigger SIM-1 PSS and eNB under Operator-1 to suspend ongoing active timers, internal states and buffers. Further to this operation, eNB under Operator-1 will not allocate PCR to SIM-1. After RFIC tune away end event at SIM-1, it will send resumption implicitly or explicitly, which will enable eNB and UE both to resume active timers, internal states and buffers. Based on the SIM-1 PSS request, eNB under Operator-1 will resume allocating PCR to SIM-1.

Following figure 1 shows the flow of our proposed system. Here we have show that the complete process from send data to receiving data in the network. Firstly, network will be created. In second stage Sender and receiver will be set in network. Network log will be monitored in terms of throughtput, UE admission Rate, Latency and reliability of network. We are using signaling protocols like Medium Access Control (MAC) layer (c) Layer 1 (L1). Each of the above-mentioned signaling has particular level of latency and reliability. We propose to apply above-mentioned signaling in scenario specific manner to address all possible tune away events. Through extensive simulation derived from mathematical modelling and measurements obtained from test bed with commercial DSDS UEs, the results reveal an improvement in overall PCR utilization for an operator and increase in UE admission by up to 30% in comparison with current DSDS solutions. Finally we are comparing our result with previous system.

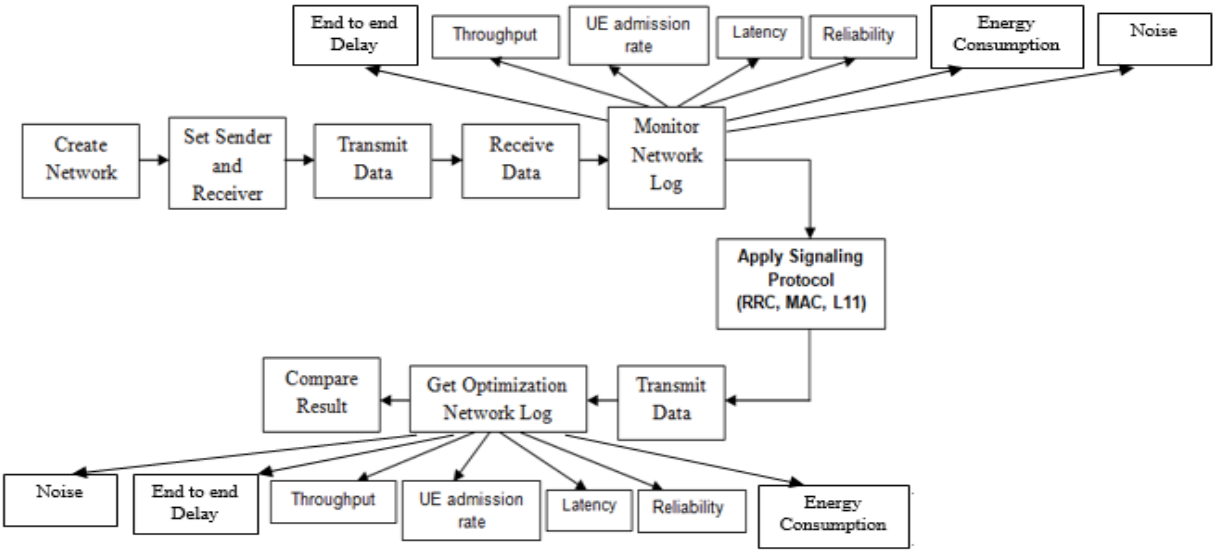

Fig .1: Block Diagram of Proposed System

V. CONCLUSION

Finally, this system to overcome the wastage using the signaling protocol, to the best of our knowledge, for first time this paper proposed Signaling indication from UE to network for RFIC tune away event to reduce network PCR wastage. This signaling is done by: (a) Radio Resource Control (RRC) layer (b) Medium Access Control (MAC) layer (c) Layer 1 (L1). Each of the above-mentioned signaling has particular level of latency and reliability.

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