Innovation-14

1. **Brief Name of the Innovation:**

   A Method for Ensuring High VoIP Capacity in LTE

2. **Contact Information:**

   Dr. Suvra Sekhar Das, G. S. S. S. T., IIT Kharagpur, India

   Email id: suvra@gssst.iitkgp.ernet.in

   Priyangshu Ghosh, Qualcomm India Pvt Ltd, Hyderabad, India.

   Email id: priyangshu@qualcomm.com , pghosh06@gmail.com

3. **What is the technology?**

   Voice scheduling in LTE like packet switched systems

4. **What does the technology do?**

   In LTE the traditional circuit switched voice calls are supported as Voice over IP (VoIP). LTE is expected to support a very high number of VoIP users while satisfying the required QoS. For VoIP, the QoS is defined by a maximum end-to-end delay and packet loss rate. As opposed to circuit-switched voice, in packet switched network voice traffic is characterized by random arrival of small packets with stringent delay requirements. In time varying wireless environment, the Packet Scheduling (PS)-Radio Resource Allocation (RRA) for VoIP therefore must be designed to match the random VoIP packet arrivals to the channel variations of each user in the best possible way so as to maximize the number of supportable VoIP users while meeting the stringent delay limits. Hence, designing schedulers for VoIP is a very challenging task for LTE systems. This work aims to design schedulers for VoIP service considering realistic constraints such as TBS formation and Control Channel (CCH) limitation.

5. **Explain the specific problem this technology has created to address or solve**

   VoIP packets in 4G networks require a variable bandwidth unlike GSM. The scheduling of VoIP packets is based on the Channel Quality Indicator (CQI) of the user. The capacity of the network, which is given by the maximum number of satisfied users, depends on the VoIP scheduling algorithms

Contributions:

- A software test bed has been developed. The test bed is a System Level Simulator that emulates a Multi-Cell, Multi-User, Multi-Carrier network scenario. The simulator has been used to implement real time traffic such as VoIP.
- Two different VoIP Scheduling Algorithm, Dynamic and Semi-Persistent has been implemented. It has been observed that Dynamic supports less number of users but consumes considerable control channel resources while semi-persistent algorithm supports a larger number of users leading to an increase in capacity. A further increase in capacity has been observed with an improved Semi-Persistent algorithm.
- A method has been developed for the estimation of the number of PRBs required by a user to make a VoIP call based on the user SINR distributions.

6. Why is it better? How much better?

i) Better efficient usage of radio resources.

ii) Efficient control channel usage.

iii) VoIP capacity improvement by nearly 11% (i.e., 30 users/5MHz) when compared to conventional semi persistent scheduling methods.

iv) Over a long time, for large number UEs, it saves a significant amount of overhead bits and also improves the capacity in terms of VoIP users by 9.7 %.

7. Have you filed for Intellectual Property (IP)? Have Patent Cooperation Treaty (PCT) applications filed?

Patent document is under preparation and almost on the verge of completion.

8. What is the development stage of this innovation?

Prior studies and patent search have been done; the proposed method is verified in software platform using a 3GPP calibrated System Level Simulator. Results are better compared to the existing literature's result.

9. Have any prospective users or buyers shown interest in this technology?

No

10. Who do you consider competitors or competing technology?

Base station & base station chip manufacturers

11. List the milestones remaining to be accomplished to bring your technology to full development and ready for the intended end-user?

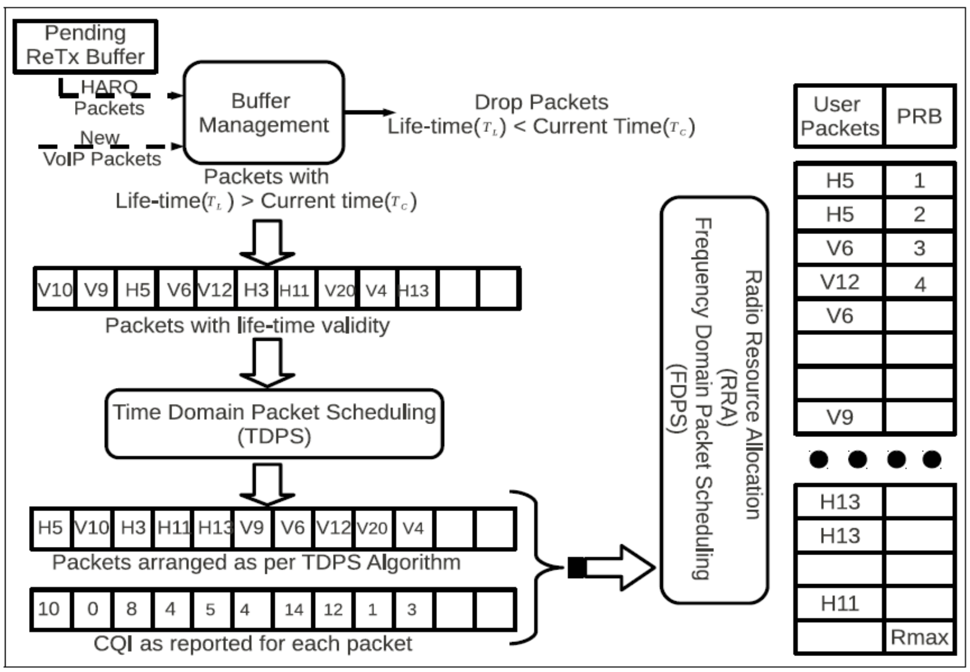
It should go through legal advice before filing the patent.

12. Broad Technical Specifications System Simulation Parameters

Parameters	**Values**
Network Layout	Hexagonal grid with 19 sites, 3 sectors per site
Inter-site Distance	200 m
Scenario	Urban Micro-Cellular [1]
Carrier Frequency	2.4 GHz
eNB Tx Power	41 dB over 10 MHz
System Bandwidth	5 MHz (25 PRBs)
Sub-carrier spacing	15 KHz
TTI Duration	1 ms (14 OFDM symbols)
Control Channel Overhead	3/14 OFDM symbols
Antenna Configuration	1x2 MRC, 4x2 SFBC-FSTD
User Velocity	3 Kmph
Shadow Fading (σ)	4 (Outdoor) / 7 (Indoor)
Rx Noise Figure	7 dB
Thermal PSD	-174 dBm/Hz
Link to System Mapping	EESM
Link Adaptation BLER target	10%
CQI	Frequency domain resolution – 1 CQI / 2 PRBs

CQI Reporting Delay	2 ms
HARQ	8 HARQ Channel (Stop & Wait), Chase Combining (4 Retransmissions)
Traffic Model	2 state Voice Markov Model
User Distribution	50% Indoor users and 50% outdoor users

13. Diagram or Pictures: VoIP Scheduler Architecture



14. References:

i) ITU-R M.2135 – ITU-R Tech. Report, “Guidelines for Evaluation of Radio Interface Technologies for IMT-A”, 2008