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Application specific LTE TX Power Optimization using Predictive Modelling

Hinduja Ichapuram, Prasad R Rao, Maulik Patel, Diwakar Sharma and Tushar Vrind
Samsung Semiconductor India R&D, Samsung Electronics Bangalore, India

Motivation

- There are existing proposals for intelligent hand off decisions based on radio channel conditions (directed by eNB) which are highly dependent and controlled by the feedback and indications provided by the UE resulting in power hungry RF operations.
- This paper proposes a novel method for deferring and optimizing LTE TX power for background data by reducing the RFIC's power consumption using predictive algorithm is used to determine and schedule TX at an optimal power level.

Problem Description

- There are existing proposals for intelligent hand off decisions based on radio channel conditions (directed by eNB).
- Most of the power control algorithms are highly dependent and controlled by the feedback and indications provided by the UE resulting in power hungry RF operations.
- This patent proposes a novel method for deferring and optimizing LTE TX power for background data by reducing the RFIC's power consumption.
- Predictive algorithm is used to determine and schedule TX at an optimal power level.
- This idea also finds application in low power distributed wireless sensor networks/IoT.

System Model

- Training curve is derived by factors like MCS, PL, NRB(s) allocated by the eNB.
- Post training, the UE would check the built power profile from the previous trials to find the probability of a TX power more optimal than eNB's request, within the affordable delay interval for a given QoS.
- Given that the uplink (UL) data of the application is delay tolerant (based on QoS) the UE may decide to defer its TX to the instance in the future where the TX power is likely to be low.
- The location of the UE is calculated by fingerprinting three Observed Time Difference Of Arrival (OTDOA) signals, or opportunistically using the Global Positioning System (GPS), eNB cell ID or Wi-Fi.

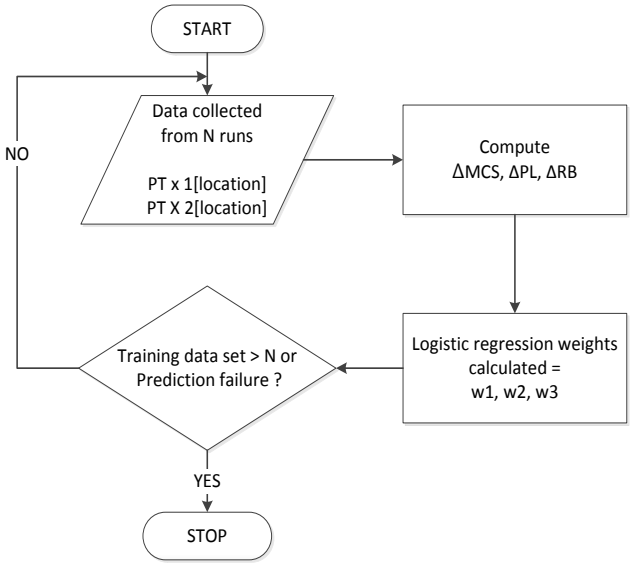
CLPC Equation

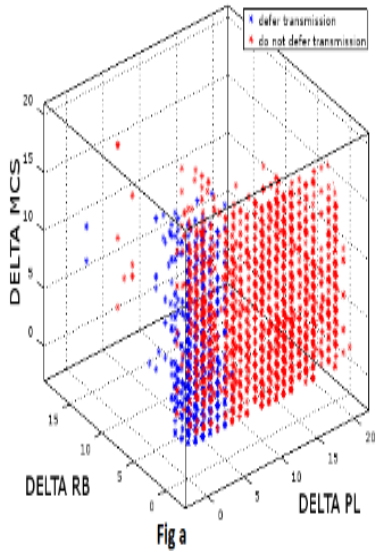
- $P_{PUSCH}(i) = \min\{P_{CMAX}, 10log_{10}(M_{PUSCH}) + P_{o\_PUSCH}(j) + \alpha(j).PL + \Delta_{TF}(i) + f(i)\}$

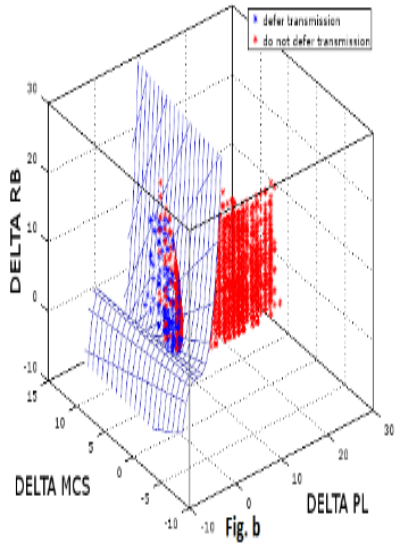
- $P_{Tx}[loc]$ - Power Transmitted by the UE
- $M_{SRS}[loc]$ - Number of Resource Blocks allocated
- $PL[loc]$ – Path loss observed
- $MCS[loc]$ –MCS of the uplink data observed

- The above data is collected per location ($MCS[loc]$) which forms the basic training set.

Logistic Regression - Training







- * denotes a difference ($[\Delta_{MCS} \quad \Delta_{PL} \quad \Delta_{RB}]$) observed between uplink conditions, in the same geographic location
- * denotes a difference observed between the uplink conditions of two different geographic locations

Algorithm and Results

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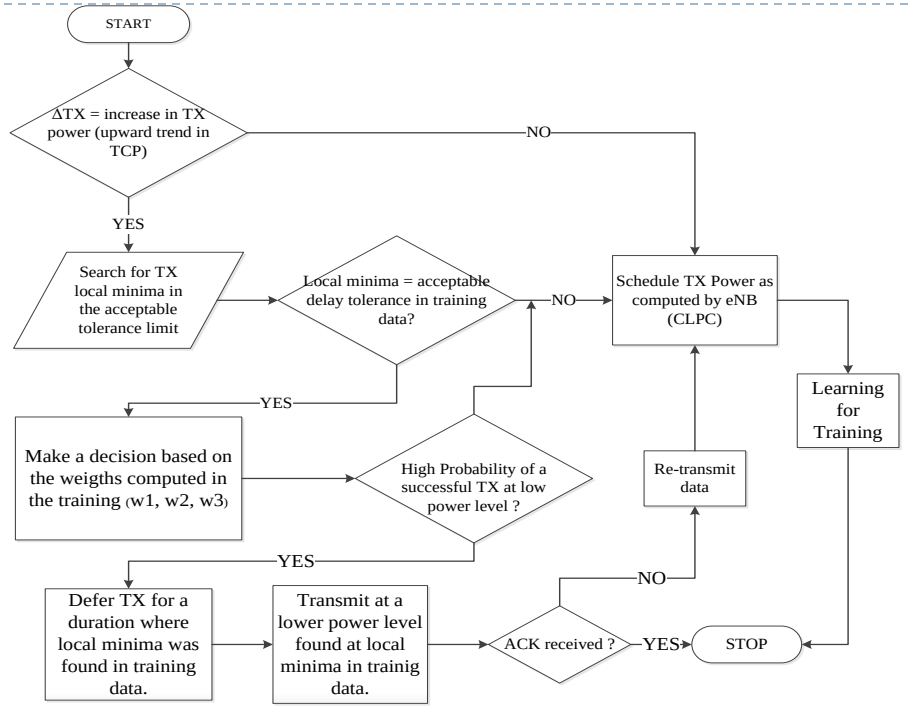

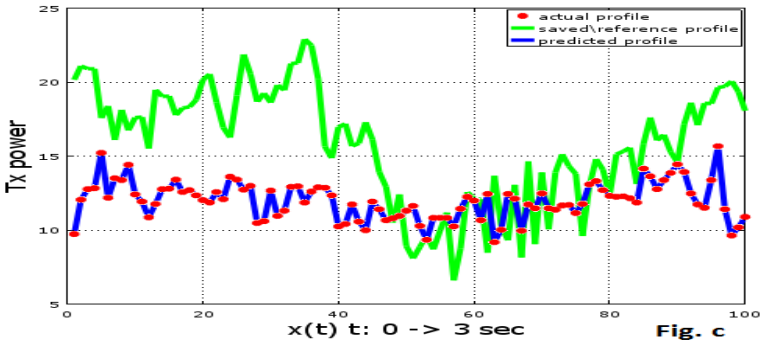

Fig. c

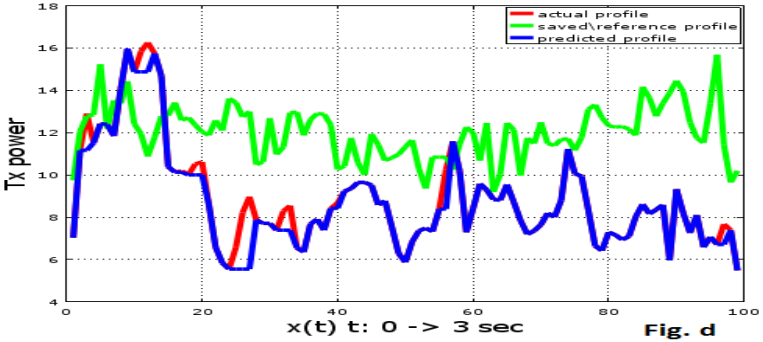

Fig. d

Conclusions

- A cross layer method to optimize LTE TX power for delay insensitive applications (Background Traffic) has been proposed.
- Logistic regression based prediction was used to find an optimal LTE TX power based on trained data for a specific geographical location.
- This idea will contribute to enhance the battery life of the DUT, use resource of the network efficiently.
- It finds a strong use case in IoT devices wherein battery life is very critical and data is delay insensitive in nature.

References

- Mobility Prediction Method for vehicular network using markov chains Arfah Hasbollah*, Sharifah H. S. Ariffin, N. Fisal
- Dowling, Martin. "Location aided wireless signal characteristic adjustment." U.S. Patent Application No. 10/74