**Performance Analysis of Uplink Scheduling Algorithms in**

**LTE Networks**

Scheduling is referring to the process of allocating resources to User Equipment based on scheduling algorithms that is located at the LTE base station. Various algorithms have been proposed as the execution of scheduling algorithm, which represents an open issue in Long Term Evolution (LTE) standard. This paper makes an attempt to study and compare the performance of three well-known uplink schedulers namely, Maximum Throughput (MT), First Maximum Expansion (FME), and Round Robin (RR). The evaluation is considered for a single cell with interference for three flows such as Best effort, Video and VoIP in a pedestrian environment using the LTE-SIM network simulator. The performance evaluation is conducted in terms of system throughput, fairness index, delay and packet loss ratio (PLR). The simulations result show that RR algorithm always reaches the lowest PLR, delivering highest throughput for video and VoIP flows among all those strategies. Thus, RR is the most suitable scheduling algorithm for VoIP and video flows while MT and FME is

appropriate for BE flows in LTE networks.

**Maximum Throughput (MT) Scheduler**

The MT is used to maximize the overall throughput by continually assigning each RB to UE that is

capable of maximizing the overall throughput in the current TTI interval. In MT scheduler, UE with the

highest value of CQI will be served first with the required RBs. Thus, UEs with poor CQI values (such as

cell-edge users) are not assigned with sufficient resources. Such UEs will suffer from low throughput, and

even starvation may occur (11). The metric calculation of MT is expressed as:

𝑚𝑖,𝑘

𝑀𝑇 i

Mi,k = 𝑑 k (t)

where, m\_(i,k)^MT presents the metric of the i-th user on the k-th RB and d\_k^i (t) is the expected data-rate for the i-th user at time t on the k-th RB.

VoIP flows are used for real time services while infinite-buffer as known as

Best effort (BE) flows represented the non-real time. VoIP flows have much stricter delay requirement than

that of video and BE flows. Packets transported by a dedicated radio bearer are generated at the application

layer by three different traffic generators; trace-based, VoIP and infinite-buffer. The trace-based application

delivers packets based on video trace files, which are obtained from (7). The voice flows of G.729 are

generating VoIP application. An ON/OFF Markov chain is modeled for the voice flow, where the mean value

of 3 s is distributed exponentially with the ON period and the OFF period has a truncated exponential

probability distribution function with an average value of 3 s and an upper limit of 6.9 s (18). The source

delivers 20 bytes sized packets every 20 ms during the ON period, as the standard source data rate is 8 kbps,

while the data rate is zero during the OFF period because of the Voice Activity Detector. Finally, the Infinite-

Buffer application model demonstrates a greedy source that constantly possesses packets to be delivered (7).

The performance of MT, FME and RR algorithms is evaluated based on throughput, fairness index,

packet delay and PLR. The Fairness index is calculated using Jain’s fairness index method (19) and it is

expressed as:

N 2 2

FI=(Σxi) / N (Σxi)

1 1

where xi is the throughput assigned to user i among N competing flows

The performance metric of throughput (in Mbps) represents the rate of successful packet being

delivered over physical channel. The parameter is calculated by dividing the number of successfully received

bits with the duration of the flow and can be mathematically expressed as:

K T

Throughput =(1/T)Σ Σ ptransmiti(t)

i=1 i=1

where ptransmiti (t) is the size of transmitted packets of user i at time t, K is the total number of

users and T is the total simulation time. A single cell of 1 km of radius with eNode B located at the centre of

the cell is modelled. The number of UE is varied from 10 to 50. Each UE is handling three flows which are VoIP, video and BE. The movement of UE in the cell is adopting the random direction

model. The speed is set to 3 km/h, which resembles the pedestrian scenario.

This paper has studied the performance of three different scheduling algorithms for real-time and

best effort services using the LTE-SIM. The study compares the performance of three scheduling algorithms,

namely the MT, FME and RR for the performance metrics of throughput, packet delay, PLR, and fairness.

The best effort, video and VoIP traffic are delivered by each UE in the pedestrian environments that is

moving at 3 km/h. For RT Traffic, MT and FME have the highest packet loss ratio value and the lowest

throughput. Therefore, these algorithms may be a good solution for non-real-time flows but is unsuitable to

handle the RT multimedia services. RR algorithm reaches the lowest PLR among all those strategies and is the most suitable for VoIP flows and video flows. This study shows the importance of a good scheduling strategy in a network base station.