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CAPACITY ANALYSIS FOR 2G, 3G AND FREQUENCY DIVISION DUPLEXING FOR A NODE ACCORDING TO THE USER PROFILE

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ABSTRACT

At Dialog Axiata PLC, the transmission division has to decide the capacity for each service that they provide to the customers. In order to that, they have defined a scale of capacity for each service. They recommend those capacity values for all links in Sri Lanka. But when we consider about the customer base variation in Sri Lanka, it is inefficient to provide the same capacity for the whole country. Further, there may have areas which have excess link capacity and also shortage of the link capacity. To avoid this problem, a research has been done based on the customer utilization. An analysis has been done to calculate the capacity for a node with respect to the services by calculating the throughput of each service in the busy hour of a month. To find out the busy hour, data for a month have been analyzed according to 2G, 3G and FDD. By doing this kind of an analysis the company can save their expenses, and also this will help to improve their quality of the service and reputation.

Key words: Throughput, Busy hour, Code tree, Spreading factor, HSDPA, Resource block

1. INTRODUCTION

Normally, capacity for a site depends on the services which are provided to those sites. In Dialog Axiata PLC, they have constant capacity value for each service. But the capacity which needs for a site depends on the number of users in that area. Because of that, we can provide different capacities for each service depending on the number of users in the area. Since all the sites have equal capacity for each service there are several disadvantages. In rural areas, there may have excess capacity for a site. It is an additional cost for the company. But in urban areas, there might be lack of capacity. It will be a reason to decrease of the quality of the service. Accordingly, it will affect the income of the company directly.

The company use Key Performance Indicator (KPI) analysis to measure the variation of the customer usage. These KPI analyses handle by the Network Planning division. It uses to identify view of the network. Using KPI analysis cellular operators can cover their networks. There are simple counters which based on an equation for each service. In 2G time slots occupancy, in 3G OVSF (Orthogonal Variable Spreading Factors) utilization and in FDD resource block utilization was obtained using KPI analysis. It helps to give more purposive measurements of performance. KPI data per cell and KPI data per BSC can be obtained[1].

2. METHODOLOGY

Using KPI the data need for 2G,3G, FDD measurements have been collected. To calculate 2G throughput, time slots occupancy in a node has been collected according to each cell. Since the 3G was based on code tree, spreading factor utilization by using KPI measurements. Downlink PRB usage was obtained to calculate the throughput of FDD using KPI counters[1].

Throughput of voice in 2G was calculated using Erlang B table because the relevant data observed in erlangs by using KPI analysis. The number of time slots can be finding out using Erlang B table. Further four steps to illustrate way of using erlang B table[3].

1. Collect traffic data
2. Determine the average busy hour
3. Choose a target GOS
4. Use Erlang B table

To find out the throughput for GPRS data and voice codec the speeds were used in Dialog Axiata PLC was 20Kbps and 12.2Kbps. Temporary block flow utilizations were used to find out throughput of GPRS. Following equations used for the throughput calculations for 2G

$$\text{Throughput for Voice} = \text{number of channel} \times 12.2\ \text{Kbps} \quad (1)$$

$$\text{Throughput for GPRS using TBF} = \text{number of time slots} \times 20\text{kbps} \quad (2)$$

$$\text{Average Throughput ABC Node} = \text{Maximum For Voice} + \text{Maximum for GPRS} \quad (3)$$

The techniques in Code tree were used to calculate 3G throughput in a link. According to the data observed from KPI analysis about spreading factor (SF) utilization the number of busy codes and number of blocked codes were measured. The spreading factor is different according to the service. Bellow table 01 shows the spreading factor and type of modulation in order to services[4,5].

Table 01: Modulation and SF analysis

Services	SF for Down link	SF Up link	Modulation
AMR speech half rate	256	128	QPSK
Speech	128	64	QPSK
CS 64 (video)	32	16	QPSK
PS 64	32	16	QPSK
PS 128	16	8	QPSK
PS 144	16	8	QPSK
HSDPA	16	8	16 QAM

Table 02: Data rate and Modulations types for each SF

Spreading Factor	Data rate	Modulation Used
256	0.03	QPSK
128	0.06	QPSK
64	0.12	QPSK
32	0.24	QPSK
16	1.44	16QAM
8	0.96	QPSK
4	1.92	QPSK

$$\text{Data rate} = \frac{3.84}{SF} \times \text{No of bits according to Modulation} \quad (4)$$

$$\text{Throughput per Second} = \frac{3.84}{SF} \times \text{No. of bits order to Modulation} \times \text{No of codes} \quad (5)$$

In HSDPA using (SF = 16) there is special calculation because of the TTI (Transmission Time Interval). TTI has equal three codes in SF 16[4,5,6]. There for the throughput calculation for SF 16 is differ from above equation as in bellow equation 6.

$$\text{Throughput per second in SF 16} = \text{bit rate} \times \text{No. of TTI} \quad (6)$$

$$\text{Number of TTI} = \frac{\text{Number of used codes}}{3} \quad (7)$$

The procedure used for the throughput calculations for FDD is shown[7].

Subcarrier spacing = 15 kHz

Time Period = 0.5 ms

Number of subcarrier per RB = 12

One Resource Block = 12 × 7 = 84 Resource element (with normal PC)

Bandwidth of a RB = 12 × 15 = 180 kHz

One Resource Block = 12 × 7 × 2 = 168 Symbols per ms (normal PC)

Modulation used = 64 QAM (6 bits per symbol)

$$\text{Throughput for single chain} = \frac{168 \times \textit{Number of used RB} \times 6 \times 1000}{10^6} \text{ Mbps.} \quad (8)$$

When using 2×2 MIMO throughput = 2 × Throughput for single chain[7] (9)

$$\text{Effective Throughput} = \text{Total throughput} \times \frac{75}{100}$$

When using 10MHz, Number of RBs in 0.5ms time = 50

Total number of RBs in 1s = 50 × 2 × 1000 = 100000

Number of used PRBs = Total PRB Usage × Total PRB available in time period × 10^{-2} (10)

3. RESULTS AND DISCUSSION

Table 03: Maximum capacity values and busy hour

Services	Date	Time (h)	Maximum capacity (Mbps)
2G	2016/1/13	22.00	3.1611
3G	2016/1/03	02.00	42.28
FDD	2016/1/02	01.00	55.21

Table 04: Maximum capacity of each service due to each busy hour

Date	Time	2G (Mbps)	3G (Mbps)	4G (Mbps)	Total (Mbps)
2016/1/13	22.00	3.1611	38.34	11.32	52.82
2016/1/3	02.00	0.1164	42.28	36.63	79.02
2016/1/2	01.00	0.000	40.72	55.21	95.93

It was possible to determine the maximum value of capacity for each service in busy hour. The busy hour was selected from the same data set by using maximum utilization of each service. According to the calculations the table no.03 shows the maximum data rates which used in a period of the month. In order to above table 04 it is clearly understand that maximum value for the Node was 95.93 Mbps.

4. CONCLUTION

Dialog Axiata PLC uses capacity value of 100Mbps for a node which has both 3G and FDD and 50Mbps for a node which has only 3G and 2G services. According to this research, it could be obtained the actual capacity values which used in each service. Also it is clearly identified the busy hours for each service. Although it was necessary to decide initial capacity for a link, after doing this kind of calculation it is easy to decide correct capacity for a link at present and future. Further this research can be extended to according to rural and urban areas of the country. Doing such work, it will give many advantages for the company. And also this can be done for different district and provinces in Sri Lanka. Also we can find congestion of the link and find out how much of capacity should be added to those values. From this type of work, the optimum and the most suitable capacity for a node can be defined according to the areas.

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