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Enhancement of E-GSM Channel Capacity with Function Diversion of 3G to 2G Frequency

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A B S T R A C T

The main observation of this reserch is the installation and analysis of frequency function diversion from 3G to 2G network to enhance the Channel capacity. The frequency 850 MHz that is previously owned by Telkom Flexi, then shifted to belong to Smartfren and will be transferred to become 2G GSM operated by Telkomsel Madura. The result shows that the transfer process of the frequency function goes well. This produces that the average value of drive test before diversion are Rx Level = 87.969%, Rx Qual = 87.791%, SQI = 80.809%. The average value of drive test after diversion are Rx Level = 91.967%, Rx Qual = 89.926%, SQI = 82.049%. The traffic value before diversion is 503.296 Erlang and 627 Erlang for after diversion. While the blocking before diversion is 24.36% and the blocking after diversion is 1.6%.

Keywords: Enhancement, Channel Capacity, Frequency Function Diversion.

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1. Introduction

The development in telecommunication network system widely affects through the world. The increasing of subscribers of any services must be followed by good coverage, capacity and quality of service. The telecommunication technology moves on from 2G, 3G up to 4G. It causes the old technology slowly is abandoned.

But this fact is not suitable to Madura Island. Madura island consists of 4 regencies (Bangkalan, Sampang, Pamekasan and Sumenep). Almost of them are included into regencies that the indigence level is very high. 2G handset users are still very high. The majority of Madura people use telephone and SMS as the main telecommunication activities. The population of handsets in Madura, according to Telkomsel Paper Lesson Learned Sharing: Network Service Optimization of 2G GSM on Telkomsel Madura Using E-GSM Band, is shown in figure 1.

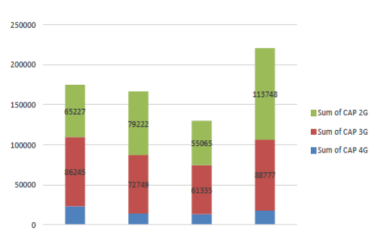

Figure 1. Graph of Handsets population in Madura, November 2016

The high demand of 2G network in Madura must be anticipated in order to provide good service to the subscriber. One methode that is proposed to be applied in this research is E-GSM frequency function diversion to enhance channel capacity of 2G network. The ex-smartfren frequency is used in expanding capacity of Telkomsel Madura, while the smartfren applies 4G.

This research idea begins from other researchs especially in analysis, planning and optimization of telecommuniation network. There is many research in analysis and optimization of telecommunication networks. In network performance analysis and network planning analysis, there are papers for example, comparative analysis and RF planning in mobile communication on different sites with drive test based assessment proposed by Govind and Sonika, (2015), analysis of methods in capacity improvement of GSM network observed by Nura, (2015), comparative analysis of signal strength of GSM and IS-95 CDMA Network observed by Makanjuola et. al., (2015), review on 2G, 3G and 4G radio network planning observed by Tushar et. al., (2013), interference analysis of CDMA network with dynamic channel assignment algorithm observed by Ohaneme et. al., (2012), analysis of short call drive test of GSM network observed by Atif et. al., (2015), and capacity enhancement metods review in cellular systemproposed by Bharat et. al., (2011).

In network performance optimization, there are many papers such as, GSM network performance enhancement with intelligent optimization method and drive test based proposed by Richa et. al., (2012), GSM access network evaluation and performance optimization proposed by Mudassar

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et. al., (2010), cellular network optimization with frequency reuse technique proposed by Adegoke et. al., (2015), capacity enhancement of CDMA network with cell splitting technique proposed by Sohrab et. al., (2013), efficiency improvement and handover performance optimization of GSM network proposed by Arulananth et. al., (2015), identifying the causes of call setup failure in GSM service test area and necessitate steps to increase the call success rate with drive test based observed by Syed et. al., (2014), minimizing the hand off failure probability by increasing the total number of channels with help cell splitting proposed by Ranjan and Debabrata, (2015), and coverage optimization of CDMA network in South-Eastern Nigeria proposed by Shoewu et. al., (2011). This research proposes to optimize and enhance the channel capacity of E-GSM by diverting the frequency function from 3G to 2G Network and then to analyze the performance through drive test.

2. Methodology

The main idea of this research is frequency function diversion of 3G to 2G network, to enhance channel capacity with E-GSM in Telkomsel Madura. The sites that are observed are shown in table 1.

Table 1. Observed Sites

Site Name	Cell Name
Pademawu	Pademawumg2
Taroan	Taroanmg1
Samatanproppotbg	Samatanproppotbg1
Samatanproppotbg	Samatanproppotbg3
Kardulukpragaantbg	Kardulukpragaantbgmg3
Pademawu timur	Pademawu timur-0
Pademawu timur	Pademawu timur-3
Kalianget	Kaliangetmg1
Kalianget	Kaliangetmg2
Batangbatangmadura	Batangabatangmaduramg2
Marengan daya	Marengan daya-0
Marengan daya	Marengan daya-1
Babangapurapti	Babangapuraptimg1
Andulanggapuratbg	Andulanggapuratbgmg3

Upgrading TRX is applied by taking and using the Smartfren frequency that is diverted and shown in table 2. The observation is applied by drive test before and after frequency function diversion process. Then, the next observation is about the value of traffic and blocking probability of the cellular network before and after frequency function diversion process.

Table 2. Applied ARFCN (Absolute Radio Frequency Channel Number) on E-Band

Operator	Smartfren			Guard Band (~1 MHz)		
ARFCN	975	...	1006	1007	…	1011
UL Frequency	880.2	...	886.4	886.6	…	887..4
DL Frequency	925.2	...	931.4	931.6	…	932.4

The quality parameters of drive test are described by:

Rx Level (Received Signal Level): the level of received signal of each signal emmission.

$$R_x Level = \frac{Sample}{Total\ Sample} X100\% \quad (1)$$

Rx Qual (Received Signal Quality): the quality of received signal that is measured from Bit Error Rate (BER).

$$R_x Qual = \frac{Sample}{Total\ Sample} X100\% \quad (2)$$

SQI (Signal Quaity): the quality level of voice at the time of call.

$$SQI = \frac{Sample}{Total\ Sample} X100\% \quad (3)$$

The observation result is compared to the standard of Key Performance Information (KPI) that is applied by Service Quality Assurance Department, ICT Network Management, East Java Division of Telkomsel.

Table-3. The KPI standard of Telkomsel

KPI	Quality (Colour)				
	Very Good	Good	Enough	Bad	Very Bad
Rx Level	-75 to -10	-85 to -75	-95 to -85	-100 to -95	-120 to -100
Rx Qual	0 to 2	2 to 4	4 to 6	-	6 to 7
SQI	18 to 30	-	0 to 18	-	-18 to 0

Other performance parameters are defined by offered traffic, blocking probability and the use of time slot, that is observed before and after frequency function diversion process. The blocking probability parameter is also measured specially on TCH (Traffic Channel) and SDCCH (Standalone Dedicated Control Channel) that is observed in 3 weeks after the frequency function diversion.

3. Result and Discussion

The result of the research can be defined as upgrading TRX and the change of configuration before and after
frequency function diversion process. It is described as follow,

Site Pademawu. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 14 TRX with configuration 4/6/4. Upgrading TRX is applied on ARFCN 997 and 999.

Site Taroan. The capacity before diversion is 21 TRX with configuration 4/6/6/5 and capacity after diversion is 23 TRX with configuration 6/6/6/5. Upgrading TRX is applied on ARFCN 1000 and 1004.

Site Samatan Proppo. The capacity before diversion is 14 TRX with configuration 4/6/4 and capacity after diversion is 18 TRX with configuration 6/6/6. Upgrading TRX is applied on ARFCN 989, 991 and 993, 995.

Site Karduluk Pragaan. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 16 TRX with configuration 4/4/8. Upgrading TRX is applied on ARFCN 1003, 1005, 1009 and 1011. Site Pademawu Timur. The capacity before diversion is 12 TRX with configuration 3/3/3/3 and capacity after diversion is 18 TRX with configuration 6/3/3/6. Upgrading TRX is applied on ARFCN 990, 992, 998 and 994, 996, 1000.

Site Kalianget. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 16 TRX with configuration 6/6/4. Upgrading TRX is applied on ARFCN 995, and 997.

Site Batang Batang Madura. Capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 16 TRX with configuration 4/8/4. Upgrading TRX is applied on ARFCN 989, 991, 993 and 995.

Site Marengan Daya. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 18 TRX with configuration 8/6/4. Upgrading TRX is applied on ARFCN 994, 996 and 1002, 1010. Site Babangapurapti. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 14 TRX with configuration 6/4/4. Upgrading TRX is applied on ARFCN 988 and 990.

Site Andulanggapura. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 14 TRX with configuration 4/4/6. Upgrading TRX is applied on ARFCN 993 and 995.

The descriptions show that all frequency function diversion process from 3G to 2G network to enhance channel capacity with E-GSM in Telkomsel Madura is successful. The next step is assessment process to examine the performance of the frequency function diversion process. The first assessment is defined from the drive test result that is shown in table 7. The example of drive test results is shown by table 4 for Rx Level, table 5 for Rx Qual and table 6 for SQI. All of the examples are taken from site Pademawu.

Table 4. Rx Level values of the drive test result on site Pademawu.

	Range	Before	After
RxLevel	-75 to -10	96.91%	99.40%
	-85 to -75	3.09%	0.60%
	-95 to -85	0.00%	0.00%
	-100 to -95	0.00%	0.00%
	-120 to -100	0.00%	0.00%
	Total	100.00%	100.00%

Table-5. Rx Qual values of the drive test result on site Pademawu

	Range	Before	After
Rx Qual	0 to 2	90.35%	91.34%
	2 to 4	3.38%	3.78%
	4 to 6	3.52%	3.81%
	6 to 7	2.75%	1.06%
	Total	100.00%	100.00%

Table-6. SQI values of the drive test result on site Pademawu

	Range	Percentage	Percentage
SQI	18 to 30	81.82%	84.42%
	0 to 18	17.92%	15.58%
	-18 to 0	0.26%	0.00%
	Total	100.00%	100.00%

Table 7 shows that the performance of the diversion process is good. The best mean value of Rx level increases from 87.969% to 91.967%. The best mean value of Rx Qual also increases from 87.791% to 89.92%. so does the best SQI mean value, from 80.809% to 82.49%.

Table-7. The mean value of Rx Level, Rx Qual and SQI of observed sites

KPI	Range	Before	After
RX Level	-75 to -10	87,969%	91,967%
RX Qual	0 to 2	87791%	89.92%
SQI	18 to 30	80809%	82.49%

Besides that, the performance of the frequency function diversion process is shown by figure 2 that shows about offered traffic value before and after diversion process and figure 3 that shows about blocking probability before and after diversion process.

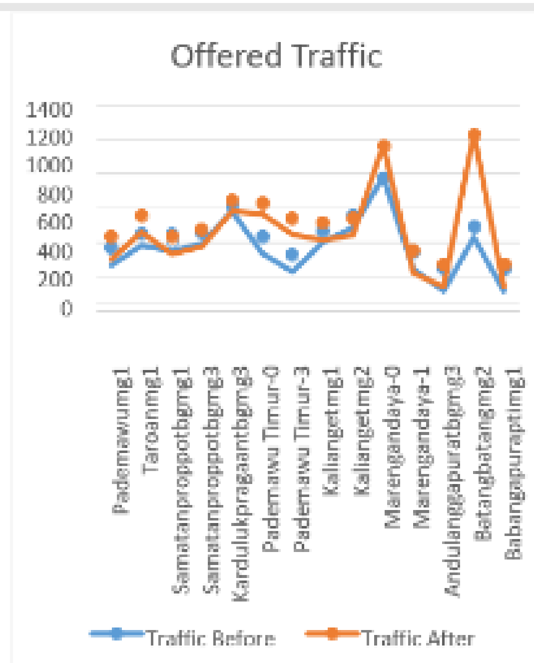

Figure 2. Graph of offered traffic before and after diversion process

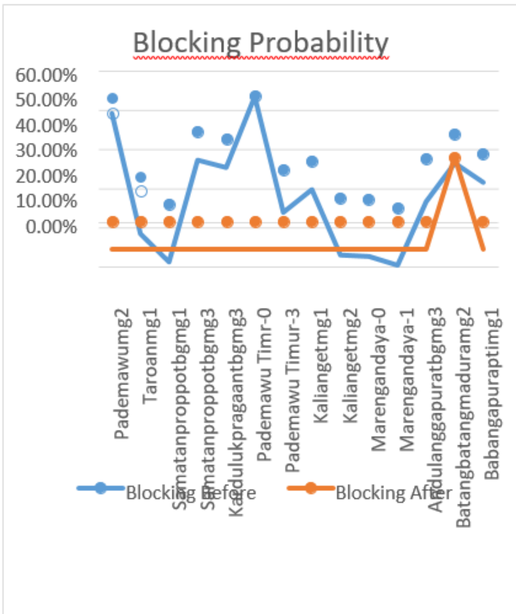

Figure-3. Graph of blocking probability before and after diversion process

From figure 2, the offered traffic after diversion process is greater than before diversion process. The mean of offered traffic before diversion process is 503.296 E and it becomes 627 E for after diversion process. It means that the channel capacity after diversion greater than before and the diversion process is successful.

From figure 3, the blocking probability after diversion process is lower than before diversion process, even almost all of the values are zero. The mean of blocking probability before diversion process is 24.36% and it becomes 1.6% for after diversion process. It means that the channel capacity after diversion greater than before and the diversion process is successful.

The blocking probability is also measured specially on TCH (see figure 4) and SDDCH (see figure 5).

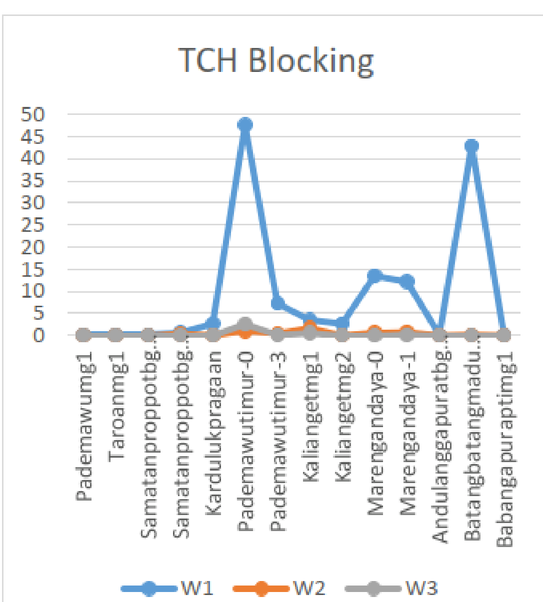

Figure-4. The blocking probability of TCH

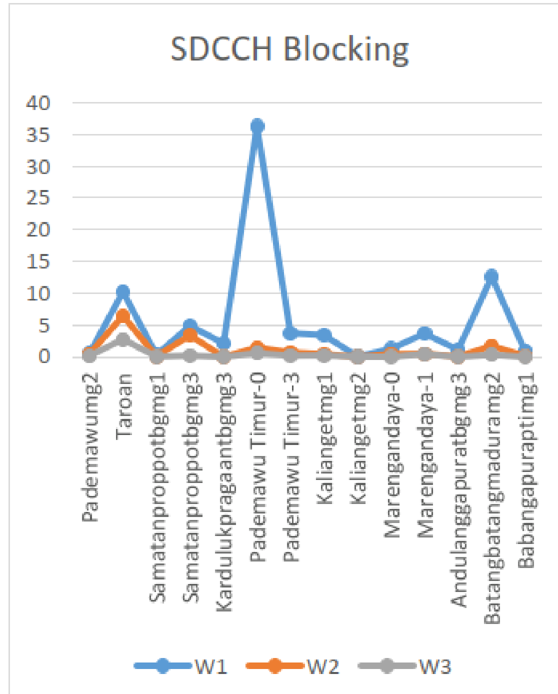

Figure-5. The blocking probability of SDCCH

From figure 4 and figure 5, the blocking probability of TCH and SDCCH were observed in one week before diversion process (W1), in the week of diversion process (W2) and one week after diversion process (W3). Both of them show that the blocking probability before diversion process of frequency function are high. But they decrease deeply after diversion process. It shows that the channel capacity has been enlarged and the diversion process is successful.

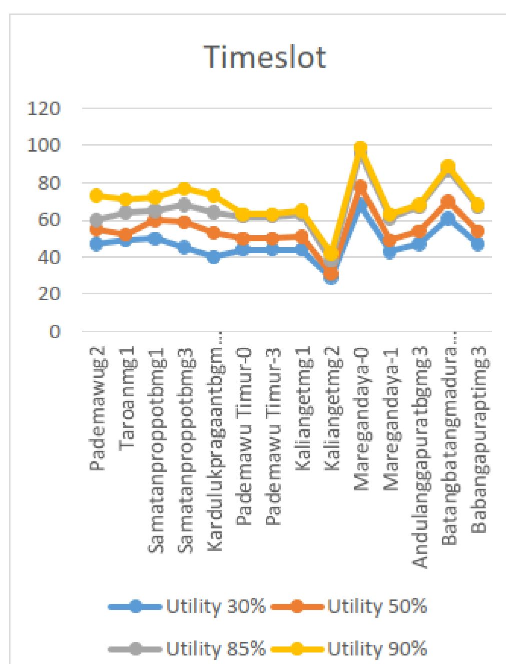

Figure-6. Graph of time slot number that is used with different network utility after diversion process of frequency function

Figure 6 shows about the use of time slot that is measured after diversion process of frequency function, with different network utility. When the network utility increases from 30% up to 90%, then the use of time slot also increases linearly. It means, the enhancement of E-GSM channel capacity compresses the blocking probability.

4. Conclusion

The diversion process of frequency function from 3G to 2G network on Telkomsel Madura is successful. It increases the channel capacity of 2G network in there. It is supported by proofs that :

1. The best mean values of Rx Level, Rx Qual and SQI of the drive test after diversion are higher than before diversion.
2. The mean of network blocking probability after diversion is lower than before diversion.
3. Even specifically, the blocking probability of TCH and SDCCH after diversion are lower than before diversion. 4. The mean value of offered traffic after diversion process is greater than before diversion process.
4. The use of time slot increases linearly to the increasing of the network utility, even almost no blocking.

REFERENCES

[1] Adegoke A. S., Babalola I. T., and Onasanya M. A., 2015. Optimization of Cellular Network System Using
[2] Frequency Reuse Technique. Journal of Information Engineering and Applications, vol. 5, No. 1 : 8-12.
[3] Arulananth T. S., Jaya S., Gangatharan N., Baskar M., 2015. GSM Optimization of Coverage Area using Agilant Tool. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 4, issue 5 : 4093-4098.
[4] Atif M. J., Khalid H. B., and Amin B. M., 2015. QoS of Short Call Drive Test. International Journal of Engineering, Applied and Management Sciences Paradigms, vol. 22, issue 01 : 117-123.
[5] Bharat B., Ajay K., and Amit K. G., 2011. Capacity Enhancment in Cellular System – A Review. International Journal of Network and Mobile Technologies, vol. 2, No. 2 : 91-106.
[6] Govind S., and Sonika S., 2015. A Review on Drive Test and Site Selection for Mobile Radio Communication. International Journal of Advanced and Innovative Research, vol. 3, issue 5.
[7] Makanjuola N. T., Shoewu O. O., Akinyemi L. A., and Ajasa A. A., 2015. Comparative Analysis of GSM Network and IS-95 CDMA Network Using Signal Strength. The Pacific Journal of Science and Technology, vol. 16, No. 1 : 159-172.
[8] Mudassar A., Asim S., and Adeel A., 2010. Radio Access Network Audit and Optimization in GSM (Radio Access Network Quality Improvement Techniques). International Journal of Engineering and Technology (IJET-IJENS), vol. 10, No. 01 : 55-58.
[9] Nura M. S., 2015. Coverage and Capacity Improvement in GSM Network. International Journal of Novel Research in Electrical and Mechanical Engineering, vol. 2, issue 3 : 57-62.
[10] Ohaneme C. O., Idigo V. E., Nnebe S. U., and Ifeagwu E. N., 2012. Analysis of Interference and Channel Capacity in A CDMA Wireless Network Using Dynamic Channel Assignment (DCA) Strategy. International Journal of Computer Networks and Communications, vol. 4, No. 5 : 149-163.
[11] Ranjan K. M.,and Debabrata S., 2015. Co-Centric Cell Splitting Technique Usingg Frequency Reuse. International Journal of Future Generation Communication and Networking, vol. 8, No. 5 : 231-238.
[12] Richa C., Jyoti K., and Prakash P., 2012. Intelligent Optimization of GSM Network. International Journal of
[13] Engineering Science and Innovative Technology, vol. 1, issue 2.
[14] Shoewu O., Adedipe A., Edeko F.O., 2011. CDMA Network Coverage Optimization in South-Eastern Nigeria.
[15] Amerian Journal of Scientific and Industrial Research, 2(3) : 346-351.
[16] Sohrab A., Ashish M., Mohd G. S., and Tauheed Q., 2013. Capacity Improvement by Cell Splitting Technique in CDMA System over Telecommunication Network. International Refereed Journal of Engineering and Science, vol. 2, issue 7 : 01-08.
[17] Syed S., Banani T., and Rajat P., 2014. RF Optimization for Call Setup and Analysis of GSM Network Using Agilent Tools. International Journal of Science and Research, vol. 5, issue 2 : 1556-1559.
[18] Tushar S., and Jadon J. S., 2013. Review on 2G, 3G and 4G Radio Network Planning. International Journal of Engineering, Business and Enterprise Applications, 84-89.