OPTIMIZATION OF 3G WCDMA BASE STATIONS IN BANGKOK, THAILAND

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Abstract:
The objective of this study is to calculate the optimized 3G base stations sufficient for users in Bangkok by using WCDMA technology. Three forecasting methods: Linear method, Holt's method and Decomposition method have been applied to investigate usages' tendency in three services: CS AMR, HSDPA and HSUPA. The method which has the least Mean Absolute Percent Deviation is selected and then the quantities of usages at the end of 2014 are forecasted. The number of base stations in Bangkok is considered to calculate base stations divided into 50 districts. A mathematical model has been applied by using Excel Solver 2010 to identify the optimal solution. The calculation results are 2,452 stations increasing 845 stations from current stations. The simulation program Mentum CellPlanner has been applied to calculate the level and quality of signal. The simulation results show that the level of signal CPICH RSCP from 0 to -85 dBm is 82% and the quality of signal CPICH Ec/No from 0 to -14 dB is 86% which are above acceptable levels.

Keywords: base stations management, propagation delay problem, mobile user forecasting, Mentum CellPlanner simulation

1. INTRODUCTION

At present, telecommunication network service providers in Thailand are moving to the next level. After 3G auction in Oct, 2011, lots of users have been interested in getting 3G service causing more traffic congestion. One of telecommunication network service providers determined quantities of usages at the end of 2014 would be 10 times comparing to the beginning of 2012. According to increasing users, the optimized 3G base stations would provide sufficient telecommunication network service for users in Bangkok by using WCDMA technology.

2. RESEARCH METHOD

2.1. Collect data

Quantities of usages from the 5th week in 2012 to the 46th week in 2013 were collected in three services: CS AMR, HSDPA and HSUPA. Areas of each district in Bangkok were considered.

2.2. Comparing 3 forecasting methods

Three forecasting methods which were Linear method, Holt's method and Decomposition method were compared by mean absolute percentage deviation (MAPD). The method which had the least MAPD would be selected.

2.3. Forecasting mobile service usages

The quantities of usages at the end of 2014 were forecasted from selected forecasting method in order to calculate the optimized 3G base stations in Bangkok.

2.4. Determining the sufficient base stations in Bangkok

Radius of base station was calculated from Okamara-Hata propagation; then, the number of sufficient base stations in Bangkok was determined. Both uplink and downlink pathlosses were calculated and compared to areas in Bangkok and compared to forecasted quantities of usages at the end of 2014 by using Excel Solver 2010 to identify cell load. After that determining whether or not cell load exceeded specification.

2.5. Determining the number of base stations divided into 50 districts

Divided the number of base stations into 50 districts due to portion of quantities of usages in the 46th week in 2013.

2.6. Determining level of signal and quality of signal

Located base stations according to the number of base stations in each districts by the simulation program Mentum CellPlanner which selected crowded usage areas and distance between new base stations and current base stations should not over 600 m. Then, the level and quality of signal were calculated and determined whether or not both of them were above specification.

3. RESULT

MAD and MAPD of 3 forecasting methods were as shown in table 1. Due to MAPD of Holt's method in all services were the lowest, Holt's method would be selected to forecast the quantities of usages at the end of 2014 and the results were as shown in table 2.

Table 1: MAD and MAPD of 3 forecasting methods

Service	Method	MAD	MAPD
CS Amr	Linear	208,449.1413	0.1310
	Holt's	133,450.0959	0.0845
	Decomposition	205,574.5459	0.1292
HSDPA	Linear	32,137,063.4800	0.0763
	Holt's	31,718,022.5300	0.0753
	Decomposition	33,360,395.3900	0.0792
HSUPA	Linear	11,774,537.2200	0.1876
	Holt's	4,515,127.2110	0.0719
	Decomposition	5,868,614.5470	0.0935

Source: A case study of telecommunication network service provider

Table 2: Forecasting result in 3 services

Usages	CS Traffic (Erlang)	HSDPA Traffic (Mbyte)	HSUPA Traffic (Mbyte)
Actual usages in the 5th week in 2012	427,375.76	90,344,999.40	11,263,850.83
Forecasting usages in the 52th week in 2014	3,418,778.94	1,144,078,944.38	172,525,078.54
Increasing usages	2,991,403.18	1,053,733,944.98	161,261,227.71
Increasing usages (%)	700%	1,166%	1,432%

Source: A case study of telecommunication network service provider

From forecasting usages result in the 52th week in 2014, CS service requirement was substituted to calculate CS cell load. By using Excel Solver 2010, the number of base stations was 2,429. The downlink cell load was 63% which did not exceed limit at 70% and the uplink cell load was 50% which did not exceed limit at 50%. Both HSDPA and HSUPA cell loads also did not exceed limit. The number of base stations was divided into 50 districts as shown in table 3. There were 845 base stations increasing from current stations. The simulation program Mentum CellPlanner results showed that the level of signal CPICH RSCP from 0 to -85 dBm is 82% and the quality of signal CPICH Ec/No from 0 to -14 dB is 86% which were above acceptable levels as shown in table 4 and 5.

Table 3: the number of base stations in 50 districts

District	CS Traffic (Erlang)	Portion of quantities of usages	Weighted forcasting base stations	Current base stations	Different
Bang Bon	48,188.63	0.020	50	26	24
Band Sue	36,633.27	0.015	38	23	15
Huai Khwang	65,482.11	0.028	68	52	16
Bang Khen	65,818.51	0.028	68	38	30
Bang Kapi	82,283.83	0.035	85	63	22
Bang Khun Thian	80,512.88	0.034	83	42	41
Don Mueang	41,614.40	0.018	43	23	20
Khan Na Yao	29,984.11	0.013	31	16	15
Bang Khae	58,050.28	0.025	60	31	29
Bang Rak	54,296.84	0.023	56	63	-7
Bang Na	47,379.13	0.020	49	30	19
Khlong San	31,409.01	0.013	33	22	11
Chatuchak	138,924.09	0.059	143	113	30
Chom Thong	44,964.43	0.019	47	28	19
Dusit	40,913.05	0.017	42	30	12
Din Daeng	58,527.31	0.025	61	30	31
Bueng Kum	47,306.62	0.020	49	31	18
Bangkok Noi	53,057.72	0.022	55	29	26
Bang Phlat	31,597.96	0.013	33	18	15
Bang Kho Laem	31,763.39	0.013	33	14	19
Bangkok Yai	19,903.26	0.008	21	10	11
Nong Khaem	40,854.58	0.017	42	20	22
Phaya Thai	47,060.84	0.020	49	42	7
Min Buri	38,492.04	0.016	40	25	15
Wang Thonglang	61,468.35	0.026	64	33	31
Phasi Charoen	44,601.54	0.019	46	27	19
Samphanthawong	16,575.15	0.007	17	9	8
Thon Buri	28,932.46	0.012	30	14	16
Nong Chok	22,220.21	0.009	23	16	7
Pom Prap Sattru Phai	19,621.54	0.008	21	12	9
Watthana	91,531.90	0.039	94	61	33
Phra Nakhon	33,441.37	0.014	35	21	14
Khlong Toei	58,866.63	0.025	61	51	10
Pathum Wan	78,776.16	0.033	81	89	-8
Prawet	68,118.08	0.029	70	38	32
Saphan Sung	28,057.02	0.012	29	15	14
Lat Phrao	43,680.47	0.018	45	24	21
Phra Khanong	19,984.87	0.008	21	13	8
Thung Khru	35,717.99	0.015	37	22	15
Sathon	38,925.54	0.016	40	32	8
Thawi Watthana	26,610.52	0.011	28	17	11
Suan Luang	51,135.78	0.022	53	35	18
Sai Mai	39,511.15	0.017	41	19	22
Khlong Sam Wa	35,242.68	0.015	37	25	12
Lat Krabang	66,152.47	0.028	68	39	29
Ratchathewi	70,970.01	0.030	73	69	4
Taling Chan	35,834.20	0.015	37	24	13
Yan Nawa	43,625.26	0.018	45	30	15
Lak Si	45,547.42	0.019	47	34	13
Rat Burana	28,641.02	0.012	30	19	11
Total	2,368,808.08	1.000	2,452	1,607	845

Source: A case study of telecommunication network service provider

Table 4: the level of signal of before and after increasing base stations

RSCP (dBm)	Before			After		
	Counted point	**Portion (%)**	**Cummulative portion (%)**	**Counted point**	**Portion (%)**	**Cummulative portion (%)**
0 to -65	3,461	45%	45%	3,751	49%	49%
-65 to -80	430	6%	51%	428	6%	54%
-80 to -85	2,161	28%	79%	2,151	28%	82%
-85 to -90	1,033	13%	92%	939	12%	95%
-90 to -95	434	6%	98%	341	4%	99%
-95 to -100	153	2%	100%	72	1%	100%
-100 to -105	15	0%	100%	6	0%	100%
Total	7,687	100%		7,688	100%	

Source: A case study of telecommunication network service provider

Table 5: the quality of signal of before and after increasing base stations

EcNo (dB)	Before			After		
	Counted point	**Portion (%)**	**Cummulative portion (%)**	**Counted point**	**Portion (%)**	**Cummulative portion (%)**
0 to -6	4,589	35%	35%	4,956	39%	39%
-6 to -12	2,444	18%	53%	2,567	20%	60%
-12 to -14	3,489	26%	79%	3,324	26%	86%
-14 to -16	1,618	12%	92%	1,282	10%	96%
-16 to -18	776	6%	97%	426	3%	99%
-18 to -30	336	3%	100%	86	1%	100%
Total	13,252	100%		12,641	100%	

Source: A case study of telecommunication network service provider

4. SUMMARY

Holt's method was selected to forecast the quantities of usages at the end of 2014. Calculating result by using Excel Solver 2010, the number of base stations was 2,429. The downlink cell load, the uplink cell load, HSDPA cell load and HSUPA cell load did not exceed limit. However; after dividing base stations into 50 districts, the number of base stations became 2,452 increasing 53% from current stations. The simulation results showed that the level of signal CPICH RSCP from 0 to -85 dBm and the quality of signal CPICH Ec/No from 0 to -14 dB were above acceptable levels.

REFERENCE LIST

1. Bartlett, A. and N N Jackson. (2002). Network planning considerations for network sharing in UMTS. 3G Mobile Communication Technologies 489:17-21 problem. *Computers & Industrial Engineering 63:*819-830.
2. Bose, R. (2001). A Smart Technique for Determining Base-Station Locations in an Urban Environment. *IEEE Transaction on vehicular technology 50*(1): 43-47
3. Heikkinen T. (2011). Wireless network planning and ther efficiency of price-based network formation in a continuum model. *Sicencedirect Sustainable Computing Informatics And System* 9:305-313
4. Huang, X., U. Behr and W. Wiesbeck. (2000). Automatic Base Station Placement and Dimensioning for Mobile Network Planning. *IEEE Transaction on wireless communications 4*:1544-1549
5. Lin, B. and P.-H. Ho. (2009). Dimensioning and location planning of broadband wireless Networks under multi-level cooperative relaying. I*EEE Transaction on wireless communications 8*(11): 5682-5691

6. Mansour, A. A. (2008). Convolution-Based Placement of Wireless Base Stations in Urban Environment. *IEEE Transaction on vehicular technology 57*(6):3843-3848
7. Siomina, I., P. Varbrand and D. Yuan. (2006). Automated optimization of service coverage and base station antenna configuration in UMTS networks. *IEEE Wireless Communications 13*(6): 16-25
8. St-Hilaire, M. and S. Liu. (2011). Comparison of different meta-heuristics to solve the global planning problem of UMTS networks. *Computer Networks 55*: 2705-2716
9. Wang, J. S., Y.-L. Hsu,H.-Y. Lin and Y.-P.Chen. (2008). Minimal model dimension/order determination algorithms for recurrent neural networks. *Sicencedirect pattern recognition letters 8*:812-819
10. Yang, J., M.E. Aydin, J. Zhang and C. Maple. (2007). UMTS base station location planning: a mathematical model and heuristic optimisation algorithms. *IET Commun 1*(5):1007-1014
11. Yang, M. and W. Shi. (2008). A Linear Least Square Method of Propagation Model Tuning for 3G Radio Network Planning. *IEEE 4*: 150-154
12. Zola, E. and F. Barceló. (2006). About the Location of Base Stations for a UMTS System:Analytical Study and Simulations. *IEEE Journal of communications and networks 8*:49-58