Determining Number of e-Node B for Digital Dividend Public Safety Communication in Jakarta Area

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ABSTRACT

Today, the use of communication system for public safety and regulation purposes is still narrow-band based, that is communication that transmits low-speed voice and data services. Each government agency, such as the government of Jakarta (Pemda DKI), police, health department, fire department, and the national disaster management agency, builds its own network independently. Therefore, it is difficult to coordinate the service between agencies if there is an emergency situation or disaster. Good communication system for public safety services will create conducive condition that will eventually create tranquility in the community. Jakarta, as the capital city of Indonesia, needs communication systems that create such condition. This paper determines the number of e-Node B for 700 MHz digital dividend network for Public Safety Communication services in Jakarta based on LTE technology. The services include voice, video, and data. In this study, it is assumed that determination of the required number of e-Node B is started from year 2012 to 2022 by considering the bit rate required by the public safety officer. The assumption of ratio of public safety officer in Jakarta is based on its population data. Radio network planning is based on coverage approach and capacity approach. The design of its coverage and capacity are analysed by using network dimensioning. Dimensioning coverage is conducted by calculating the link budget for dense urban, and urban areas. We use the 9955 RNP (Radio Network Planning) to calculate the link budget and predict the system's coverage. From the calculation, it is shown that e-Node B number required to cover the Jakarta area is 140. Dimensioning of capacity is based on the services bit rate required by the public safety officer. The services are , voice, video, and data. Traffic profile is based on the assumption in year 2012, 2015, and 2020. By the capacity calculation, it is shown that a total of 49 sites is required.

Keywords: Public Safety Communication, Radio Network Planning, e-Node B, Link Budget, Dimensioning, LTE, Digital Dividend

1. INTRODUCTION

1.1 Background

Public safety is an activity of prevention, treatment and protection against things that harm other people who may have a significant effect, injury, loss or damage such as crime and disaster whether caused by people or nature [1]. Therefore, public safety is important for the creation of a secure and comfortable condition in the community so that it can support national stability.

Public safety communication refers to radio communications used by agencies and organizations dealing with maintenance of law and order, protection of life and property, emergency situations, dealing with a serious disruption of functioning of society, posing a significant widespread threat to human life, health, property or environment, whether caused by accident, natural phenomena or human activity, and whether developing suddenly or as a result of complex long term processes [2]. The growing demand of telecommunication and radio communication by public safety agencies and organizations, including those dealing with emergency situations and disaster relief, is driven by their roles that are vital to the maintenance of law and order, protection of life and property, and emergency response. The current public safety communication is mostly narrow-band supporting voice and low data-rate applications.

Jakarta as the capital city of Indonesia, serves as the center of government and economic center with a high population density, needs to have a system of public safety. Agencies that are related to public safety are the national disaster management agency (BNPB), local government, fire department, law enforcement officers (Police) and health department. For supporting the performance of those government agencies, it is required to have a reliable communication system. In addition to supporting the communication with the high mobility, this system must support the existence of an interoperable and broadband-based service like video calls and multimedia-based communications.

Today, the communication systems in supporting public safety agencies have different standards, such

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as by using different frequency range between 300 - 800 MHz and by using different technologies. The most widely used technologies are the conventional systems, trunking systems, PSTN (Public Switched Telephone Network) and commercial cellular networks. Thus, the existing communication systems in agencies related to public safety do not support the interoperability. Even, in an institution there is no guarantee that the communication system supports the interoperability among its users. A level of interoperability [3] of the system for public safety officer is required to communicate and coordinate with each other.

A study related to deployment of public safety has been done in the united states. In [4], it was demonstrated that a nationwide broadband network that serves local, state, and federal emergency responders would solve the technical interoperability issues. This broadband network uses 10 MHz of spectrum in the 700 MHz. It also demonstrates the estimate cost in the deployment. From the estimation, it was shown that the cost estimate can change dramatically by adjusting a few critical input parameters, which include coverage reliability, building penetration margin, total capacity requirements, maximum data rate, and build-out requirements. That work identified a first-cut estimate of the cell sites required for a nationwide, broadband, public-safety-grade wireless network under a variety of scenarios.

By observing [4], it is important that Jakarta should have its own public safety wireless. Before implementing it, it is required to design the radio network planning that is suitable for the current condition. The first stage of radio network planning is to determine the system's requirements. This paper analyzes the number of e-Node B required by using digital dividend 700 MHz for public safety communications in Jakarta area. The use of a single frequency [5] for different organizations of public safety would enable them to communicate and mitigates the interoperability problem during emergency situations. In this paper, we use radio network planning based on cellular system LTE (Long Term Evolution) because as stated above, the system must be broadband in order to serve the multimedia public safety services. The user data in this paper is base on a survey conducted in public safety organization in Jakarta area.

1.2 Motivation

Public Safety Communications is deployed based on the fact that most of emergency situations such as a big fire, traffic jam, big flood, and riot could not be solved by only single public safety entity. A coordination between each public safety officer to serve the society is required. Public safety communications today consume a large amount of spectrum per user [3]. Further, unlike cellular systems, public safety communications have generally been legacy operated which results in inefficient use of frequency spectrum.

Due to the spectrum efficiency of modern digital technologies and the movement towards larger network operation areas, analysis of the required capacity for the public safety broadband network should not rely on assumptions based on today's technology and network designs. As time goes on, it will become increasingly more attractive to build converged data and voice networks, while most of the public safety technology are currently narrow band services. As voice and data communications continue to converge, users have a greater expectation for both voice and mobile wireless data capabilities.

Broadband systems that can provide reliable, interoperable voice and data systems will likely replace narrowband voice systems and low data rate networks. The goal of public safety communications planners should be not only consolidation onto an integrated broadband voice and data network, but also an orderly migration of existing public safety mission critical voice communications systems, over time to a common frequency band and technology platform, which will provide inherent interoperability and improve spectrum efficiency while reducing overall costs in the long term.

1.3 LTE Overview and Determining Public Safety User

In this section we will first overview the LTE standard as our main basis to develop this system. We determine public safety user as a demand of the public safety communication. In addition, the network dimensioning, such as the assumption of number of user and the coverage area should be determined before conducting simulation to get the proper number of e-Nodes B required.

1.3.1 LTE

LTE (Long Term Evolution) technology was introduced by 3GPP (3^{rd} Generation Partnership Project). Latest release of release 10 developed as a preparation for advanced 4G [6]. This technology is able to support bandwidth 1.4 MHz to 20 MHz, both FDD and TDD. LTE utilizes a simpler architecture, the latest high-speed technologies, and commercially available devices, all of which create economies of scale and reduce operating costs for public safety agencies. With LTE's standardized protocols and interfaces and everyone using commercially available devices, more public safety personnel can talk to one another. LTE supports an open device ecosystem. The all-IP nature of LTE helps with interoperability because more and more public safety agencies are moving to IP-based systems. Another specific benefits use. LTE for public safety communications are : interoperability, situational awareness, video, digital imaging, large data files, GIS, automatic vehicle location, computer aided dispatching, telemetry, and improved task force operations. LTE-core network in the system architecture evolution (SAE) is called envelope packet core (EPC), it is all-IP to support 3GPP standard and non standard radio access network.

1.3.2 Determining Public Safety User

Users of public safety are personnels who respond to day-to-day emergencies and to disasters. They would typically be public personnel grouped into mission oriented categories, such as police, fire brigades, emergency medical response, and government personnel civilians. All these public safety personnel would be using public safety communications services during an emergency or disaster. Public safety user may be combined together into categories that have similar wireless communication usage patterns, i.e. the assumption is that all users grouped into "police" category personnel would have similar demands for telecommunication services. For this model, the categories will only be used to group public safety users with similar wireless service usage rates. That is, for police, each officer may have a radio (user equipment), so the wireless penetration rate is 100% for police. For ambulance crews, there may be two people assigned to an ambulance, but only one radio, so the penetration is only 50% for ambulance crews. The current penetration rate can easily be determined if the number of mobile stations deployed is known. It is simply the ratio of the number of radio (user equipment) deployed to the number of public safety users in that category. We need to determine the public safety user populations. This can be collected for each public safety user category; police, law enforcement, fire brigade, emergency medical response, etc. This data is collected from the specific metropolitan government or public safety organizations. This data may be available from several public sources, including annual budgets, census data, and reports published by national or local agencies.

Table 1: *Estimation of population growth in Jakarta area [7].*

Year	Amount (millions)
2010	8.5
2015	8.7
2020	8.8
2025	8.8

The definition of the number of personnel in disaster department in Jakarta is based on organizational structure for disaster management. For fire department, it is based on ideal conditions in every district where there is one post and in one post there are two teams, each team consisting of six persons. On the other hand, the police and health departments are based on ideal ratio of total number of personnel compared to the total population. The ratio is shown in Table 2. The ratio 1 police to 400 populations is an ideal condition of the united nations. The ratio between medical officers to 100,000 populations is based on an ideal condition of the national development planning board.

Table 2: *Ratio of personnel in police [9] and health departments [10].*

Personnel	Ratio
Police	1 : 400
Specialists	6 : 100,000
General Practitioners	40 : 100,000
Dentists	11 : 100,000
Nurses	107 : 100,000
Obstetrician	100 : 100,000

The data in Table 3 are obtained from each agency by making questionnaire in 2010. Each population category has a different growth condition. Jakarta local government, medical service and police have the same growth each year. 100 users officer increase every year. The growth fire brigade service each year is 15 users. The growth of national disaster relief board each year is 20 users. The purpose of these categories is to describe the users of the public safety communications. Since the radio network planning does not care about the categories of the user, it becomes a homogeny user that we call public safety user.

2. NETWORK DIMENSIONING

Network dimensioning [8] provides the first, quick assessment of the probable wireless network configuration. Network dimensioning is a part of the whole planning process, which also includes detailed planning and optimization of the wireless cellular network. As a whole, planning is an iterative process covering design, synthesis and realization. A proper set of inputs is vital for dimensioning to yield accurate results. Wireless cellular dimensioning requires some fundamental data elements such as subscriber population, traffic profile, area to be covered, frequency band, allocated bandwidth. Network dimensioning approach is calculating the number of required sites based on coverage (link budget) requirements, and capacity requirements. Outputs of network dimensioning are: site count for coverage and capacity. The final number of sites is the bigger number form coverage and capacity point of view.

2.1 Coverage Approach

For cell planning, it is very important to be able to estimate the signal strengths in all parts of the area to be covered, that is, to predict the path loss. The most accurate best path loss models that can be used are semi- empirical that is based on measurements of

Table 3: *Total public safety user.*

Year	Jakarta Local Government	Fire Brigade	Medical Service	Police	National Disaster Relief Board	Total Users
2012	1400	3470	24000	21500	135	50505
2013	1500	3485	24100	21600	155	50840
2014	1600	3500	24200	21700	175	51175
2015	1700	3515	24300	21800	195	51510
2016	1800	3530	24400	21900	215	51845
2017	1900	3545	24500	22000	235	52180
2018	2000	3560	24600	22100	255	52515
2019	2100	3575	24700	22200	275	52850
2020	2200	3590	24800	22300	295	53185
2021	2300	3605	24900	22400	315	53520
2022	2400	3620	25000	22500	335	53855

path loss attenuation in various terrains. The use of such models is motivated by the fact that radio propagation cannot be measured everywhere. However, if measurements are taken in typical environments, the parameters of the model can be fine-tuned so that the model is as good as possible for that particular type of terrain.

2.1.1 Target Area Coverage

In this paper, we used Jakarta area morphologies type as shown in Fig. 1 below. It consists of dense urban and urban area categories. Dense urban area is 114 km^2 while urban area is 564.92 km^2.

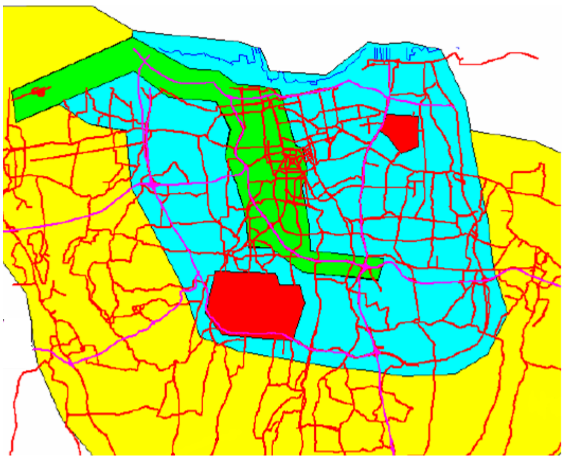

Fig.1: *Jakarta clutter area category [11], green is dense urban area, sky-blue and red are urban area.*

2.1.2 Parameters for Coverage Approach

Network dimensioning approached by coverage calculation is obtained using appropriate link budget. An accurate calculation of link budget is essential, because it determines how representative our network planning is to the real state of the field. Path loss model used in this planning is Hata model as given by :

$$PL = A + B\log(f) - 13.82\log(H_b)a(H_m) + [44.9 - 6.55\log(H_b)]\log(d) + L_{other} \quad (1)$$

where, f = carrier frequency (MHz), H_b = BTS antenna height (m), a(H_m) = correction factor for receiver antenna, d = distance between BTS (transmitter) and MS (receiver) (km), L_{other} = area correction factor (dB), 0 dB for suburban area and rural, 3 dB for urban area. For urban and dense urban area, value of a(H_m) in 700 MHz can be calculated by using:

$$a(H_m) = 3.2[\log(11.75H_m)]^2 - 4.97 \quad (2)$$

The values of A and B for 700 MHz are A = 69.55 and B = 25.16. The parameters that used in the link budget are:

$$\text{e} - \text{Node B Receive Sensitivity} = (\text{Thermal Noise Density} + \text{Effective e} - \text{Node B Noise Figure} + (10 \times \log(10)(\text{Used Bandwidth})) + \text{Target UL SINR}) \quad (3)$$

where, value of thermal noise density = -174 dBm, this is default value by Alcatel Lucent effective e-Node B noise figure = 2.5 dBm is default value by Alcatel Lucent, used bandwidth = 1800 kHz, target UL SINR = 0.2 dB is default value by Alcatel Lucent.

$$\text{e} - \text{NodeB Receive Sensitivity} = (\text{Thermal Noise Density} + \text{Effective e} - \text{Node B Noise Figure} + (10 \times \log(10)(\text{Used Bandwidth})) + \text{Target UL SINR}) = 108.747279 \quad (4)$$

e-Node B Receive Sensitivity = 108.74729, so e-Node B Receive Sensitivity is 108.7472749 the same with

108.7.

$$\begin{aligned}\text{Maximum Acceptable Pathloss (MAPL)} = {} & \text{UE Max Tx Power} + \text{UE Antenna Gain} + \text{FSS Gain} - \text{IoT} - \text{Shadowing Magin} + \text{Handoff GainPenetration Margin} - \text{Body Losses} - \text{Cable \& Connector Losses} + \text{e} - \text{Node B Antenna Gaine} - \text{NodeB Rx Sensitivity Additional UL Losses.}\end{aligned} \tag{5}$$

UE max Tx power = 23 dBm, this value is based on the user equipment specification. Table 4 shows parameters used in maximum acceptable pathloss calculation. The result of this calculation is used to calculate cell coverage.

Table 4: *Parameters used in maximum acceptable pathloss calculation.*

No	Parameters	Value
1	UE Max Tx Power	23 dBm
2	UE Antenna Gain	0 dBi
3	Freq. Selec.Sched.Gain	1.8 dB
4	IoT	3 dB
5	Shadowing Margin	8.8 dB
6	Handoff Gain	3.6 dB
7	Penetration Margin	17 dB
8	Body Losses	0 dB
9	Cable and Connector Losses	0.5 dB
10	e-Node B Antenna Gain	15 dBi
11	e-Node B Rx Sensitivity	108.7 dB
12	Additional UL Losses	0 dB

$$\begin{aligned}\text{MAPL} = {} & \text{UE Max Tx Power} + \text{UE Antenna Gain} + \text{FSS Gain} - \text{IoT} - \text{Shadowing Magin} + \text{Handoff GainPenetration Margin} - \text{Body Losses} - \text{Cable \& Connector Losses} + \text{e} - \text{Node B Antenna Gaine} - \text{Node B Rx Sensitivity Additional UL Losses.}\end{aligned} \tag{6}$$

where, MAPL = 122.8 dB, UL K1 = 120.7 dB, UL K2 = 33.8 dB.

$$\begin{aligned}\text{UL Cell Range} &= 10^{(\text{MAPL}-\text{ULK1})/\text{ULK2}} \\ &= 1.138185419 \approx 1.14 \text{ km}\end{aligned} \tag{7}$$

Three-sector site: area of a site = 3 × area of a sector or sector area (Cell area coverage). In this paper, UL cell range coverage = 1.949 × UL cell range × UL cell range. The clutter map of Jakarta area is divided by two categories, dense urban area, and urban area. This map is used as a references when we plan to deploy sites of the cellular. Value of site = target area

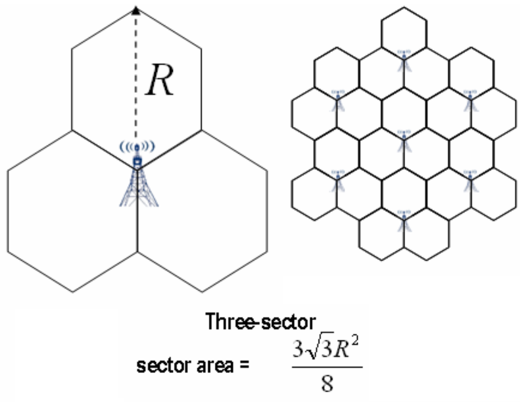

Fig.2: *Network planning principles use three sector site [12].*

Table 5: *Category map clutter of Jakarta area and calculation of area coverage.*

No	Clutter	Area Coverage (km^2)	Remark
1	Dense Urban	114	Jakarta Clutter Map
2	Urban	564.96	Jakarta Clutter Map

coverage/area coverage (km) where : area coverage = 1.949 × R × R. In this paper we used 3 sector. All site = value of site dense urban-up link + value of site urban-up link. R between down link and up link is the same because as a limitation of up link budget side.

2.2 Capacity Approach

Network dimensioning approached by capacity calculation is a capacity planning to determine the number of sites due to capacity. The subscriber density and subscriber traffic profile are the main requirements for capacity dimensioning. Parameters in this traffic profile are based on the assumption from the network. It is based on generic traffic profile inputs. In this paper we do not determine the number of e-Node B yet. The number e-Node B calculation is obtained based on the expectation of traffic profile and it will be the reality in the real implementation.

2.2.1 Type of Service and Traffic Profile

In this paper, we use three general types of services, namely voice, video call, and data transfer. Bit rate requirements for voice is based on packet size for an adaptive multi rate (AMR) 12.2 VoIP codec while bit rate require for video call and data transfer is 512 kbps. Table 7 shows type of services and bit rate requirements are for three terms of deployment. It means that for 2012 until 2022, there are only three periods of investment year. The first period is year

Table 6: *The value of site base on two categories of clutter area in Jakarta area.*

No	Parameter	Dense Urban		Urban		Formula	Remark
		DL	UL	DL	UL		
1	Cell Range (km)	1.16	1.16	1.74	1.74	A	UL Cell Range
2	Area Coverage UL Cell Range km^2	2.6225744	2.6225744	5.9007924	5.9007924	B=1.949*A*A	Formula Area Coverage with 3-sector is 1.949*R8R
3	Target Area Coverage (km^2)	114	114	564.96	564.96	C	Target Area Need to Cover
4	Value of Site	43.4687382	43.4687382	95.74307342	95.74307342	D=C/B	Value of Site base on Clutter
5	Value of Site base on Clutter	44		96		E=MAX (DL:UL)	Limitation in UL
6	All Site	140				F=E Dense Urban+E Urban	Final Value of Site

2012, the second period is year 2015, and the third is year 2020. A traffic profile gives an estimate of the traffic to be carried by the system. Different types of traffic that will be carried by the network are modelled. Each wireless network has its own set of parameters. Table 8 shows design parameters requested by the user since year 2012 until 2020. It is shown that VoIP service is a dominant services 100 % for all the subscriber per site in year 2012, 2015, and 2020. It means that voice service eases the communication among the user of public safety. It is shown that two ways video services it is 50% of the user using this service. The traffic volume between down link and up link is the same because typically a video service needs symmetric traffic. It is different in data traffic, it shows that the traffic data volume will increase based on the typical usage assumption. The traffic volume year 2020 is almost double to that of year 2015, and 2012 respectively. The typical traffic data is asymmetric. Table 9 below shows the number of

Table 7: *Type of services and bit rate requirement.*

Type of Services	Bit rate requirement		
	2012	2015	2020
Voice	12.2 kbps	12.2 kbps	12.2 kbps
2 ways Video	512 kbps	512 kbps	512 kbps
Data Transfer	512 kbps	512 kbps	512 kbps

sites required base on the number of subscriber divided into the number of subscriber per site. This paper is based on the assumption of three terms of deployment. It means that for 2012 until 2022, there are only three periods of investment year. Number of the subscriber is based on the data in the Table 3, and the number of the subscriber per site is base on the Table 8. By division the number of subscriber with the number of the subscriber per site, it gets the number of the sites required. Based on that calculation the number of sites required in Jakarta until 2022 is 49 sites.

3. SIMULATION RESULTS AND ANALYSIS

Coverage estimation is used to determine the coverage area of each base station. Coverage estimation calculates the area where base station can be heard by the users (receivers). It gives the maximum area that can be covered by a base station. But it is not necessary that an acceptable connection (e.g. a voice call) between the base station and receiver can be established in coverage area. However, base station can be detected by the receiver in coverage area. Coverage planning includes radio link budget and coverage analysis. Based on the calculation that is described in the section 2.1 coverage approach, 140 sites using 700 MHz are needed for public safety communication in Jakarta area.

Coverage analysis fundamentally remains the most critical step in the design of LTE network. Radio link budget is at the heart of coverage planning, which allows the testing of path loss model and the required peak data rates against the target coverage levels. The result is the effective cell range to work out the coverage-limited site count. This requires the selection of appropriate propagation model to calculate path loss. With the knowledge of cell size estimates and of the area to be covered, an estimate of the total number of sites is found. This estimate is based on coverage requirements and needs to be verified for the capacity requirements.

Capacity planning deals with the ability of the network to provide services to the users with a desired level of quality. After the site coverage area is calcu-

Table 8: *Traffic profile base on generic traffic model.*

Year			2012	2015	2020
Enter Total # Subs per Site			1188 subs	795 subs	507 subs
VoIP	% Subs		100%	100%	100%
	Traffic Intensity/Sub/BH		25.00 mErl	25.00 mErl	25.00 mErl
	BHCA/Sub		0.50	0.50	0.50
Two Way Videos	% Subs		50.0%	50.0%	50.0%
	Traffic Volume /Sub/BH	DL	43200 kbits	43200 kbits	43200 kbits
		UL	43200 kbits	43200 kbits	43200 kbits
	BHCA/sub		0.06	0.06	0.06
Data Transfer	% Subs		50.0%	50.0%	50.0%
	Traffic Volume /Sub/BH	DL	175000 kbits	175000 kbits	175000 kbits
		UL	43200 kbits	86400 kbits	150000 kbits
	BHCA/sub		20.78	20.78	20.78

Table 9: *Capacity calculation base on generic traffic.*

Investment Year	Subs	Subs/Site	Sites Required
2012-2015	51510	1188	44
2015-2020	1474	795	2
2020-2022	1056	507	3
Total	54040	2490	49

lated using coverage estimation, capacity related issues are analysed. This involves selection of site and system configuration, e.g. channels used, channel elements and sectors. These elements are different for each system. Configuration is selected such that it fulfills the traffic requirements. In some wireless cellular systems, coverage and capacity are interrelated. Capacity based site count is then compared with the coverage result and greater of the two numbers is selected as the final site count.

Based on the calculation is described in the Section 2.2 capacity approach, 49 sites using 700 MHz are needed for public safety communication in Jakarta area.

In the cellular deployment, the maximum value [13] between coverage approach and capacity approach will be used as a reference, so the value of 140 sites is used to cover Jakarta area. The aim of public safety communication services is to cover the maximum Jakarta area. In this paper, there are 5 simulations result base on the required of the number of demand and traffic profile public safety communications. The simulation results are : the number of sites to cover Jakarta area, coverage signal level of down-link, histogram of the signal level, coverage data throughput of down-link, and histogram of the data throughput.

Simulation A shows 140 e-Node B for cover Jakarta area. This simulation shows homogeneous distance among each e-Node B and homogeneous antenna sectors. This is an ideal radio network planning deployment in cellular.

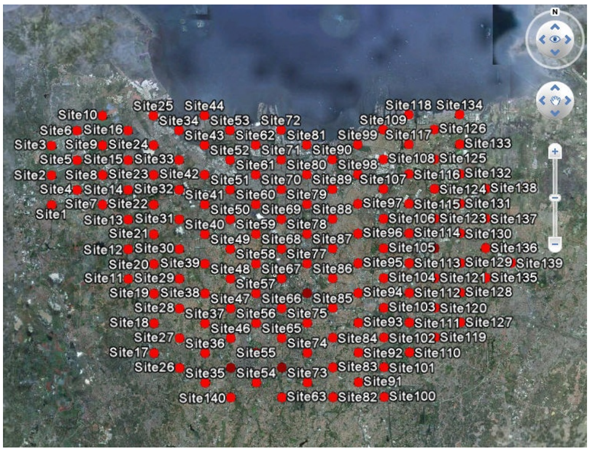

Fig.3: *Simulation A : number of site to cover Jakarta area since year 2012 to year 2022.*

Simulation B shows signal level for down link side to cover Jakarta area. It means the signal level from e-Node B down to the user equipment. There are six types of signal level. They are represented by different six colours. The range signal level in dBm is -60 to -110. The best signal level is -60 dBm and the worst signal level is -110. It shows in simulation C histogram of signal level.

With the 144 km^2 dense urban area and 564.96 km^2 urban area, the total target of coverage area is 708.96 km^2. Based on the simulations B and C above, the percentage of the value of signal level are :

1. Coverage area with -60 dB or more is 9.5992 %
2. Coverage area with -70 dB or more is 28.0309 %
3. Coverage area with -70 dB to -80 dB is 60.132 %
4. Coverage area with -80 dB to -90 dB is 2.2277 %
5. Coverage area with -90 dB to -100 dB is 0.0103 %
6. Coverage area with -100 dB to -110 dB is 0 %

In LTE network, by signal level of 90 dB it could make a good connection. Based on the value of signal level -90 dB to -100 dB mentioned above, it shows that the percentage coverage area is only 0.0103 %,

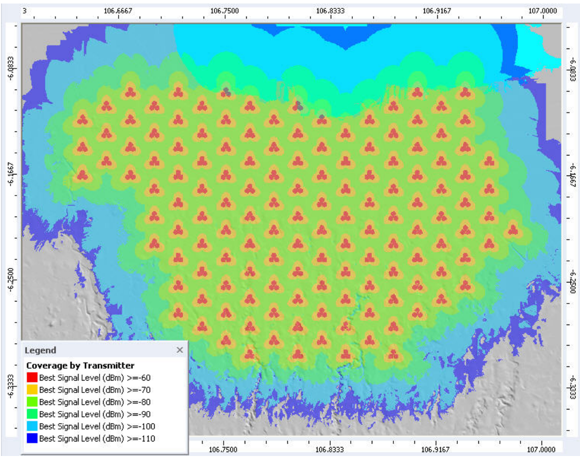

Fig.4: *Simulation B : coverage signal level down link, year 2012 to year 2022.*

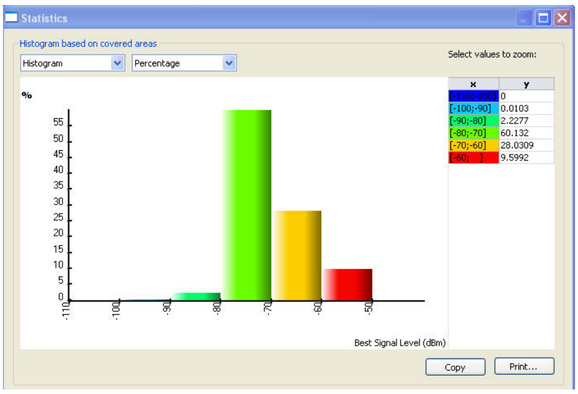

Fig.5: *Simulation C : histogram of signal level is based on coveraged areas.*

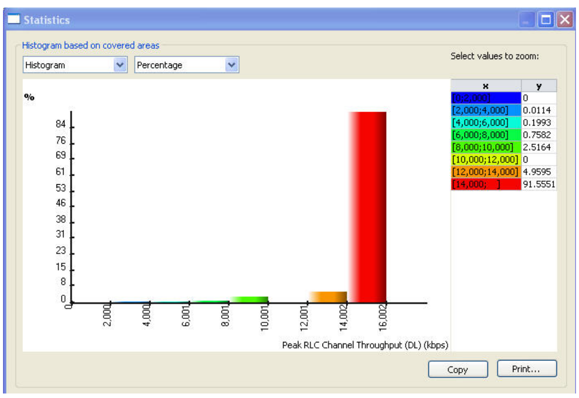

Fig.6: *Simulation E : histogram of data throughput is based on coveraged area.*

it means that 99.987 % of Jakarta area has been covered. It can be concluded that 99.987 % of Jakarta area has a good connection with LTE network .

Simulation D shows data signal level for down link side to cover Jakarta area. It means the signal level from e-Node B down to the user equipment. They are represented by different eight colours.

Simulation D and E show distribution of data throughput based on coverage area It can be explained as follows :

1. Area with the data throughput 14 Mbps or more is 91.5551 %
2. Area with the data throughput 14 Mbps - 12 Mbps is 4.9595 %
3. Area with the data throughput 12 Mbps - 10 Mbps is 0 %
4. Area with the data throughput 10 Mbps - 8 Mbps is 2.5164 %
5. Area with the data throughput 8 Mbps - 6 Mbps is 0.7582 %
6. Area with the data throughput 6 Mbps - 4 Mbps is 0.1993 %
7. Area with the data throughput 4 Mbps - 2 Mbps is 0.0114 %
8. Area with the data throughput 2 Mbps - 0 Mbps is 0 %

Based on the Table 7, the services requirements as follows : voice 12.2 kbps , video call 512 kbps and data transfer 512 kbps. Total requirement is 1036.2 kbps (1.036 Mbps). Distribution data throughput 2 Mbps - 0 Mbps is 0 %, it means that the value of the requirement data throughput 1.036 Mbps is 0 % too. It can be concluded that the whole data throughput required could be accommodated by LTE network.

4. CONCLUSIONS

Public safety communication is an essential system for public safety officer, hence the main purposes of this system can cover the whole Jakarta area. By using cellular based public safety communication with its services voice, video, and data, communication and coordination among the public safety users to better serve the public would be enhanced. The radio network planning has been investigated and demonstrated for the deployment at Jakarta area. The planning has been designed based on LTE standard using 700 MHz. The proposed planning uses 10 MHz frequency bandwidth channel. In the design, it has taken the number of cells by coverage approach and capacity approach. Based on the coverage approach it is required 140 e-Node B in Jakarta area while based on the capacity approach it is required 49 e-Node B.

Public safety communication is deployed for year 2012 until year 2022 with the assumption of three terms of deployment. In the capacity, model it shows the minimum requirement for public safety still can be accommodated until 2022 and Jakarta area it can coverage too.

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