

## RELIABILITY BASED PERFORMANCE ANALYSIS OF BASE TRANSCEIVER STATION (BTS) USING RELIABILITY, AVAILABILITY, AND MAINTAINABILITY (RAM) METHOD

Judi Alhilman<sup>1</sup>, Rd. Rohmat Saedudin<sup>2</sup>

<sup>1,2</sup> Industrial Engineering Department, School of Industrial and Systems Engineering, Telkom University  
Jl. Telekomunikasi Terusan Buah Batu, Bandung, West Java, Indonesia 40257

<sup>1</sup>[judi.alhilman@gmail.com](mailto:judi.alhilman@gmail.com), <sup>2</sup>[roja2128@gmail.com](mailto:roja2128@gmail.com)

### ABSTRACT

In the world of telecommunications, BTS is one of the most important part because through BTS communication can be run either the receiving or sending information. For that BTS should be always ready to use by customers, because if the BTS is damaged then the communication between users will be disrupted and the user will be dissatisfied that could lead to loss of customers that will have an effect on the reduction of the company's revenue. To find and improve the reliability of BTS to always be ready for use by consumers, so in this study analyzed the performance of BTS using the method of Reliability, Availability and Maintainability (RAM). In this study, the data used is data between failure (TTF) and the data length of repair (TTR) of base stations in the area surrounding Bandung, this data was analyzed by the application of MINITAB and BlockSim 9. The results of the study are the reliability system rate 99.99% at an interval of 72 hours, inherent availability rate of 100% for 8760 hours at a time, it already meets the factors key performance indicator (95%) in the system and maintainability system at  $t = 12$  hours is 98.14%.

*Keywords:* Availability, BTS., Maintainability, Reliability,

### 1. INTRODUCTION

In the modern era and the era of communication today, communication become one of the tools that we absolutely need in this life to support a wide range of our activities. Growth in the number of customers and users of telecommunications must also be balanced with development of infrastructure that can either cover and provide excellent service. Generally if devices have been used in long time, so to keep remains excellent performance with an adequate level of reliability, the devices need good maintenance programs, as well as BTS. If an interruption occurs that causes BTS down, it will result in a loss of potential revenue and lead to loss of consumer confidence in the company. In a telecommunications network, availability is a very important part because the effect on the network coverage, customer satisfaction and customer network performance. For that BTS maintenance program as well to increase reliability, availability and maintainability (RAM) is

needed. To determine the critical unit of BTS that causes the biggest loss for the company is used the method of Reliability Block Diagram that can be shown with the lowest levels of reliability and availability of the BTS [2].

The following is Availability BTS data at a time for 24 hours per month.

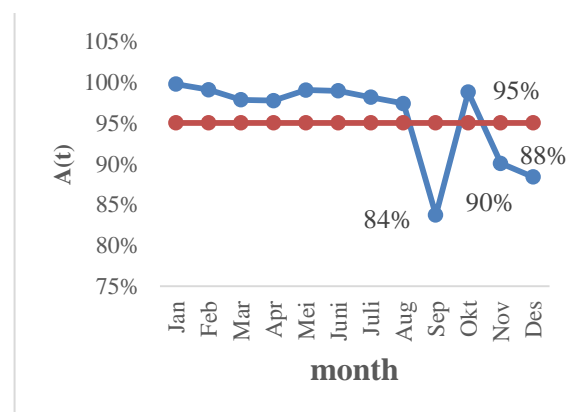


Figure 1 Availability  
Source : PT. Telkomsel, 2011

From availability data in figure 1, there are

availability existing below international standard IVARA at 95%. To do RAM Reliability, Maintainability & Availability based on Time to Failure and Time to Repair data from system its self [4]

**2. THEORETICAL BACKGROUND**

Life Data Analysis is used to predict about the life of the machine or equipment, by adjusting a statistical distribution of the life data obtained from the samples for the machine or equipment. Statistical distribution obtained can be used to estimate the characteristics of the life of the machines or equipments, such as reliability, probability of failure at a time, the average life cycle, and the failure rate. Steps to make the life of data analysis:

1. Collect life data from the machines or equipments.
2. Determine the distribution of time which may correspond to the life data.
3. Estimate the distribution parameters which may correspond to the statistical distribution of the data.
4. Data plot that can estimate the characteristics life of the machines or equipments.

**2.2 Reliability, Availability & Maintainability (RAM) Analysis**

Reliability, Availability and Maintainability (RAM) Analysis is a method that can be used to predict the performance of reliability, availability and maintainability of a system or equipments, and as a basic to provide for optimization of systems or equipments. Key performance indicators of RAM is the availability, in which the availability is part of the time when the system is fully functioning. RAM Analysis can be used to help select the concept, and to be able to provide detailed decisions related to the system at the front end engineering. RAM can also be used to identify sensitive and critical subsystems in the production system that can provide an effect on system performance. (Ebrahimi, 2010), (Moubray, 1991)

**2.3 Reliability**

Reliability is a possibility that shows the ability of a system or components to

Analysis, is required calculation of

function under the conditions set for a certain period of time [3]. Function used in the data distribution in this reliability is the function of the reliability and function of the rate of destruction. Reliability function is a function that shows the probability of a component or system to perform its function satisfactorily without failure condition in a specific time period. Mean while, the rate of failure function is a function that indicates the level of damage that occurs per unit time [3].

1) Exponential Distribution

Reliability Function

$$R(t) = e^{-\lambda t} \dots\dots\dots(1)$$

Failure Rate Function

$$h(t) = \lambda \dots\dots\dots(2)$$

2) Normal Distribution

Reliability Function

$$R(t) = \int_t^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(t-\mu)^2}{2\sigma^2}} dt \dots\dots\dots(3)$$

Failure Rate Function

$$h(t) = \frac{\frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(t-\mu)^2}{2\sigma^2}}}{\int_t^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(t-\mu)^2}{2\sigma^2}} dt} \dots\dots\dots(4)$$

3) Distribusi Weibull

Reliability Function

$$R(t) = e^{-\left(\frac{t}{\alpha}\right)^\beta} \dots\dots\dots(5)$$

Failure Rate Function

$$h(t) = \frac{\beta}{\alpha} \left(\frac{t}{\alpha}\right)^{\beta-1} \dots\dots\dots(6)$$

**2.4 Availability**

According to Moubray (1997), availability is defined as a measure of the time it takes for a system to actually operate.

Availability can be defined as the probability that a system operates according to its function within a certain time in the specified operating conditions [3]. Availability is a function of a cycle of operation time and downtime and is a measure of the success of a system to carry out the mission of certain operating system calls an specified time.

**2.4.1 Inherent Availability**

Inherent availability is a measure of the readiness of a system when evaluated in ideal environmental conditions [3]. Inherent availability can be calculated based on the following equation:

$$Ai = \frac{MTTF}{MTTF+MTTR} \dots\dots\dots(7)$$

**2.5 Maintainability**

According to Ebeling (1997), maintainability is defined as the probability of a system or component that is defective in conditions of full employment within a predetermined period of time and with a certain maintenance procedures. One of the parameters maintainability commonly used is the Mean Time To Repair (MTTR). MTTR obtained using Equation (8)

$$MTTR = \int_0^{\infty} t \cdot h(t)dt = \int_0^{\infty} (1 - (t))dt \dots(8)$$

$h(t)$  = probability density function for time to repair

$H(t)$  = Cumulative distribution function for time to repair data

$t$  = time.

**2.7 Maintenance Performance Indicator (MPI)**

Performance measurement is a fundamental thing in management. According to Kumar, et al (2011) performance indicators used to calculate the performance of a system or process. This is important because it can identify the difference between current performance and the desired performance,

and provide an indication of the reduction of the discrepancy. As a result of some calculations, performance indicator (PI) can be used in maintenance activities, called Maintenance Performance Indicator. These performance indicators are commonly used to reduce down time, cost and waste, operate more efficiently, and increase operating capacity. List of performance indicators will reflect the needs and objectives of the company. Performance indicators can be divided into two parts, the Leading Indicator and Lagging Indicators.

**3. RESEARCH METHODOLOGY**

Steps being taken in the processing of data, including:

**3.1 Reliability Block Diagram (RBD)**

To determine the serial or parallel systems can be done by using RBD.

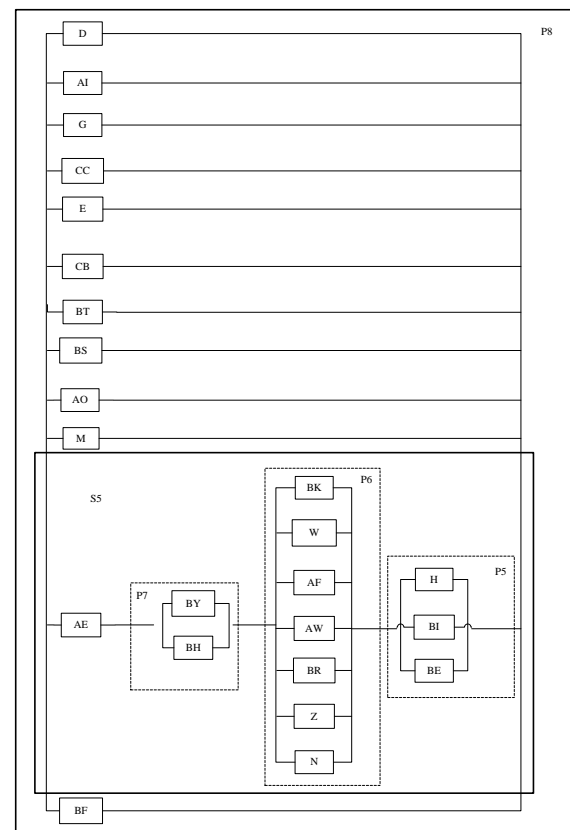


Figure 2 Reliability Block Diagram

To determine the distribution used Anderson - Darling test in Minitab 17

software. Data tested are TTF and TTR data using Normal, exponential, and Weibull distribution.

### 3.2 BTS Plotting Distribution

Plotting distribution is used to find parameters of the distribution selected on Unscheduled Maintenance. From data plotting obtained three kinds of distribution are normal, exponential and weibull distribution, in accordance with the data is Weibull distribution with two parameters.

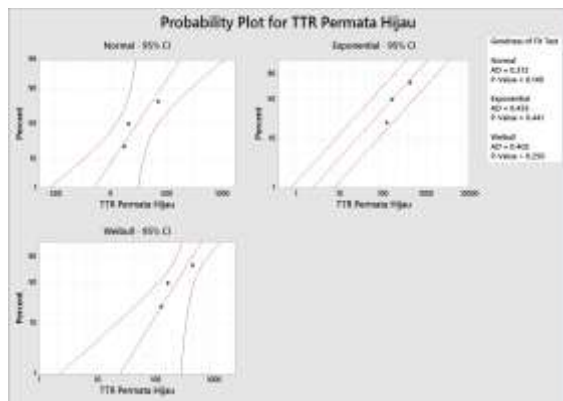


Figure 3 Plotting Distribution

Parameters used by the constant time. The length of time prescribed is between six hours up to 72 hours, with an interval of six hours. Table 1 shows the reliability of the system.

Table 1 Reliability System

t (hour)	RP8 (%)
6	100.00
12	100.00
18	99.99
24	99.99
30	99.99
36	99.99
42	99.99
48	99.99
54	99.99
60	99.99
66	99.99
72	99.99

### 3.3 Availability Calculation

Based on the characteristics of the damage that the distribution and selected parameters of the unit, with the time spent by the time used is constant. Tipe availability is inherent availability. Using the formulation and RBD existing models do analytical calculations inherent availability. Table 3 shows the result of inherent system availability.

Table 2 Inherent Availability Result

BTS	Availability
Babakan Sari	95.72%
Gumuruh	99.68%
Buah Batu	99.98%
Turangga	99.91%
Batununggal	99.90%
Tol Buah Batu	99.98%
Sukamenak	99.99%
STT Telkom	99.92%
Lengkong	98.88%
Ciganitri	99.99%
Dayeuh Kolot	99.85%
AS5	99.91%
Availability System P8	100.00%

### 3.4 Maintainability Calculation

Based on the analysis of Maintainability System calculation in 12 hours, the result showed in Table 3 below.

Table 3 Maintainability System

t (hour)	Maintainability
1	60.21%
2	76.95%
3	85.46%
4	90.13%
5	92.86%
6	94.55%
7	95.67%
8	96.45%
9	97.03%
10	97.48%
11	97.84%
12	98.14%

## 4. RESULTS AND DISCUSSION

### 4.1 System Distribution Analysis

Each unit has a different distribution from the TTF and TTR, which makes the value of MTTF and MTTR of each unit are also different .

### 4.2 Maintainability Analysis

Maintainability is calculated using all maintenance activities that cause the engines break down.

From the reliability system data, company can determine preventive maintenance interval during which time there is an opportunity for the machine can perform its function. Based on table 1, the system can do activities PM every 72 hours. With reliability systems that have a short period of time, it can be said that there is still place for improvement.

### 4.3 Plant Availability Factor Analysis

The value of the inherent availability indicate that the effectiveness of the system is very high. This suggests that the availability of the default of the machines on the system is very good, so it can produce optimal MTTF and MTTR for system availability. With the company's target for availability is 95%, it can be said that the inherent availability already passed of a given target.

### 4.4 Maintenance KPI Analysis

Assessment system can not be separated from the use of key performance indicator, because KPI provides a standard that makes it easy to see quality of system. For BTS system in Bandung area used IVARA World Class Targets for Key Performance Indicator.

## 5. CONCLUSION

### 5.1 RAM Analysis

Based on calculations using RAM Analysis based on reliability modeling block diagram, the system has a reliability rate of 99.99 % at 72 hours based on analytical approach, Maintainability calculations using RAM Analysis based on reliability

block diagram modeling, it was found that the entire unit in the system has a chance to fix at minimum 4-12 hours to be able to function in 90 %. During 2011, Inherent Availability of the system is 100.00% based on analytical approach.

Based on the results of the analysis showed that the value of inherent availability factor (100%) already meet the Key Performance Indicator factor (95%) on the system.

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## AUTHOR BIOGRAPHIES

**Judi Alhilman** is a lecturer in Department of Industrial Engineering, Faculty of Industrial & System Engineering, Telkom University, Bandung. He received her Master of Industrial Engineering from New Mexico State University, USA in 1994, His research interests are in the area Maintenance Management and Data

Mining. He is a Head of Maintenance Management Professionalism of Industrial

**Rd Rohmat Saedudin** is a lecturer in Department of Industrial Engineering, Faculty of Industrial & System Engineering, Telkom University, Bandung. He received her Master of Industrial Engineering from Institut Technology Bandung in 2005. His research interests are in the area Maintenance Management and Data Mining. He is a vice dean of Industrial & System Engineering Faculty. His email address [rdrohmat@telkomuniversity.ac](mailto:rdrohmat@telkomuniversity.ac).