Transmission Performance Analysis of TDMA Radio and MAC Communication of TDMA Protocol

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Abstract. Radio is one of the wireless network system devices that is still widely used today. Transceiver was used because the radio can function as a transmitter and receiver. In this paper, half-wave dipole antenna for radio communication as a transceiver on TDMA Digital Radio was simulated. The antenna was used at 167.5 MHz and radio communication channel. In collecting the data, spectrum analyzer was used as the measuring tool. To analyze the output signal generated by TDMA Digital Radio, the data sample on both measurements. This paper compared the TDMA Digital Radio communication with simulation by using MATLAB. Analyze the Channel Power that has become the output of Spectrum Analyzer, and the measurement of Spectrum Analyzer Measurement was using MATLAB.

1. Introduction
Digital Radio with a system of Time Division Multiple Access (TDMA) is a communication tool that has good quality, radio is one communication tool that uses air as a transmission medium [1]. Digital Signal Processing is the basis for the formation of a better communication [2].

In the TDMA system has a division of slots, has several slots that can be filled with more than 2 communications at a time. Both slot 1 and slot 2 are not interfered with each other [3], because they have been arranged with the time domain. This is the use of the TDMA protocol MAC that regulates channelization transmission in TDMA [4].

Some media access controls can be used to group into two categories, namely distributed and centralized. In a distributed approach, each node decides itself to process transmission [5]. If multiple users send, you must create a protocol for managing collisions [6]. In a centralized approach, the base station is responsible for deciding who can access the channel [7]. The base station assigns a time slot for each user at the time.

The results of the analysis model with the simulation prove that the analysis of performance with the TDMA MAC Protocol system has proven to be accurate and consistent [8]. In this paper focus on analyze the output of TDMA Radio. Using TDMA system in Digital Radio collaborate between Digital Signal Processing and Medium Access Control to make good quality of communication using radio. In a TDMA system, each Primary User accesses the channel at the beginning of its corresponding time slot in each TDMA frame and completes a packet transmission at the end of a time slot. The time length that is used for transmitting one packet, that is, one packet transmission duration[9].
Digital Radio convert analog information to biner numbers value always dynamic base on input audio signal. Transmitter system in digital radio shift analog signal to biner number. Then digital transmitter processing input audio signal for modulation. Digital receiver radio will accept audio signal back, it called demodulation[10]. In dividing communication, MAC Protocol TDMA is necessary on it for avoiding collision each transmissions[4]. Function of MAC Protocol TDMA manage channelization on TDMA, in slot 1 or slot 2 do not disturb each channel by time domain[11]. In this paper simulate transmission using MATLAB application to compare with real data in communication system that has captured while measuring.

2. Principle of radio communication
Radio communication means wireless communication that using air as media transmission for radio wave propagation which based on transmitter (Tx) and receiver (Rx). Transmitter consists of modulator and Transmitter Antenna, while Receiver consists of demodulator and Receiver Antenna. Modulator functions modulate information to signal that will transmit by transmitter antenna. Demodulator on receiver antenna will demodulate electricity signal to signal information as like signal before modulation.

3. Frequency range
The frequency range is allocated frequency in such a way that the existing radio systems do not interfere with each other. In telecommunication frequencies around 3 kHz to 3 THz. On the table 1 below, shows allocation frequency on radio system.

| Band               | Frequency    | Utility                  |
|--------------------|--------------|--------------------------|
| Extremely Low Frequency | 3-30 Hz     | Underwater Communication |
| Super Low Frequency  | 30–300 Hz    | Underwater Communication |
| Ultra Low Frequency  | 300-3000 Hz  | Communication in mining  |
| Very Low Frequency   | 3- 30 KHz    | Underwater Communication |
| Low Frequency        | 30-300 KHz   | Navigation               |
| Medium Frequency     | 300-3000 KHz | Broadcast radio AM       |
| High Frequency       | 3- 30 MHz    | Amateur Radio             |
| Very High Frequency  | 30-300 MHz   | Broadcast radio FM and television |
| Ultra High Frequency | 300 – 3000 MHz | Television and handphone |
| Super High Frequency | 3 – 30 GHz   | Wireless LAN              |
| Extremely High Frequency | 30-300 GHz | Astronomy Radio           |

4. LOS (Line of Sight)
Line of Sight is path produce highest power from other mechanisms. Earth’s ground transmission limit distance by curve of Earth. In figure 1, Loss path means shrinking signal as number of positivity in desibell (dB), define as difference between transmission power and receiver transmission.

![Figure 1. Path LOS.](image-url)
5. **Reflection path**  
LOS path often referred as unobstructed path. Three other wave propagation mechanisms, namely reflection, diffraction and scattering produce paths that are included in the category of obstructed paths. This makes the last three paths have a lower effectiveness than the LOS path, due to larger path losses.

The ground of the earth and the ionosphere layer together can form repetitive wave reflections to obtain a very far radio range.
For example fading radio wave fading is the volume variation in SW (Short Wave) radio reception. During the day, the fading that occurs is quite disturbing, while at night the SW radio reception is better because the earth's atmosphere is more stable than during the day.

6. Digital signal
Digital signal has not continuous amplitude over time. If bit desire for transmit through communication media in digital signal so that bit should be transform to electricity wave. For example bit 1 representative by electric gain +1 volt and bit 0 representative by electricity gain -1.

![Figure 5. Representation digital signal in electricity gain.](image)

Bit rate define as number of bit that sent in one second that stated in bit per second (bps). Formula of bit rate (R)

\[ R = \frac{b}{t} = \frac{\log_{2}L}{t} \quad (1) \]

7. Medium access control (MAC)
Medium Access Control (MAC) is a method of transmitting signals that have nodes connected to the network without collisions between signals. In wireless communication, information must be complete and clear. MAC requires access that allows information without interruption of collisions [13], even though it has more than one channel. In general, MAC is used for a communication network topology protocol that focuses on the channeling section, which is divided into three types, FDMA, TDMA, and CDMA.

![Figure 6. Medium access control technique.](image)
In the figure 6 above for method that adopted is the MAC technique in Channelization using TDMA, more specifically on the MAC Protocol on TDMA Channelization that will be applied to TDMA Digital Radio. A data transmission needs good quality, and without error or interference. Therefore, the node in TDMA will be discussed in the TDMA Protocol MAC that takes place in the transmission. Medium Access Protocol has 2 types of design, namely contention-based, and contention-free. In this case it will be discussed is contention-free which has TDMA in its transmission retrieval [13].

The Contention-Free protocol aims to avoid collisions by allocating transmission sources to nodes in the network. Contention-free protocols generally include multiple division multiple access (TDMA), multiple division multiple access (CDMA), and frequency division multiple access (FDMA). Dynamic TDMA protocols are mainly based on reallocating slots or adapting the number of slots, as a function of the number of active nodes and traffic intensity, routing information, and using time slots associated with messages to determine channel access.

8. Result and discussion
In TDMA Digital Radio measurement is divided into two measurements, measurement with real data using spectrum analyzer at State of Polytechnic Sriwijaya in Telecommunications laboratory. Radio aircraft use an open antenna dipole with 167.5 MHz frequency that will be used for TDMA Digital Radio, and in MATLAB 167.5 MHz simulation on the frequency span. This measurement is to compare the Power Channel on each measuring instrument, both simulation and real system.

The implementation of the open dipole antenna is done as a transmitter, the transmitter antenna has a 167.5 MHz frequency which is owned by PT. PLN APD S2JB for communication. On this article, testing of measuring instruments and application testing is carried out.

Signal power testing is performed using a spectrum analyzer and MATLAB application. To measure the radio signal, the open dipole antenna is used to receive the signal range by testing the channel on TDMA Digital Radio. The first measurement uses a span frequency of 1 MHz and 30 kHz. The following is a comparison of the measurement results obtained.

Figure 7. Comparison first data of waveforms on real data and matlab.
In the table above can be seen the comparison between real data with MATLAB is not much different visually. In the figure 7 is the result of the Frequency with 1 MHz Span Frequency which is a signal without modulation, or without modulation.

In the figure 8 and 9 on table, signal that has been entered information that is within the limits of a Frequency Modulation, in real data using a frequency of 30 kHz which is an FM with input information. As for MATLAB the same audio input is entered when taking real data, which is audio sound, changes dynamically with Hz scale for an FM Modulator and FM Demodulator.

9. Conclusion
The more positive the dBm value, the greater the power that can be emitted, and the better the information will be sent. Based on the data that has been taken, the best value of real data is at a frequency of -28.27 dBm. MATLAB can simulate the frequency that will be used by making it a center frequency. The quality of the radio signal that has been captured can be a reference to the quality of a MAC TDMA Protocol used on the Radio by comparing BER on each Digital Modulation.

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