A STUDY ON THE ESTIMATION OF TRAFFIC QUANTITY AND MAC PROTOCOL IN RADIO WAVE ENVIRONMENTAL MONITORING

Koji ENDA (Yokohama National Univ., Yokohama, Japan
; enda@kohnolab.dnj.ynu.ac.jp)
Ryuji KOHNO (Yokohama National Univ., Yokohama, Japan; kohno@ynu.ac.jp)
Yokohama National University,
79-5 Tokiwadai, Hodogaya, Yokohama, Kanagawa,
240-8501, Japan.

ABSTRACT

In case of actualizing cognitive radio (CR) concept, it is significant the radio wave environmental monitoring (RWEM) which cognizes radio wave using situation of surrounding device. RWEM is composed of physical layer and MAC layer. In this paper, we focus on MAC layer because that its estimation leads to an increase of communication occasion. The plural terminals estimate the position of target, and estimate whether transmit or not. It enables to estimate traffic quantity of target. Furthermore, checking the transmission situation of each target and surrounding device, we judge whether contention base protocol or control base protocol and estimate target's MAC protocol.

1. INTRODUCTION

Recently, Cognitive Radio technique has been getting a lot of attention due to its attractive concept that the time and frequency sharing leads to higher efficient communication system. In order to fulfill this concept, it is necessary to construct Radio Wave Environmental Monitoring (RWEM) system that the terminals cognize the usage situation of radio wave around them. The RWEM requires estimating the position, the transmission power, the MAC protocol, and the traffic quantity of the monitoring target. The estimation of MAC protocol is that estimates control base or contention base protocol

In this paper, we focus on the estimation of MAC protocol and traffic quantity, because the estimation of their parameters makes it possible to analyze performance in time domain. Therefore, their estimations lead to improve the communication opportunity of Cognitive Radio (CR) system. As to conventional RWEM, the single terminal only monitors surrounding situation, for instance, carrier sense and it judges whether can transmit or cannot transmit in target frequency. However, by information obtained from only single terminal, proper usage area of radio wave cannot be estimated. Therefore, Communication opportunity of CR system can be improved by cooperating in some terminals and estimate the usage area properly. As a procedure of our proposal, firstly, it is configured that the position and transmission power information of monitoring target has been estimated. Therefore, the communication situation of target system can be estimated by following and analyzing the transmission time of some target systems. Next, MAC protocol can be estimated by analyzing the existing system performance in case of receiving interference from other system. Furthermore, Traffic quantity of each existing system can be estimated by integrating its past analysis information, and these processes make it possible to analyze their communication timing. Therefore, it is able for existing system to estimate radio wave usage situation and for CR system to decide the priority of communication. Finally, we show that our algorithm can estimate MAC protocol of existing system and improve the communication opportunity of CR system.

2. RADIO WAVE ENVIRONMENTAL MONITORING

A cognitive radio is aware of its own capabilities, the needs of its user, the radio environment, and the governing regulations in ways that allow it to configure itself intelligently to optimize its performance in response to novel and rapidly changing environment. For purposes of analysis, it is convenient to represent the world of cognitive radio technology as three domains in order to provide a functional structure. These are the performance preferences of user, spectral regulations and radio domains. The radio domain is defined to include both the radio environment and the radio hardware, and the cognitive systems receive both the radio hardware information and radio environment information.

The radio environment is formulated as the superset of waveforms and propagation channel data. Because parametric representation of both the waveform and channel is essential to machine reasoning and learning, the waveform is defined by PHY and MAC layer parameters. We use the term "signal" for the PHY layer parameters,

which includes carrier frequency, channel bandwidth, symbol rate, pulse shape, modulation, error correction coding, etc. The signal recognition is the starting point of radio cognitive behavior. The design challenges arise because it is inseparable from the signal reception procedure and therefore bears all the challenges of receiver design and adds more because now the signal is to be received cognitively.

2.1. Definition of Radio Wave Environmental Monitoring in Paper

The cognitive radio technique is composed of coexistence between some systems and CR systems, and the radio wave environmental monitoring (RWEM). We focus on the RWEM. Furthermore, RWEM is composed of the estimation of Physical layer and the estimation of MAC layer. Physical layer is that the position and the transmission power. MAC layer is composed of the estimation of traffic quantity and MAC protocol.

2.2. System Model

Some CR terminals are able to communicate each other and transmit the monitoring information regularly. Firstly, they perform career sense in their frequency, and analyze the signal transmitted from monitoring target. Next, by analyzing transmission timing of target and received power from monitoring target terminal (MTT), its position and transmission power is estimated by positioning algorithm, for example, time difference of arrival (TDOA), received signal strength (RSS) or angle of arrival (AOA). Transmission power is estimated by calculating the distance attenuation from each CR terminal's received power. After estimating this position and transmission power, the parameters of MAC layer are can be started to estimate. Furthermore, the statistical characteristics of each MTT's transmitting time are analyzed. This shows figure 1.

2.3. Estimation of MAC Protocol

That which estimates MAC protocol is that judges Contention base protocol or control base protocol. In order to estimate them, it is necessary to analyze target's transmission start time in case of the transmission of other MTT.

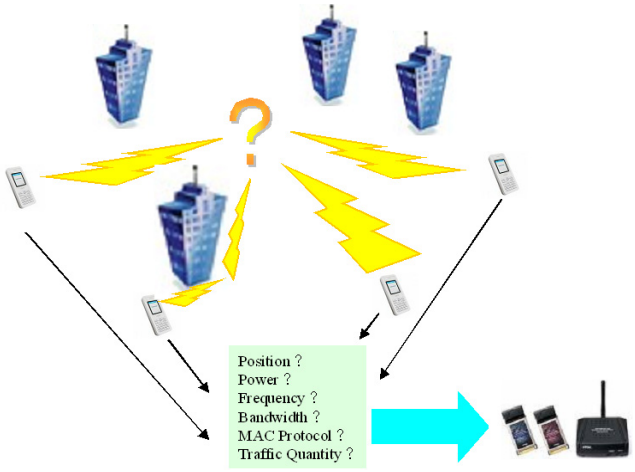

Figure1. Radio Wave Environmental Monitoring Model

2.4. Estimation of Traffic Quantity

That which estimates traffic quantity is that one MTT communicates other MTT how interval they communicate. Furthermore, it is important for CR system to know that MTT communicate where other MTT. In order to estimate traffic quantity, it is necessary to know each transmission and reception information of MTT. The transmission situation in time domain of control base protocol and contention base protocol shows figure 2.

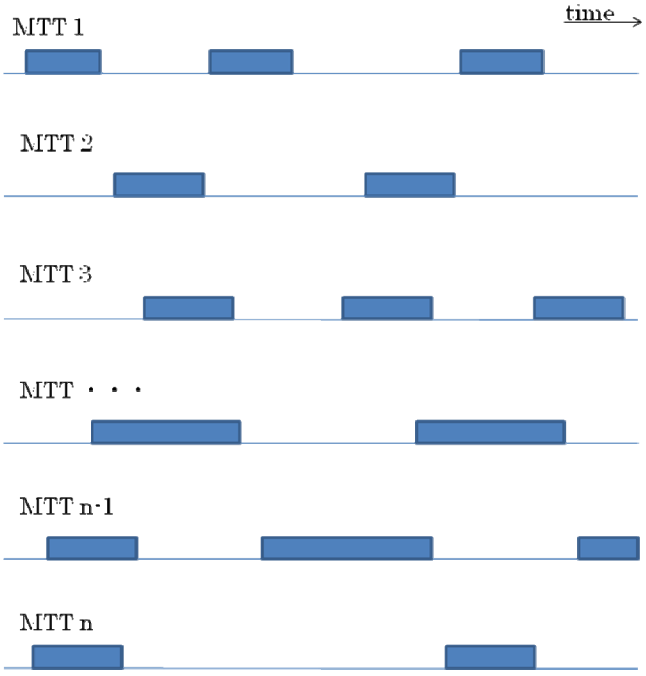

Figure 2 Transmission Timing in Control Base Protocol and Contention Base Protocol

3. ESTIMATION ALGORITHM OF TRAFFIC QUANTITY AND MAC PROTOCOL

3.1. MAC Protocol

In order to estimate MAC protocol, at first, some MTTs must exist (no less than 3 MTTs). By analyzing the behavior in case of sensing signal transmission from other MTT, it is able to estimate whether contention base protocol or control base protocol. The process of estimation algorithm is as follows.

1. CR systems have the information of whether transmission or idle of MTT 1-n.
2. Estimation system focuses on MTT i, and analyze transmission timing on the time axis.
3. If system senses transmission of MTT i, checks other MTT within transmission range limit, and trace DIFS time Td forward from transmission time Tstart.
4. If the other MTT within transmission range limit is under transmission in MTT transmission time, likelihood of control base protocol is raised.
5. If transmission of the other MTT within transmission range limit is over between Td, likelihood of contention base protocol is raised.
6. This process is performed at all monitoring time, and the larger likelihood protocol is decided and output it.
7. Furthermore, 2-6 processes is performed at all of MTT n.

The flowchart of these processes is shown in figure 3.

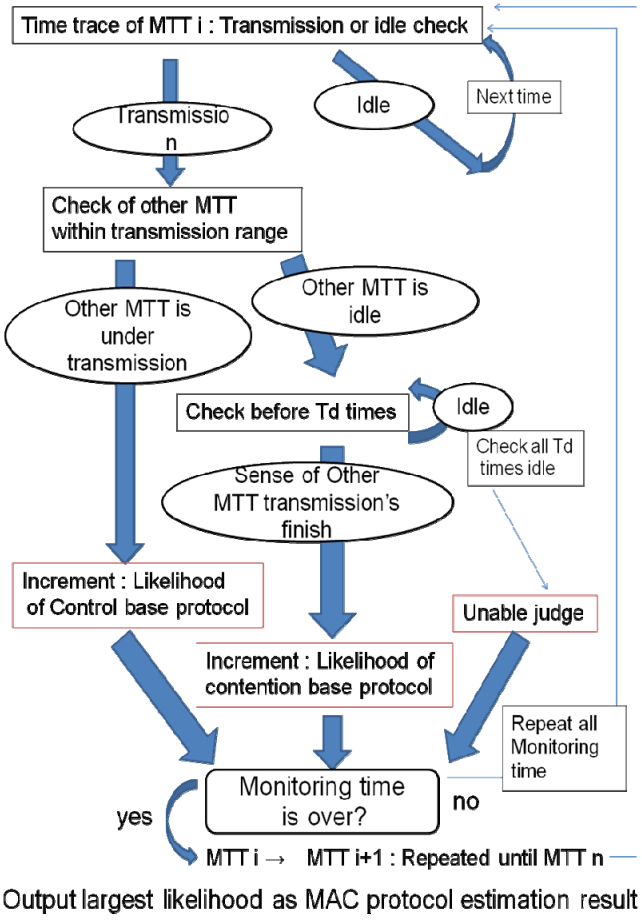

Figure3. Flowchart of MAC Protocol Estimation Algorithm

3.2. Analysis of Transmission Target and Estimation of Traffic Quantity

In order to analyze transmission target and estimate traffic quantity, similarly, some MTTs must exist (no less than 3 MTTs). Transmission target is estimated, by corresponding with transmission packet length each other and by responding after transmission of other MTT. Traffic quantity can be estimated by checking all time transmission. This estimation promotes RWEM performance.

4. NUMERICAL RESULT

In this section, we will analyze MAC protocol estimation performance. As the system model, some MTTs exist in the fixed field, and transmit the signal by each MAC protocol. We assume that CR system can check the MTT's behavior (under the transmission or idle). CR system estimate MAC protocol based on the information.
The parameters of simulations are shown in table 1.

Field	300x300[m]
Node	15,30,50
Transmission Range	300[m]
Monitoring Time	0.3[sec]
MAC Protocol Transmission Rate	Contention base : Control base = 1:1
Trial Number	5000
Backoff and DIFS time	800 [μ s]
Packet length	2.25[ms]

Table 1. Parameters of simulation

Figure 4 shows that the traffic rate (the ratio of how often each MTT perform the packet transmission process) versus MAC protocol estimation error changing node number.
Figure 5 shows that traffic quantity rate versus rate of impossible to estimate the MAC protocol.

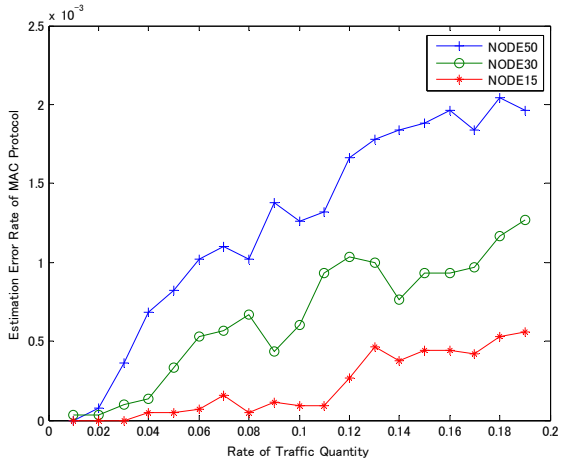

Figure 4. Estimation Error Rate of MAC Protocol vs. Rate of Traffic Quantity

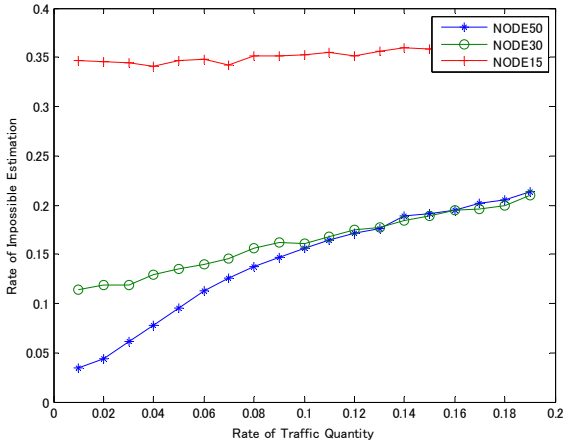

Figure 5. Rate of Impossible Estimation vs. Rate of Traffic Quantity

In figure 4, if node number increases, the error rate of MAC protocol estimation rises. The cause of error is that transmission model of the control base protocol resembles the timing of the contention base protocol. By increasing number of MTT, it is considered that the occasion of its error increase.
In figure 5, on the contrary, if node number increases, the error rate of MAC protocol estimation falls down. This algorithm is that checks transmission timing and behavior in case of the signal transmission of other MTT, therefore, the probability which cannot estimate arises.

5. CONCLUSION

In this paper, we focused on MAC protocol estimation as one of the RWEM system. In order to estimate it, the analysis in time domain was necessary. Therefore, we focused on each MTT, and analyzed the transmission situation of surrounding device. Their estimations lead to improve the communication opportunity of CR system. For example, by deriving MAC protocol information, CR system judges whether it can transmit or not. Thus, as one of the RWEM factor, MAC protocol estimation was considered to be effective.

10. REFERENCES

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