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A slot allocation scheme in wireless cellular networks

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Abstract- The diverse variation of wireless environment affects the continuous connection of data traffic, and it needs the requirements of more network efforts to provide stable network services. The burst property of data traffic can also take the load path to the mobile networks to receive suitable service. In this paper, we consider the time period mechanism that it is originated in the Discontinuous Reception (DRX) operation technique based on the system state.

Keywords- Wireless cellular networks, Load management, Long-Term Evolution Advanced (LTE-Advanced) and International Telecommunication Union – Radio (ITU-R).

1. Introduction

The wireless networks market has been dramatically increased more than any other telecommunication technique in the last decade [1, 6-10].

The wireless cellular technology is being continuously evolved to provide the suitable services to the demands of mobile system users. In addition to proving the voice call services, the appearance to various kinds of mobile terminals has led tremendous growth to data traffics in recent years. It is expected that by 2020 the requirement to using data traffic will be grown more than 500 times compared to 2009 [1]-[5][11].

There have been the extension of cellular network architecture and the continual installation of additional equipment in such this circumstance [12-20]. International Telecommunication Union – Radio (ITU-R) has introduced the new paradigm of International Mobile Telecommunications – Advanced (IMT-Advanced), which has the goal to support massive data traffic [2-4].

Hence, to satisfy this target the Third-Generation Partnership Project (3GPP) Long-Term Evolution Advanced (LTE-Advanced) systems can provides high peak data rates up to 1 Gbps on the downlink and 500 Mbps on the uplink. Also, as the competition technology to the standard of next generation wireless networks the IEEE 802.16 group proposes the Worldwide Interoperability for Microwave Access (WiMAX) systems [5-7].

The remainder of this paper is organized as follows: In section, we describe the slot allocation for the wireless network service. And, the conclusions are given in section 3.

2. Slot allocation

In this paper, we adopt the time period mechanism that it is originated in the Discontinuous Reception (DRX) operation technique based on the system state [15-16]. Also, as to the system state, we consider two connection states (stable and unstable states) to transferring data traffic. Fig. 1 shows an example of time period diagram during the network service.

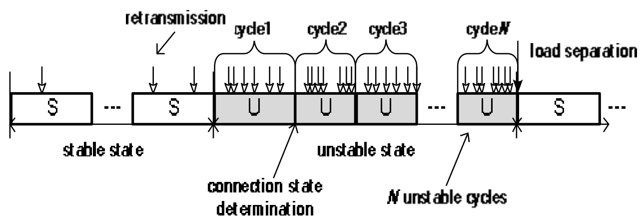

Fig. 1. An example diagram of connection states for the mobile terminal.

Figure shows the overall scenario snapshot to manage the data traffic load. Periodic time slide is flowed on the system state. In stable state ('S'), the wireless networks normally provide their services to the mobile terminal. But if the failure rate of data transmission increases by the network situation change, the system state is transitioned into the unstable state ('U') from the stable state. Here, the system state on the time slide is determined at the end of its slide window. For the state transition to the network failure rate, we define the failure threshold (f_T). By the continuous occurrence of retransmission, the retransmission occurrence density (μ_N) is higher than f_T ($\mu_N > f_T$), the connection state is changed from the stable state to unstable state. If $\mu_N < f_T$, the connection sate is not changed, and the next period slide is still about the stable state. In the figure, although the period slide size is to the stable state, at the period end the system state is determined as the unstable state caused by $\mu_N > f_T$, and vice versa. That is, when the time slide is of the unstable cycle, and $\mu_N < f_T$ at the slide end, the connection state will be the stable state with the unstable slide size. The mobile terminal continuously monitors failure occurrence in the unstable state. If the extreme inferior condition is not improved, and the retransmission frequency is high, the system will stay in the unstable state with its period slide. And, after *N* unstable cycles, the mobile terminal can implement the load separation to the stable cooperative communication. If the load separation is fulfilled, the next period slide is prepared as the slide of stable state. Here, the connection situation is same as before, and the μ_N is still high ($\mu_N > f_T$), the connection state becomes the unstable state, and previous process will be repeated. After next continuous N unstable cycles, additional load separation can be supported. If the failure rate is reduced after the load separation, the connection state will be the stable state with normal period slide.

To represent the analysis of power consumption, we define the power loss rate (P_r). It is assumed that the random variables T_s and T_u represent the entire times of stable state and unstable state, respectively. We also assume that $E[T_s]$ and $E[T_u]$ are the expectations of random variables of those two states. Hence, the P_r is given by

$$P_r = \frac{E[T_u]}{E[T_s] + E[T_u]}. \tag{1}$$

To derive the expectations ($E[T_s]$ and $E[T_u]$), firstly we assume that the first time slide is started with the time slide size of stable state. After the first stable slide, consecutive time slides of stable state can be followed, or the first time slide will be determined as the unstable time slide by the network conditions. If the first time slide becomes the unstable state slide, the first time slide of stable state has the slide size of unstable state. The overall time of stable state (T_s) consists of continuous normal stable slides and that stable slides with first unstable slide size. Hence, the expectation $E[T_s]$ can be written as

$$E[T_s] = E[T_{cs}] + E[T_{ns}] \tag{2}$$

where $E[T_{cs}]$ is the average time of continuous normal stable slides, and $E[T_{ns}]$ is the average time that consists of the first stable slide having unstable slide size and normal stable slides.

Here, $E[T_{ns}]$ is derived as

$$E[T_{ns}] = E[T_{ss}] + U_t \tag{3}$$

where U_t is the constant value of time slide size of normal unstable state, and $E[T_{ss}]$ is the average time of following stable slides after the first time slide U_t.

Hence, substituting (3) into (2), the expectation $E[T_s]$ is given by

$$E[T_s] = E[T_{cs}] + E[T_{ss}] + U_t. \tag{4}$$

In case of T_u, it shows the summation to the first unstable slide having the slide size of stable state and following general unstable slides. Suppose that S_t is the constant value of time slide size of general stable state, and then the expectation $E[T_u]$ is expressed as

$$E[T_u] = E[T_{cu}] + S_t \tag{5}$$

where $E[T_{cu}]$ is the average time of following unstable slides with the first time slide S_t.

Therefore, substituting (4) and (5) into (1), P_r can be expressed by

$$P_r = \frac{E[T_{cu}] + S_t}{E[T_{cs}] + E[T_{cu}] + E[T_{ss}] + S_t + U_t}. \tag{6}$$

4. Conclusions

In this paper, we study the time period mechanism for the slot allocation. Its scheme is originated in the Discontinuous Reception (DRX) operation technique based on the system state. As to the system state, we consider two connection states (stable and unstable states) for the data traffic transmission. In the stable state, the wireless networks can provide normal network service for the network calling. However, if the failure rate of data transmission will be increased by the network situation change, the system state can be transitioned into the unstable state from the stable state.

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