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Title	**Providing BS with Loading Information of Initial Ranging Channel**
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Re:	IEEE P802.16e/D5a
Abstract	This contribution proposes the scheme with which MSS can provide BS with the loading information of Initial Ranging Channel.
Purpose	Discussion and Adoption in IEEE 802.16e
Notice	
Release	
Patent Policy and Procedures	

Providing BS with Loading Information of Initial Ranging Channel

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Problem Statement

In order to maximize the efficiency of the contention-oriented random access channel, system should allocate the adequate resource to the random access channel and also properly set the backoff control parameters, on the basis of the loading information. However, it is not easy for BS to correctly estimate the loading on the wireless random access channel such as Initial Ranging Channel.

There may be two ways to estimate the loading on Initial Ranging Channel: One is based on the throughput (i.e. departure rate) on Initial Ranging Channel. However, since the throughput does not monotonically increase with the offered load, it is not easy to obtain the correct loading information only from the throughput (see Figure 1 (a) in Appendix). The other way is based on the total received power at BS, but the measured power on wireless link is not enough to provide the correct loading information.

Hence, there is a need of the scheme that lets BS know the more accurate loading information of Initial Ranging Channel.

Suggested Remedy

We suggest that RNG-REQ message should include a TLV of *the number of Initial Ranging contention transmissions*, for the purpose of providing BS with the loading information of Initial Ranging Channel. By informing BS of the number of RNG-REQ messages (or Initial Ranging CDMA codes) which MSS has sent until contention is resolved, MSS can simply but effectively assist BS in gathering the more correct loading information of Initial Ranging Channel.

BS estimates the loading from the reported number of contention transmissions in RNG-REQ message. Based on this estimation, it may increase or decrease its channel resource for Initial Ranging, or change the setting of the control parameter such as backoff window size if necessary.

In Appendix, we present a simple example which shows how the loading can be estimated from the reported number of contention transmissions and how the estimated loading information can be utilized to control the backoff window size of Initial Ranging Channel.

Proposed Text Change

[Remedy: Insert the following row to the end of table 362a at page 395]

11.5 RNG-REQ message encodings

……

Table 362a—RNG-REQ message encodings

Name	Type	Length	Value	PHY Scope
……	……	……	……	……
Number of Initial Ranging contention transmissions	10	1	This parameter indicates the number of Initial Ranging contention transmissions which MSS has performed until contention is resolved. For SCa and OFDM PHY modes, the value of this parameter is set to the number of RNG-REQ messages which MSS has sent in Initial Ranging Intervals including the one with this encoding. For OFDMA PHY mode, the value of this parameter is set to the number of Initial-Ranging CDMA Code (or Handover CDMA Code) transmissions on the Initial Ranging region to gain access for sending the RNG-REQ message with this encoding.	SCa, OFDM, OFDMA

Appendix

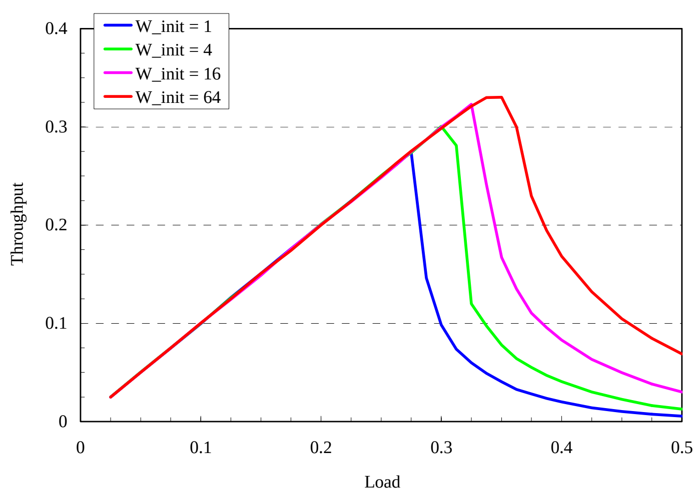
In this section, we present a simple example which shows how the loading can be estimated from the reported number of the contention transmissions and also how the estimated loading information can be utilized to control backoff window size of Initial Ranging Channel. Through the use of a *Monte Carlo* simulation, we obtained the performance results of contention channel with binary exponential backoff.

Simulation model is developed as follows: RNG-REQ Message-based Initial Ranging is considered. One slot provides one transmission opportunity. New Initial Ranging requests arrive according to independent Poisson processes. The contention resolution follows the binary exponential backoff scheme shown in IEEE 802.16-2004 Ch.6.3.8 Contention Resolution – MSS whose transmission has collided increases its backoff window by a factor of two, and then it randomly selects a number (backoff length) within its new backoff window. The various settings of Initial backoff window size (W_init) are applied (i.e. 1, 4, 16, or 64). The maximum backoff window is set to 1,024. The maximum number of retransmissions and the maximum allowable delay are limited to 16 and

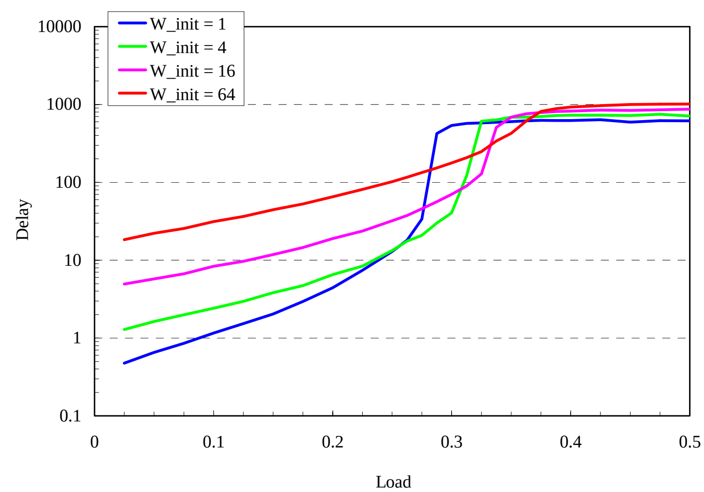
3000 slots, respectively. Considered power ramping up, probability of successful decoding for the transmitted message (i.e. RNG-REQ message) without collision is assumed to be 0.8 for the 1st transmission, 0.9 for the 2nd transmission, and 1.0 for the 3rd and over the 3rd transmission.

Performance metrics are defined as follows:

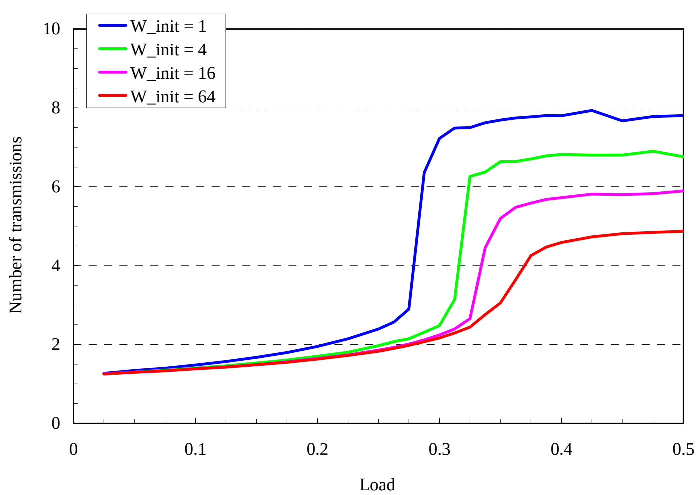
- *Throughput*: Averaged number of successful requests per slot
- *Delay*: Expected delay per successful request (in slots)
- *Number of Transmissions*: Averaged number of contention transmissions per successful request
- *Request Failure Probability*: Probability of dropping the request because the number of retransmissions or delay exceeds its maximum value.



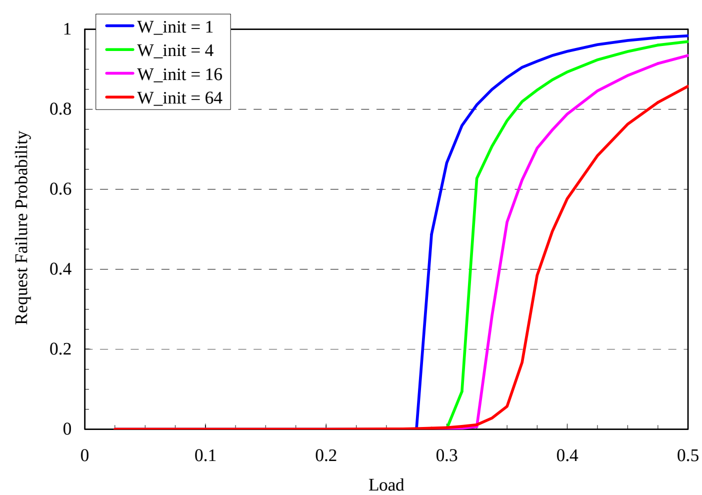
(a) Throughput



(b) Delay



(c) Number of Transmissions



(d) Request Failure Probability

Figure 1. Performance of Contention Channel with Binary Exponential Backoff

Figure 1 shows the performance results versus *Load*, which is defined as the averaged number of new Initial Ranging requests per slot. We can see that as expected, *Throughput* increases with the initial backoff window size, but it also leads to a considerable increase in *Delay* at low loading. Hence, initial backoff window size should be reduced at lower loading. Such performance results confirm that if the loading can be correctly estimated, the maximum throughput can be achieved while delay is minimized, through the appropriate setting of initial backoff window size.

We can see that *Number of Transmission* shown in Figure 1 (c) monotonically increases with *Load*, unlike *Throughput*. Also, its shape similar to the step function indicates well the instance of entering into the overload state, so *Number of Transmission* can let BS know whether the current state of Initial Ranging Channel is overloaded or not. Hence, we can conclude that the load information on Initial Ranging Channel can be sufficiently obtained from *Number of Transmissions*.