A new buffering delay aware energy efficient low latency burst transmission scheme

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1. Introduction

In this paper, we investigate packet burst transmission, which involves grouping multiple packets for efficient power reduction by utilizing the sleep functionality in networking devices[1]. It is known that when transitioning from a low-power sleep state to a wake-up state, devices require a relatively large power due to access requests. Therefore, packet burst transmission is effective to minimize power consumption by reducing the number of device activations for transmissions. However, it is recognized that increments in the number of packets grouped in burst transmission lead to excessive latency. We propose a method to tune the number of grouped packets dynamically, thereby preventing excessive latency along with effectively reducing power consumption.

2. Related work

Burst transmission was proposed in the literature [2], and performance evaluations demonstrated that burst transmission can achieve power consumption levels that are reasonably close to the ideal in Energy-Effifient Ethernet. However, when the size of grouped packets is too large, the corresponding latency is also large. The authors in the literature [3] proposed the method that sets the upper limits on the packet-grouping size and its corresponding latency. This method did not consider buffering delays, while the corresponding latency consists of the packet-grouping time and buffering delays in the bottleneck. Therefore, we propose and evaluate a new method that controls the packet-grouping size taking buffering delay into account.

3. Proposal

We propose a method to dynamically tune or adjust the packet-grouping size. Conventional schemes set upper limits on the packet-grouping size and its corresponding time, but the packet-grouping size may be insufficient or the buffering delay may increase for some links. When the packet-grouping size is too small, the reduction of the power consumption is not enough. On the other hand, when the packet-grouping size is too large, the buffering delays occur resulting in the corresponding latency increases. In our proposed method, the packet-grouping size is dynamically adjusted based on the sum of the packet-grouping time and buffering delay, in order to achieve power savings and reduce buffering delay on various links. The target delay, that is, upper limit for the sum of packet-grouping time and the buffering delay, is a hyper parameter. The key parameters are listed in the Table 1. The results are obtained as the average values of 10 simulations trials. Fig. 1 shows the average power consumption $E(P)$, and Fig. 2 shows the average latency $E(D)$, that is the sum of the packet-grouping time and buffering delay.

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Table 1: Parameters in simulations.

	value
Bandwidth(C)	100×10^3 [packets/s]
Link utilization(ρ)	0.10 ~ 0.99
Propagation delay	0.02 [s]
Target delay(t_{target})	0.02 [s]
Power consumption in sleep state	0 [W]
Power consumption in wake-up state	10 [W]
Power consumption in idle state	1 [W]
Power consumption in busy state	5 [W]
Wake-up time	10 [μs]
Maximum packet-grouping size	$C \times t_{\text{target}}$ [packets]
Simulation time	100 [sec]

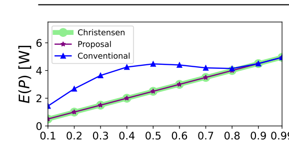

Fig. 1: Average power consumption.

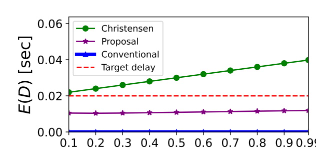

Fig. 2: Average latency.

4. Conclusions

In this paper, we proposed a new burst transmission scheme considering the buffering delay as a part of the latency. Then, we evaluated its performance through simulations. Results show that our proposed scheme can keep the latency below the target and the power consumption low, near the ideal value.

References

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