* + 1. **Compare batch arrival with single arrival**

This subsection compares the scenario with single/batch arrival. In batch arrival, we set to be twice of , and the HP packet arrival rate is . In single arrival, we set , and the HP packet arrival rate is . For a fair comparison, we set same in single and batch arrival. The LP packet arrival has the same pattern as the HP packet. Subsequently, the results are shown in Fig. 5-14 to Fig. 5-25.

In Fig. 5-14, the relationship between the expected number of all packets in the system and the HP packet arrival rate is depicted. No matter if energy arrival rates or , it is evident that the curves for batch arrival in and are higher than the curves for single arrival first and then cross over. This discrepancy arises because the arrival rate is larger than departure rate, leading to the system under heavy load. If the system is under heavy load, that is, the packet queue is always full, the time interval between packets in batch arrival is longer than those in single arrival. It gives the server more time to server packets. Subsequently, there is a better chance that packets in batch arrival can enter the system. In addition, it is evident that the curve for batch arrival is always higher than single arrival in . Due to the non-preemption of HP packets over LP packets, the more HP packets enter the server to complete the service. Packet with single arrival may let more HP packets enter the system than batch arrival. This is because packets with batch arrival may encounter situations where there is only one place, and one of the packets will be blocked.

In Fig. 5-15, the relationship between the expected number of all packets in the packet queue and the HP packet arrival rate is depicted. No matter if energy arrival rates or , it is evident that the curves for batch arrival in and are higher than the curves for single arrival first and then cross over. This discrepancy arises because the arrival rate is larger than departure rate, leading to the system under heavy load. If the system is under heavy load, that is, the packet queue is always full, the time interval between packets in batch arrival is longer than those in single arrival. It gives the server more time to server packets. Subsequently, there is a better chance that packets in batch arrival can enter the packet queue. In addition, it is evident that the curve for batch arrival is always higher than single arrival in . Due to the non-preemption of HP packets over LP packets, the more HP packets enter the server to complete the service. Packet with single arrival may let more HP packets enter the system than batch arrival. This is because packets with batch arrival may encounter situations where there is only one place, and one of the packets will be blocked.

In Fig. 5-16, the relationship between the mean waiting time of all packets and the HP packet arrival rate is depicted. Regardless of whether the energy arrival rates are or , it is evident that the curve depicting batch arrivals in and is higher compared to the curve depicting single arrivals followed by crossover. Furthermore, it is clear that the curve representing batch arrivals in is always higher than the curve for single arrivals. The trend of the curves are positively correlated with , that is, the more packets there are in the system, the more waiting time there will be.

In Fig. 5-17, the relationship between the mean waiting time of all packets in the packet queue and the HP packet arrival rate is depicted. Regardless of whether the energy arrival rates are or , it is evident that the curve depicting batch arrivals in and is higher compared to the curve depicting single arrivals followed by crossover. Furthermore, it is clear that the curve representing batch arrivals in is always higher than the curve for single arrivals. The trend of the curves are positively correlated with , that is, the more packets there are in the packet queue, the more waiting time in the packet queue there will be.

In Fig. 5-18, the relationship between the throughput of all packets and the HP packet arrival rate is depicted. No matter if energy arrival rates or , it is evident that the curves for batch arrival in and are always lower than the curves for single arrival. This is primarily attributed to the time intervals between packet arrivals, packets with single arrival arrive more frequently than batch arrival. That cause the less simulation time and the more packets be served. Additionally, the curves for batch arrival in are initially lower than the curves for single arrival and then become the same. This phenomenon can be explained in two parts. In the former part, the reason remains the same as mentioned earlier, which is due to the difference in packet arrival intervals and frequencies. Regardless of whether it is a single arrival or batch arrival, the remains the same in heavy HP load. This is because a majority of the arriving packets are of HP, which results in the LP packets being unable to receive service.

In Fig. 5-19, the relationship between the energy loss probability and the HP packet arrival rate is depicted. No matter if it is single arrival or batch arrival, it is observed that remains consistently at zero when considering . This is due to the persistent insufficiency of energy to provide the required service, as indicated by . Consequently, whenever an energy unit arrives, it is immediately consumed by a packet in the queue. On the other hand, in the case of , the curve of batch arrival is higher than single arrival in the light load. It is because the time intervals of single arrival are more frequent than batch arrival, leads the less energy loss in single arrival.

In Fig. 5-20, the relationship between the blocking probability of all arrived packets and the HP packet arrival rate is depicted. When considering or , it is observed that their respective , , and values are identical. However, the , and of batch arrival are higher than single arrival. This can be attributed to the fact that the packets in batch arrival increase rapidly at one time and may encounter situations where there is only one place, and one of the packets will be blocked, leads to get a higher , and

In Fig. 5-21, the relationship between the total loss probability of all arrived packets and the HP packet arrival rate is depicted. When comparing the curves of for and in batch arrival and single arrival, it is evident that the curve of batch arrival is always higher than single arrival. In addition, the curve of batch arrival for initially higher than single arrival and then equal to single arrival. Furthermore, it is worth noting that in the case of , the curve of batch arrival for initially higher than single arrival and then lower than single arrival.

In Fig. 5-22, the relationship between the impatient loss probability of all arrived packets and the HP batch arrival rate is depicted. Regardless of whether the energy arrival rates are or , it is evident that the curve depicting batch arrivals in and is higher compared to the curve depicting single arrivals followed by crossover. Furthermore, it is clear that the curve representing batch arrivals in is always higher than the curve for single arrivals. The trend of the curves are positively correlated with , that is, the more packets there are in the system, the more chance that packets being impatient.

In Fig. 5-23, the relationship between the impatient loss probability of all admitted packets and the HP batch arrival rate is depicted. Regardless of whether the energy arrival rates are or , it is evident that the curve depicting batch arrivals in is higher than single arrival and then equal to single arrival. Additionally, is higher compared to the curve depicting single arrivals followed by crossover. Furthermore, it is clear that the curve representing batch arrival in is always higher than the curve for single arrival. The trend of the curves are positively correlated with , that is, the more packets there are in the system, the more chance that packets being impatient.

In Fig. 5-24, the relationship between regular energy consumption ratio for serving all packets and the HP packet arrival rate is depicted. When comparing the curves of, the curves for batch arrival are lower than single arrival. In addition, for , it is found that batch arrival and single arrival remain at zero until reaches 0.2 since the harvested energy is sufficient to meet the service requirements without relying on the regular battery. Additionally, batch arrival is lower than single arrival when larger than 0.2.

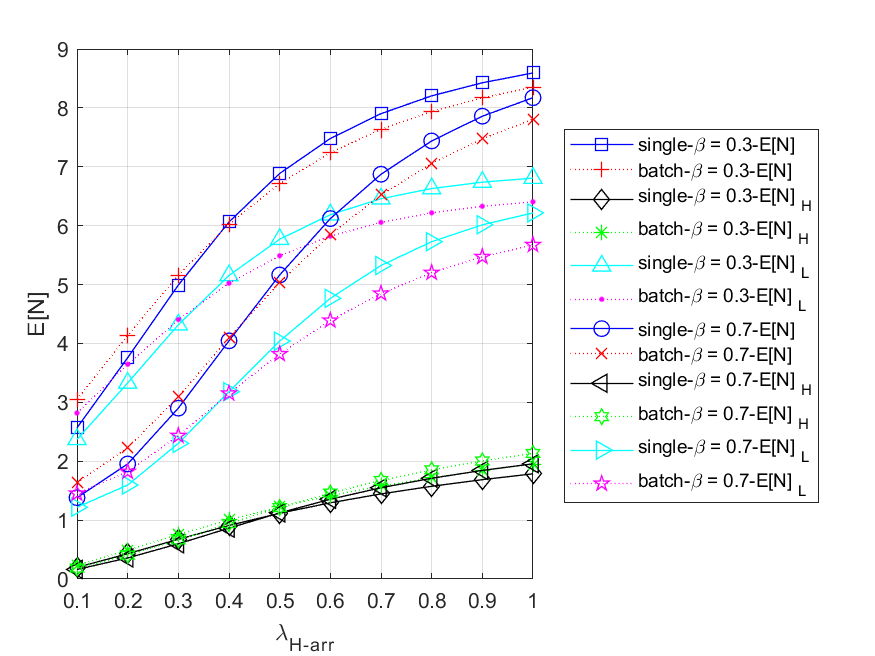


Fig. 5 - 14: The expected number of all () packets in the system vs. the HP packet arrival rate for single or batch arrival

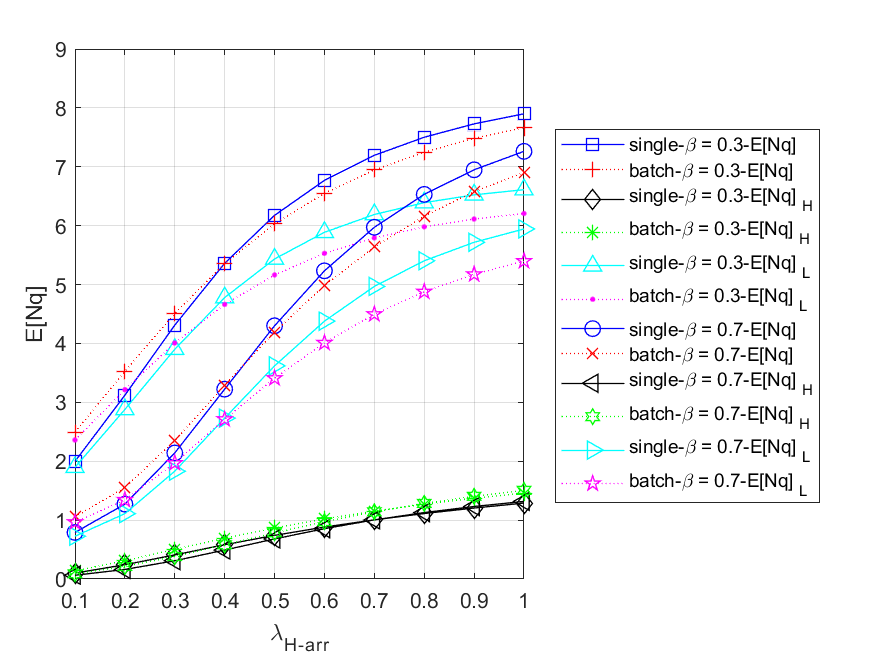


Fig. 5 - 15: The expected number of all () packets in the queue vs. the HP packet arrival rate for single or batch arrival

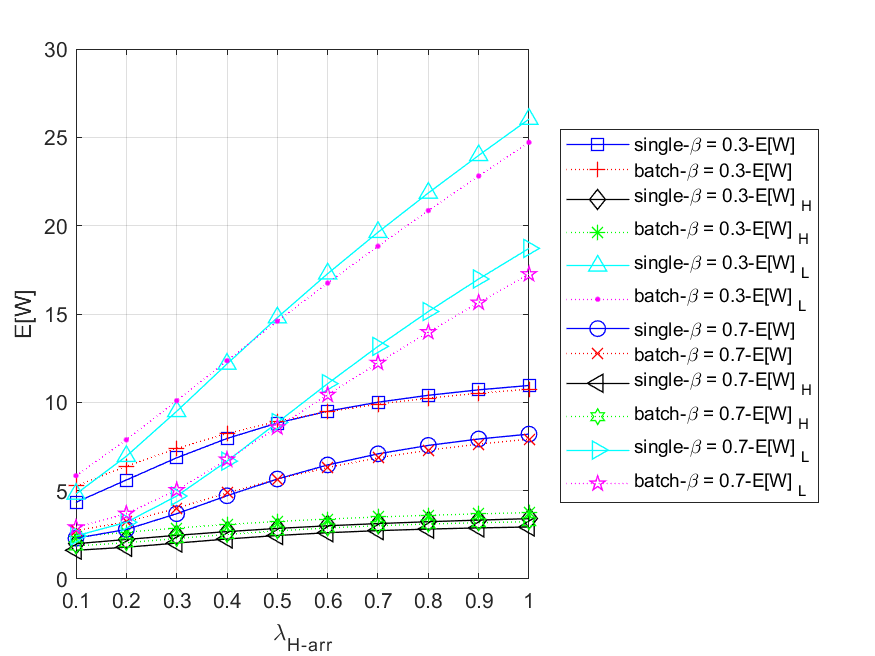


Fig. 5 - 16: The mean waiting time of all () packets in the system vs. the HP packet arrival rate for single or batch arrival

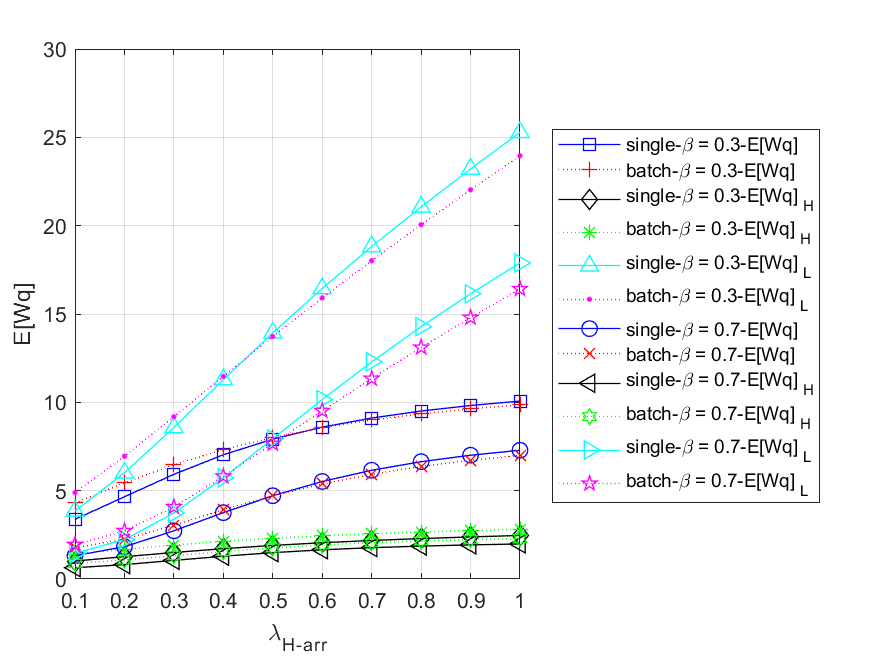


Fig. 5 - 17: The mean waiting time of all () packets in the queue vs. the HP packet arrival rate for single or batch arrival

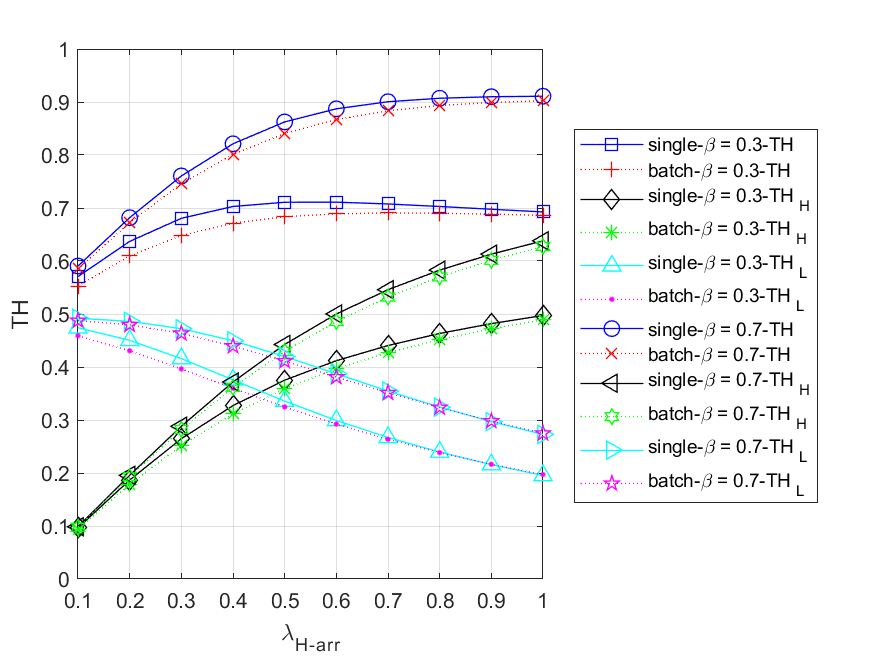


Fig. 5 - 18: The throughput of all () packets vs. the HP packet arrival rate for single or batch arrival

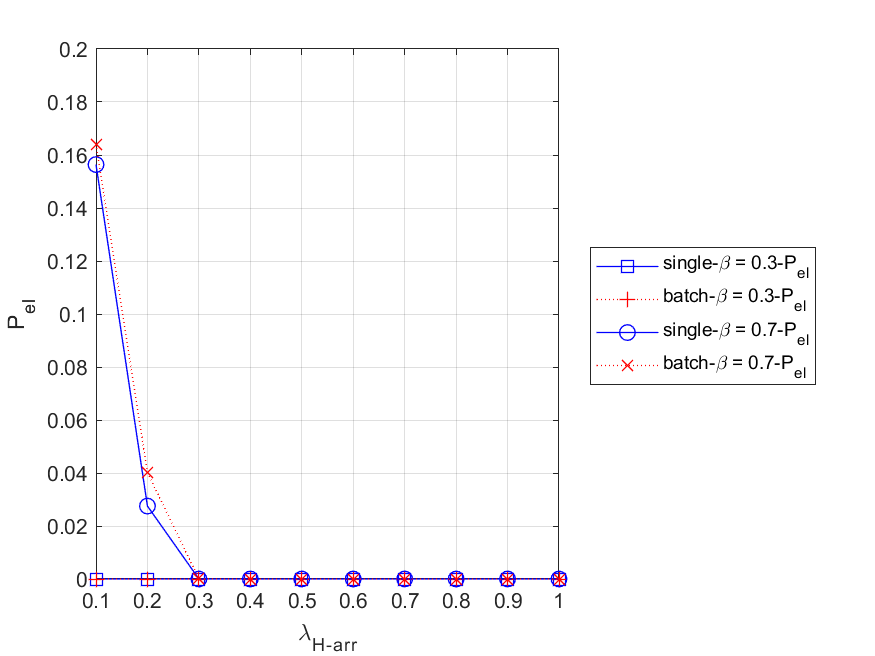


Fig. 5 - 19: The energy loss probability vs. the HP packet arrival rate for single or batch arrival

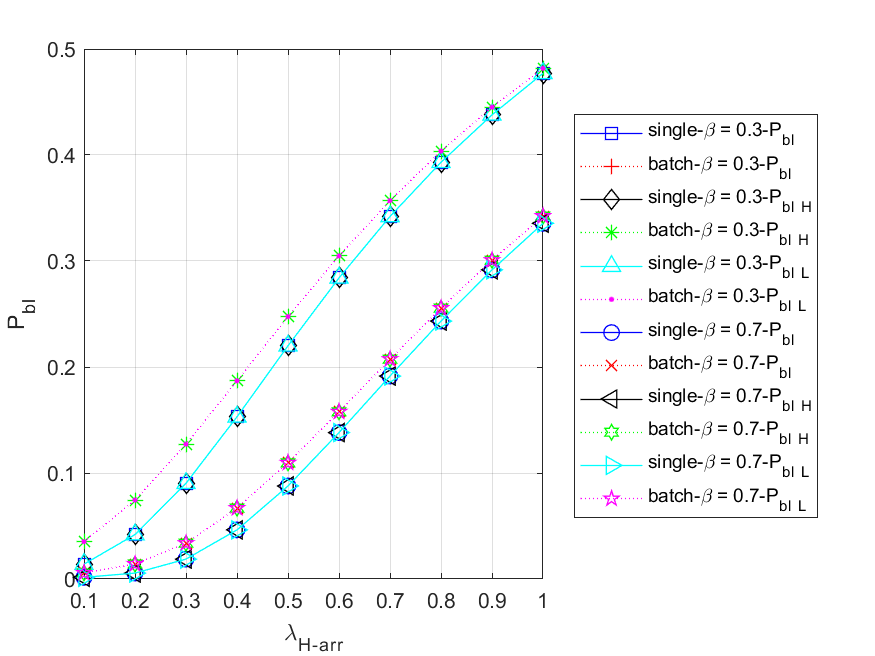


Fig. 5 - 20: The blocking probability of all () arrived packets vs. the HP packet arrival rate for single or batch arrival

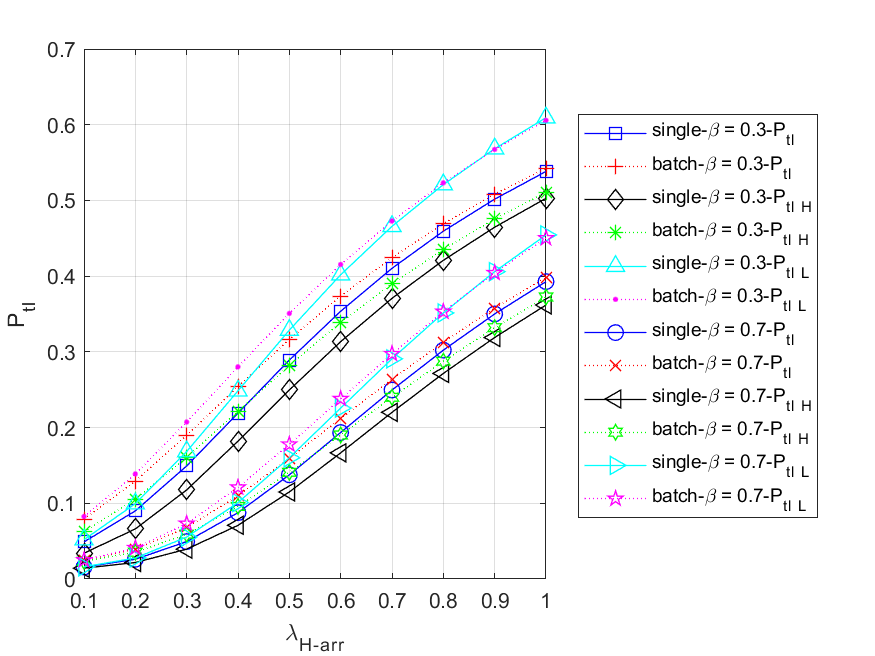


Fig. 5 - 21: The total loss probability of all () arrived packets vs. the HP packet arrival rate for single or batch arrival

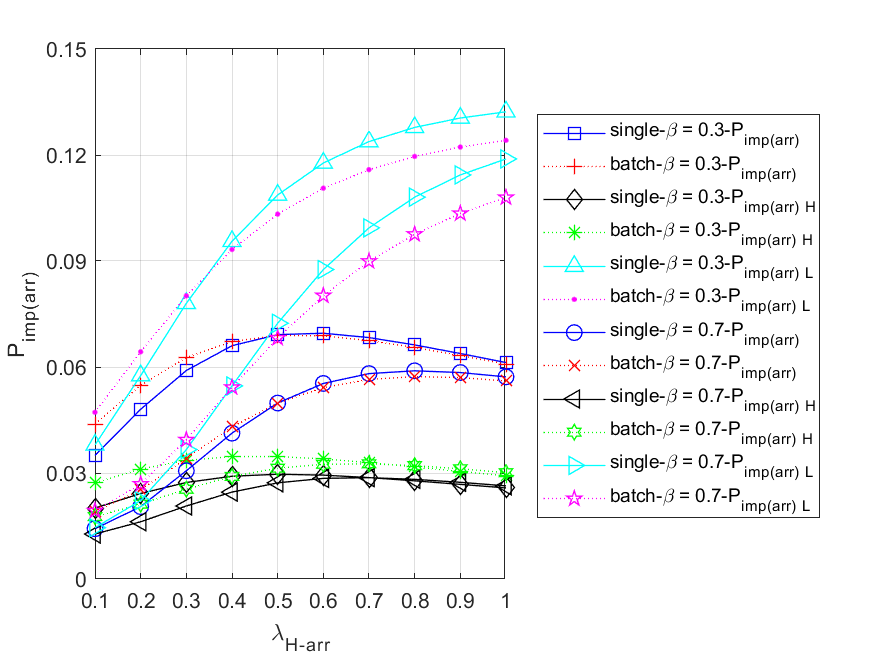


Fig. 5 - 22: The impatient loss probability of all () arrived packets vs. the HP packet arrival rate for single or batch arrival

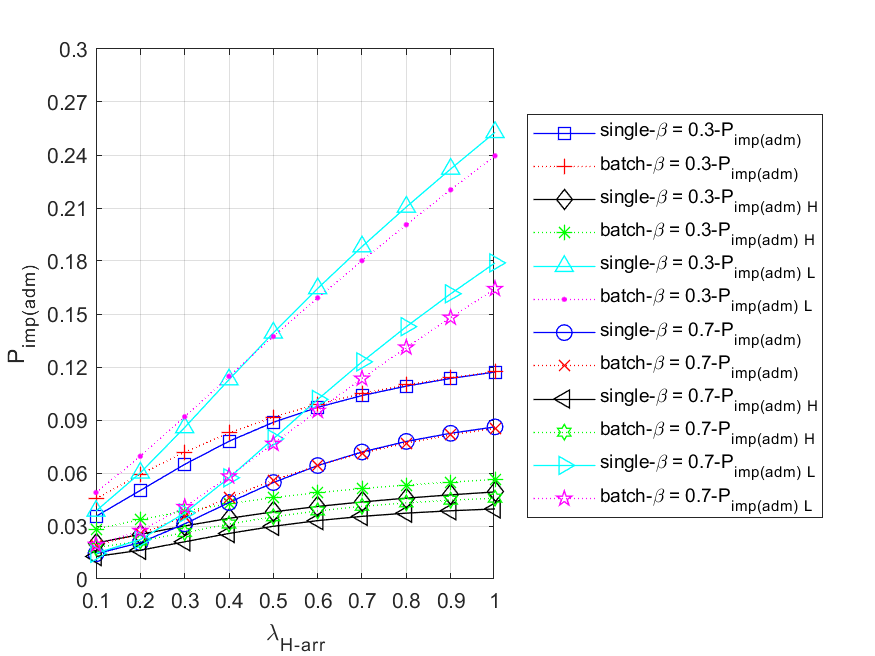


Fig. 5 - 23: The impatient loss probability of all () admitted packets vs. the HP packet arrival rate for single or batch arrival

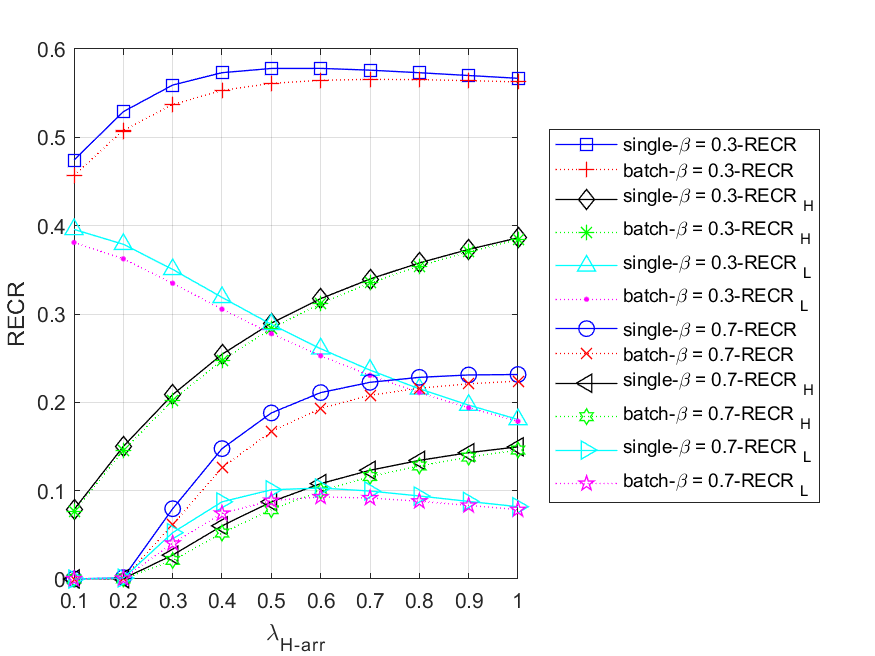


Fig. 5 - 24: The regular energy consumption ratio for serving all () packets vs. the HP packet arrival rate for single or batch arrival