A Supplementary Document for the Paper: Deep Reinforcement Learning Based Scheduling for NR-U/WiGig Coexistence in Unlicensed mmWave Bands

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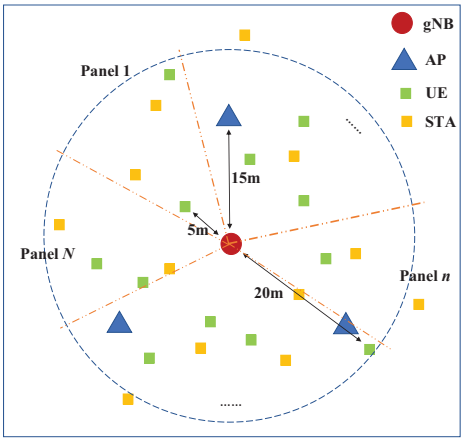


Fig. 1. The general NR-U/WiGig coexistence system.

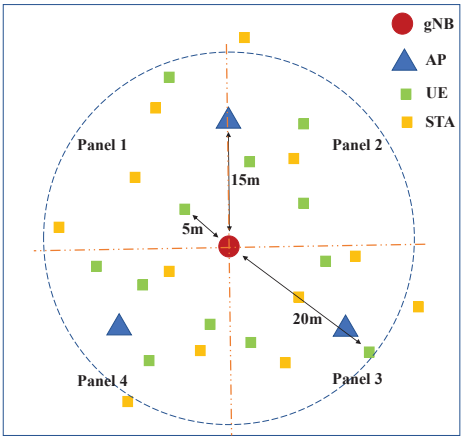


Fig. 2. The network topology for the coexistence scenario in Section V-B of our paper.

I. Introduction

This is a supplementary document for our paper: Deep Reinforcement Learning Based Scheduling for NR-U/WiGig Coexistence in Unlicensed mmWave Bands. In this document, we provide various network topologies for the coexistence of NR-U and WiGig in Section V of our paper. In general, as shown in Fig. 1, we consider an unlicensed mmWave HetNet, in which the NR-U network and the WiGig network share a common wireless channel to transmit data packets. To be specific, M multi-antenna APs and multiple single-antenna STAs are deployed in the WiGig network, and the NR-U network is composed of a multi-antenna gNB and N single-antenna UEs deployed around the WiGig STAs. Furthermore, the gNB in the NR-U network is equipped with K independent panels; and each panel $k \in \mathcal{K} = \{1, 2, \cdots, K\}$ is responsible for serving one specific UE group k containing N_k UEs located in a fixed region without interfering with other panels, wherein $\sum_{k=1}^{K} N_k = N$. In the following, we will introduce the detailed network topologies for the coexistence of NR-U and WiGig in Section V of our paper.

A. Data Rate Evaluation

The network topology corresponding to the coexistence scenario in Section V-B of our paper is presented in Fig. 2, where UEs and STAs are randomly deployed within 20 meters from gNB and corresponding APs, respectively. The gNB in the NR-U network is equipped with four panels which serve 2, 3, 3, and 4 UEs, respectively. In the WiGig network, there are 3 WiGig APs each serving 4 STAs. Among all the distances from UEs to gNB, the shortest is 5 m, and the farthest is 20 m. The distance from each WiGig AP to the gNB is 15 m.

B. Robustness to Different Data Rate Requirements

As shown in Fig. 3, in the network topology for Section V-C1 of our paper, UEs and STAs are randomly deployed within 20 meters from gNB and corresponding APs, respectively. In the NR-U network, the gNB possesses three panels and each panel serves three UEs. In the WiGig network, there are 3 WiGig APs each serving 4 STAs. Among all the distances from UEs to gNB, the shortest is 5 m, and the farthest is 20 m. The distance from each WiGig AP to the gNB is 15 m.

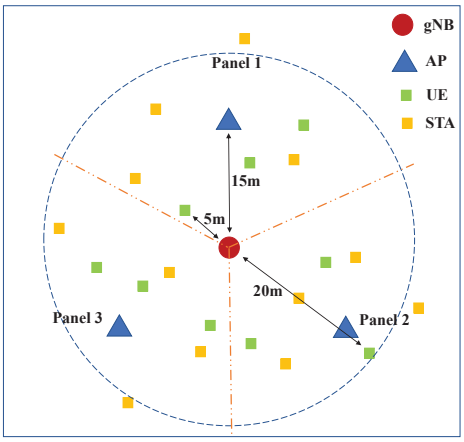


Fig. 3. The network topology for the coexistence scenario in Section V-C1 of our paper.

C. Robustness to Different Numbers of UEs

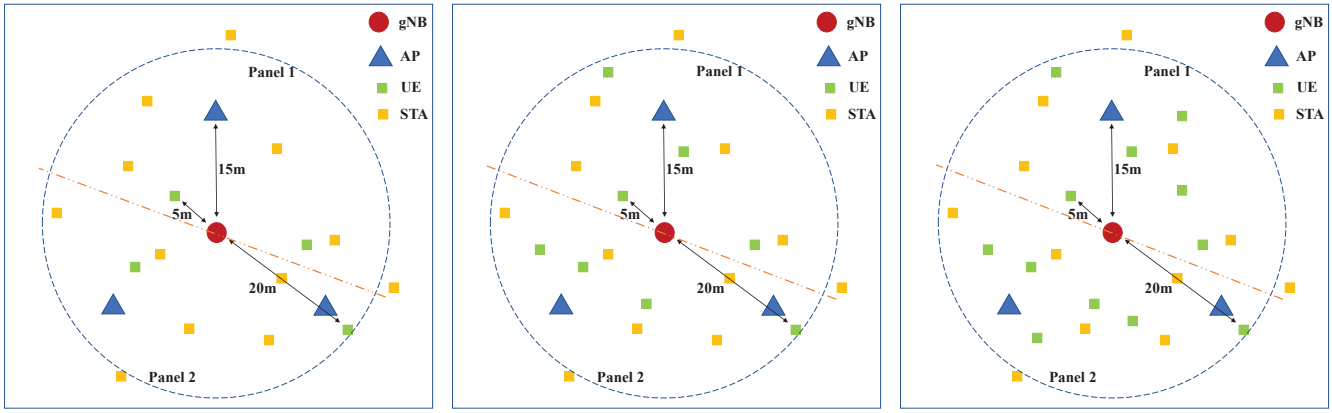
In Section V-C2 of our paper, we evaluate the robustness of various scheduling mechanisms by changing the number of UEs in each panel. Therefore, there are multiple network topologies for this coexistence scenario, which are depicted in Fig. 4. In all network topologies, UEs and STAs are randomly deployed within 20 meters from gNB and corresponding APs, respectively. In the WiGig network, there are 3 WiGig APs each serving 4 STAs. In the NR-U network, the gNB adopts two panels to serve all UEs, where the number of UEs in each panel is varied from 2 to 6 with a step size of 2. Specifically, Fig. 4a, Fig. 4b, and Fig. 4c show the scenarios where each panel serves 2, 4, and 6 UEs, respectively. Among all the distances from UEs to gNB, the shortest is 5 m, and the farthest is 20 m. The distance from each WiGig AP to the gNB is 15 m.

D. Complexity Evaluation of DeepDS and DeepCS

In Section V-D of our paper, we evaluate the complexity of DeepDS and DeepCS by changing the number of panels at gNB. Therefore, there are multiple network topologies for this coexistence scenario, which are presented in Fig. 5. In all network topologies, UEs and STAs are randomly deployed within 20 meters from gNB and corresponding APs, respectively. In the WiGig network, there are 3 WiGig APs each serving 4 STAs. In the NR-U network, the gNB is equipped with K panels each serving three UEs, where the value of K from 1 to 5 with a step size of 2. Specifically, Fig. 5a, Fig. 5b, and Fig. 5c show the scenarios where the number of panels are 1, 3, and 5, respectively. Among all the distances from UEs to gNB, the shortest is 5 m, and the farthest is 20 m. The distance from each WiGig AP to the gNB is 15 m.

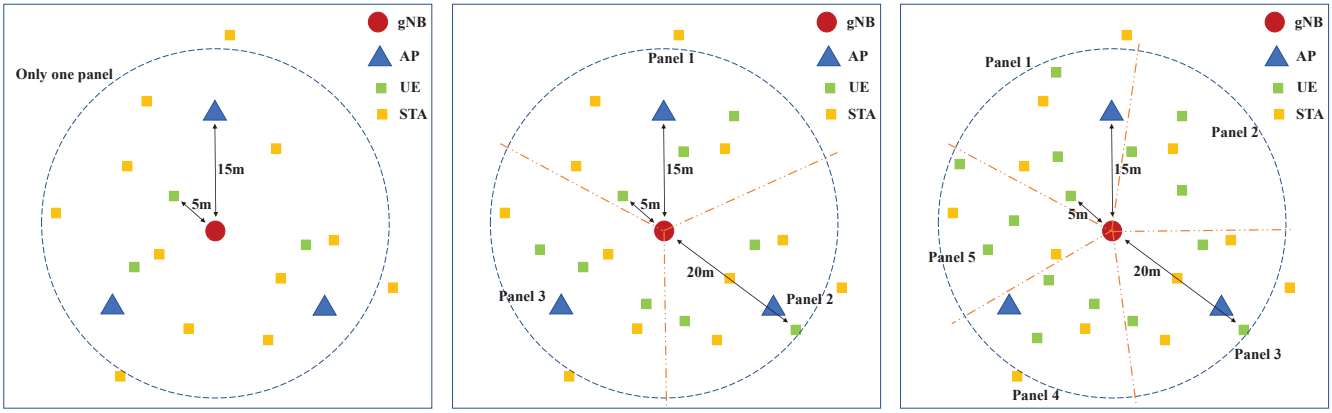
E. Performance Evaluation in Multi-gNB Scenarios

As shown in Fig. 6, in the network topology for Section V-E of our paper, UEs and STAs are randomly deployed within 20 meters from gNB and corresponding APs, respectively. In the NR-U network, each gNB possesses two panels and each panel serves three UEs. In the WiGig network, there are 3 WiGig APs each serving 4 STAs. The distance from each WiGig AP to the gNB is 15 m. In the NR-U network 1, among all the distances from UEs to gNB, the shortest is 7 m, and the farthest is 15 m; in the NR-U network 2, among all the distances from UEs to gNB, the shortest is 11 m, and the farthest is 15 m; and in the NR-U network 3, among all the distances from UEs to gNB, the shortest is 7 m, and the farthest is 15 m. Furthermore, different gNBs will interfere with each other, as presented in Fig. 6.



(a) Each panel serves 2 UEs. (b) Each panel serves 4 UEs. (c) Each panel serves 6 UEs.

Fig. 4. The network topologies for the coexistence scenario in Section V-C2 of our paper.



(a) The gNB is equipped with 2 panels. (b) The gNB is equipped with 3 panels. (c) The gNB is equipped with 5 panels.

Fig. 5. The network topologies for the coexistence scenario in Section V-D of our paper.

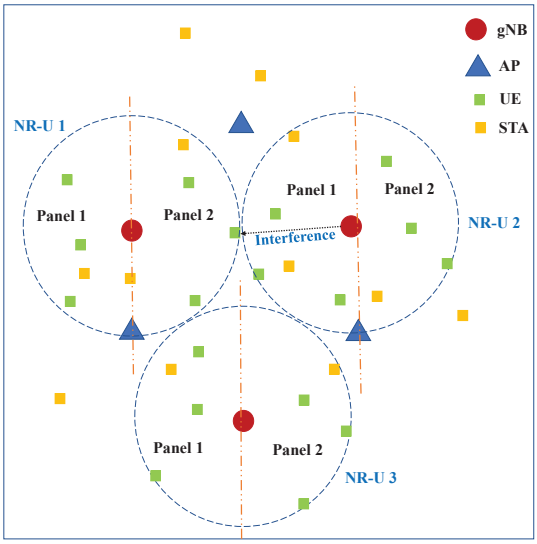


Fig. 6. The network topology for the coexistence scenario in Section V-E of our paper.