A Federated Deep Reinforcement Learning Approach for Distributed Network Slicing Orchestration

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I. Extended Abstract

Enabled by the network slicing technology, multiple and independent virtual networks can now be instantiated and customized to meet heterogeneous service requirements over 5G network deployments. The widely different requirements of 5G emerging use-cases such as Internet of things (IoT), augmented/virtual reality (AR/VR), vehicle-to-everything (V2X)communication, exacerbate the need for orchestration solutions able to concurrently accommodate these services in a resource and cost-efficient manner. Nowadays, centralized orchestration solutions are available. Such solutions require a holistic view over multiple networking domains, thus suffering severe scalability limitations that hardly fits with latency and efficiency requirements of 5G deployments.

Artificial intelligence (AI)-driven approaches recently gained momentum in network control and management. Ranging from single technological domain solutions [1], [2], to end-to-end orchestration systems [3] that however require central coordination entities. To overcome such limitations and enable massive slice deployment, we envision a fully distributed AI-driven resource allocation architecture leveraging a set of distributed and independent agents dubbed as local decision entities (DEs). Fig. 1 presents the envisioned framework, wherein multiple deep reinforcement learning (DRL) agents optimally allocate radio resources to each slice, while a federation layer enables a periodical exchange of the DRL's parameter values to improve the learning procedure and ensure computation load sharing across multiple agents. Thanks to the last developement in Network Function Virtualization (NFV) and cloud computing, suche decision entities can be dynamically deployed in the radio access network (RAN) domain as virtual software instances able to access local RAN monitoring information (for single BS or a subset of them), learn the underlying local traffic dynamics, and tailor the resource allocation process without the need of a centralized entity performing decision on the aggregated information. This approach provides several advantages: i) it enables resource allocation at the edge of the network, thus accounting for more timely and accurate information and guaranteeing faster reaction at wireless channel variations and end-user mobility patterns, ii) it avoids costly interaction with a centralized controller, providing higher resource efficiency at the core of the network which may be used during the operational phase, iii) by enabling information exchange among local DEs,

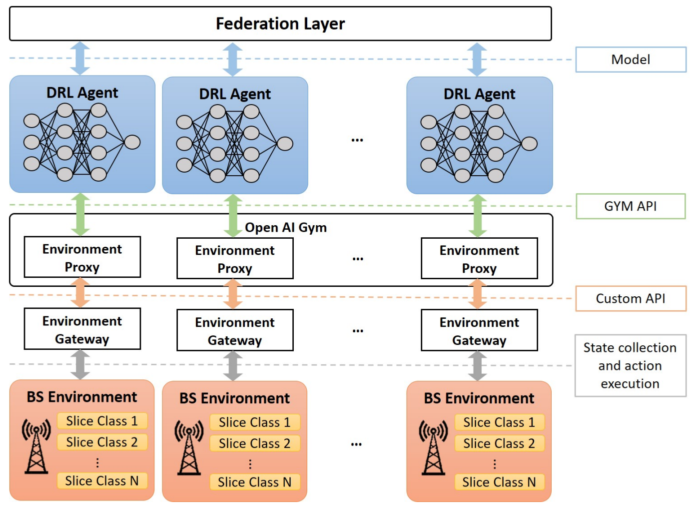

Fig. 1: Federated DRL architecture for RAN slicing.

the provisioning of federated learning schemes would further enrich the capabilities of the overall solution and provide more accurate decision-making processes.

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References

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