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Automated Service Delivery and Optimal Placement for CRANs

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Traditionally, in cellular networks, users communicate with the base station that serves the particular cell under coverage. The main functions of a base station can be divided into two, which are the baseband unit (BBU) functionalities and the remote radio head (RRH) functionalities. The RRH module is responsible for digital processing, frequency filtering and power amplification. The main sub-functions of the baseband processing module are coding, modulation, Fast Fourier Transform (FFT) and others. Data generally flows from RRH to BBU for further processing. Such BBU functionalities may be shifted to the cloud based resource pool, called as the Cloud-Radio Access Network (C-RAN) to be shared by multiple RRHs. Advancements in the field of cloud computing, software defined networking and virtualization technology may be leveraged by operators for the deployment of their BBU services, reducing the total cost of deployment. Recently, there has been a trend to collocate the baseband unit (BBU) functionalities and services from multiple cellular base stations into a centralized BBU pool for the statistical multiplexing gains. The technology is known as Cloud Radio Access Network (C-RAN). C-RAN is a novel mobile network architecture that can address a number of challenges the mobile operators face while trying to support the growing end users' needs. The idea is to virtualize the BBU pools, which can are shared by different cellular network operators, allowing them to rent radio access network (RAN) as a cloud service. However, the manual configuration of the BBU services over the virtualized infrastructure may be inefficient and error-prone with the increasing mobile traffic. Similarly, in centralized BBU pools, non-optimal placement of the Virtual Functions (VFs) might result in a high deployment cost as well as long delays to the end-users. This may mitigate the advantages of this novel technology platform. Hence, the optimized placement of these VFs is necessary to reduce the total delays as well as minimize the overall cost to operate the

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C-RANs. Despite great advantages provided by the C-RAN architecture, there is no explicit support for the mobile operators to deploy their BBU services over the virtualized infrastructure, which may lead to the ad-hoc and error-prone service deployment in the BBU pools. Given the importance of C-RANs and yet the ad-hoc nature of their deployment, there is a need of automated and optimal application delivery in the context of cloud-based radio access networks to fully leverage the cloud computing opportunities in the Internet. In this work, we propose development of a novel automated service deployment platform, which will help to automate the instantiation of virtual machines at the cloud as user demands vary to achieve end-to-end automation in service delivery for C-RANs. Also, we consider the problem of optimal VF placement over distributed virtual resources spread across multiple clouds, creating a centralized BBU cloud. The aim is to minimize the total response time to the base stations in the network, as well as to satisfy the cost and capacity constraints. In this work, we implement an enhanced version of the two common approaches in the literature, which are: (1) branch-and-bound (BnB) and (2) Simulated Annealing (SA). The enhancement reduces the execution complexity of the BnB heuristic so that the allocation is faster. The proposed enhancements also improve the quality of the solution significantly. We compare the results of the standard BnB and SA schemes with the enhanced approaches to demonstrate these claims. Our aim was to develop a faster solution which can meet the latency requirements of the C-RANs, while the performance (here, in terms of cost and latency) is not far from the optimal. The proposed work contributes to “Information & Computing Technology” pillar of ARC’18. Also, it contributes to Qatar National Vision 2030 that encourages ICT initiatives. This vision, envisages Qatar at the forefront of the latest revolutions in computing, networking, Internet, and Mobility. Mobile applications form the majority of business applications on the Internet. This research proposal addresses the latest research issues in proliferation of the novel technology such as 5G. This project is timely since there is limited research, in Qatar (as well as globally) on supporting application delivery in general in the context of multiple heterogeneous cloud-based application deployment environments.