Chapter 7
On Efficient Cache Management of Cloud Radio Access Networks for 5G Mobile Networks

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ABSTRACT

Cloud radio access networks (CRAN) have been proposed for 5G technologies to provide improved scalability, flexibility, and performance for supporting rapid increase of IoT devices. This chapter designs a new efficient cache management scheme for the baseband unit (BBU) pool in CRAN. First, it adopts the exponential-decay (EXD) scheme to keep recently frequently requested records in cache and enhances it with analytical hierarchy process (AHP) to support multiple levels of mobility and QoS. The other new algorithms include a probability-based scoring scheme, a hierarchical, or tiered, approach, and enhancements to previously existing approaches. Performance evaluation shows that the new schemes offer high cache hit ratios and a reduction in network traffic as compared with other existing and classic caching mechanisms. The authors believe that this work is important in advancing 5G technology for supporting IoT services and is also useful to other cache management systems.

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INTRODUCTION

Cellular networking technology has been advancing at impressive rates since its emergence in the technological market. With the onset of new devices, cellular networks have had to keep up with a growing demand for connectivity. This explosion of activity is evident by the Internet of Things, or IoT. Technologies needing Internet connection have even been projected to reach a staggering fifty billion devices within the next few years. IoT applications can, and will be, seen in developing areas such as smart grids, health services, homes, and even cities (Kumar & Roa, 2015).

Internet of Things (IoT) devices are increasingly entering today's market. Similar to smart phones, many IoT devices rely upon a wireless connection to utilize data services. These IoT devices often have a characteristic of large volumes at unknown locations and thus using a wired connection would not be practical. Long Term Evolution Advanced (LTE-A) is the current 4th generation (4G) mobile communication standard. It is commonly used by smartphones as the data service medium to connect with the Internet. Though LTE-A was created to provide Internet access via wireless connection, it would not be able to handle the volume of IoT devices that is projected to need data services. 5th generation (5G) mobile communication standard therefore has been proposed to handle IoT as well as rapidly growing number of smart wireless devices.

These developments have motivated the work around 5G Cloud Radio Access Network (CRAN) architecture. The CRAN is designed to utilize cloud computing technology for supporting the rapidly growing number of IoT devices. In particular, the consolidation of resources in cloud technology through virtualization and centralization, and consequently better utilization of hardware and software resources ("5G network architecture," 2016).

An important aspect of cellular networks is to achieve acceptable speeds of services in addition to supporting massive numbers of users and devices. One important way for speeding up compute and storage access is caching. Cache refers to a fast-accessible memory component that stores data so that future requests for that data can be served much more quickly. It is a vital for ensuring real-time services and for limiting network traffic due to memory or storage access.

Newer cellular architectures such as CRAN have included cache systems (Fan, Zhang & Yuan, 2016). Naturally, the cache must be efficiently maintained to make the best use of limited resources and offer users the quality of services (QoS) they were promised. This is another concept that has motivated work on finding useful and practical caching mechanisms (Tsai & Moh, 2018; Kaur & Moh, 2018).

This chapter proposes several efficient cache management algorithms and evaluates against existing schemes, aiming to provide fast access and effective resource management in 5G supporting IoT communication. This chapter is an extension of two conference papers (Tsai & Moh, 2018; Kaur & Moh, 2018). The chapter is organized as follows: The next section discusses background and related work. Section 3 dives into various cache management schemes and mechanisms. Section 4 evaluates the performance of those aforementioned schemes and is followed by the conclusion in Section 5. This is a continuation of the authors' work on 5G, CRAN, and cloud computing (Shahriari, Moh, & Moh, 2017; Su & Moh, 2018; Shahriari & Moh 2018), CRAN (Karneyenka, Mohta, & Moh, 2017; Shahriari, Moh, & Moh, 2017; Tsai & Moh, 2017a, 2017b, 2018; Kaur & Moh, 2018), and cloud and fog computing (Huang, Wu, & Moh, 2014; Reguri, Kogatam, & Moh, 2016; Choudhari & Moh, 2018; Gao & Moh, 2018).