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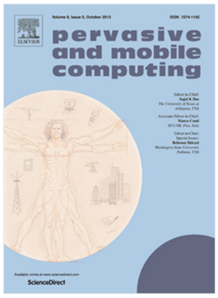

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Cognitive Caching for the Future Sensors in Fog Networking

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***Abstract*—In this paper, we propose a Cognitive Caching approach for the Future Fog (CCFF) that takes into consideration the value of the exchanged data in Information Centric Sensor Networks (ICSNs). Our approach depends on four functional parameters in ICSNs. These four main parameters are: age of the data, popularity of on-demand requests, delay to receive the requested information and data fidelity. These parameters are considered together to assign a value to the cached data while retaining the most valuable one in the cache for prolonged time periods. This CCFF approach provides significant availability for most valuable and difficult to retrieve data in the ICSNs. Extensive simulations and case studies have been examined in this research in order to compare to other dominant cache management frameworks in the literature under varying circumstances such as data popularity, cache size, data publisher load, and node connectivity degree. Formal fidelity and trust analysis has been applied as well to emphasize the effectiveness of CCFF in Fog paradigms, where edge devices can retrieve unsecured data from the authorized nodes in the cloud.**

Keywords – *Internet of Things, Fog computing, Caching, Information Centric Sensor Networks.*

I. Introduction

The growing demand for efficient distribution of content/data over the cloud has motivated the development of future Internet architectures based on named data objects (NDOs) such as, web pages, videos, documents, or other pieces of information. The approach of these architectures is commonly called information-centric networking (ICN). In contrast, current networks are host-centric where communication is based on named hosts, for example, web servers, PCs, laptops, mobile handsets, and other devices. Information-Centric Networks serves as a content-based model which focuses on client's demands disregarding of the data's address or the origin of distribution.

Information Centric Network (ICN) is the next generation model for the *Internet* that can cope with the user's requests/inquiries regardless of their data-hosts' locations and/or nature. The current *Internet* model is suffering from the exchange of huge amounts of data while still relying on the very basic network resources and IP-based protocols. Meanwhile, ICNs promise to overcome major communication issues related to the massive amounts of distributed data in the Internet. ICNs adopt a content-centric architecture which focuses more on the networked data itself rather than the meta-data. This kind of network architectures are known usually by the Content Oriented Networks (CONs) term [1]. Luckily, these CONs architectures match a lot with the emerging communication trend that aims at exchanging Big-data over tiny and energy-limited wireless sensor networks (WSNs) in order to realize numerous attractive projects such as the Smart-planet and the Internet of Things [3][4]. Thus, a new platform is needed to meet these requirements. A new platform, called Fog Computing [5], or, simply, Fog, because the fog is a cloud close to the ground is proposed to address the aforementioned requirements. Fog is a Mobile Edge Computing (MEC) that puts services and resources of the cloud closer to users to be facilitated in the edge networks.

Unlike Cloud Computing, Fog Computing enables a new breed of light applications and services, that can be run at particular edge networks, such as WSNs. In order to enable WSNs to support this trend in communication and function in a large-scale application platform, such as the *Fog Computing*, we proposed the cognitive framework in our previous work [7]. In [7], an information-centric scheme is proposed for the future WSNs using *cognitive* in-network devices that makes dynamic routing decisions based on specific *Knowledge*- and *Reasoning*- observations in WSNs. AHP is applied on quality of information (QoI) attributes in next generation WSNs such as reliability, delay, and network throughput observed over the communication links/paths [15][16]. This cognitive Information-Centric Sensor Network (ICSN) framework is able to significantly outperform the *non-cognitive* ICSN paradigms. However, this cognitive ICSN framework did not consider yet the in-network caching feature. Caching in multitude of nodes in ICNs has pivotal role in enhancing the network performance in terms of reliability and response time. In this paper,

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