Edge Computing Research Survey

Egil Olsen
University of Bergen

***Abstract*—In this paper, we present a survey in edge computing research.**

I. Introduction

Edge computing is a paradigm that can address the issues of response times, battery life, bandwidth cost, as well as data safety and privacy [1]. Edge computing calls for processing/storage of data at network edge [2], [3].

A. Efficient Management of Resources

The new Fifth-Generation (5G) feature SOTA network management techniques to manage network infrastructures and services. A major challenge is to sustain the huge complexity due to virtualization and softwarization but at the same time reduce the operational costs for cellular providers. This work presents the EU Horizon 2020 5G-PPP project SliceNet to meet this major issue [4]. In [5], [6], the authors explore challenges of edge computing, specifically service discovery, service invocation, and user mobility, in edge computing frameworks. In [7], researchers talk about Information-Centric edge (ICedge).

In [10], the researchers propose a resource preservation framework, which is integrated with cloud and edge computing suitable for edge frameworks [11]. In [8], [9], researchers design system based on architecture consisting of three tiers.

B. Storing and Caching Data

There are many researchers that study caching in edge computing, NDN and ICN. In [22], routers work together to decide what to cache, which is called 'cooperative caching', and making it an optimization issue. The Lagrangian relaxation and primal-dual decomposition approaches are used to break down the optimization problem into data placement subproblems and data locating subproblems. [23] mentions that it is hard to improve cache effectiveness for a distributed system, thus many cooperative caching methods have been discussed to make stronger the cache effectiveness. Researchers talked about P-TAC that is a distributed cache management design. In [24], authors talk about a caching strategy of NDN that splits each file and spreads them among NDN caches with the goal to reduce redundant copies and cache nuisance by not so popular content. This design reduces also the number of futile checks on caches and the delay to access the memory. This scheme also increases hit rates in the core without any reduction of hit rates at the edge computing layer, balancing the load. Much more papers have been researched [25], [26], [27]. In [28], researchers discuss Realtime Data Retrieval (RDR), a protocol that help users and device applications to identify the latest (newest) data, but ignore bad, old cache data. In [29], addressing cache pollution attacks is a prerequisite for the deployment of NDN, which is considered to be the basis for the future Internet. The authors present CoMon++, a design for easy coordination that helps with cache pollution and further attacks in NDN. In this paper, the authors suggest a design to protect cache against data pollution attacks by creating hierarchy of content name prefixes in NDN [32], [31]. Eventually, in [30], [31], authors talk that users need more time to obtain data due to attack. There are some solutions to solve cache pollution attacks in NDN, but most of them focus on full data names.

C. Offloading Computational Tasks in Edge Computing

In [12], [13], researchers study power-delay tradeoff when it comes to task offloading in a multi-tetant Mobile Edge Computing (MEC) system. Contrast to existing frameworks that depend on average or median metrics (e.g., the average queue length or/and latency), a system design is outlined that takes latency and reliability constraints into consideration.

In [14], autonomous driving is studied, which uses huge sensory data for intelligent navigation. At the same time, it has very major computation needs placed on cars with little resource. MEC can help with the heavy burden on users and application devices. Various states of edge servers and many vehicular offloading modes make task offloading to be productive a challenge. To address this problem, researchers looked into a deep Q-learning approach for the realization of optimal task offloading methods, taking into account both selection [15] of edge servers and of data transmission modes. In [16], [17], [18], the researchers discussed CoxNet, an major architecture for the computation reuse in edge computing. CoxNet helps edge servers to reuse previous computation results while arranging interdependent new computation tasks. In [19], [20], authors talk about applications that have different latency requirement: latency-sensitive processing tasks need to be done at the edge, while delay-tolerant tasks need to be done on the cloud, so not occupying the resources at the edge. In [21], authors present an edge computing framework for vehicles that integrates the computing resources of cars, and offers data processing services for other cars and pedestrians allowing the offloading of computation tasks. But, he vehicular task offloading system is volatile and non-certain, with variable wireless channel states and computing workloads. These uncertainties result in additional issues and challenges for the offloading of tasks.

D. Exchanging Data at Edge

In [40], [41], people say to address a network that can maintain connectivity when base stations, users, and edge servers fail. [42] present a peer-to-peer system for video streaming that is encoded at various different rates. The system allows few wireless user devices to improve the quality of video streaming by using Wi-Fi to share the portion of the video stream that was made by a peer via the cellular network (4G/5G) [42]. In [43], [44], peer-to-peer file sharing envision a edge system, where peers will request and retrieve the data which they are searching. Peers will retrieve the requested data from any other peer that can offer it, without having to determine the location that this data can be found. Peer-to-peer edge applications, such as BitTorrent, provide data-centric security through the leveraga-tion of cryptographic hashes. The Internet architecture of TCP/IP creates issues for peer-to-peer systems both in infrastructure-based and mobile ad-hoc networks and complicates their design [45].

E. Security

In [33], researchers first discuss requirements and existing solutions for IoT security. They subsequently talk about a brand novel security framework based on edge computing, which utilizes a agent of security to support functions for the security concerns of networking protocols, systems, and IoT devices at the edge. In [34], [35], the authors present a literature review of fundamental attack designs and corresponding defense mechanisms with characteristics specific to edge computing. The authors focus on four attack kinds that account for most of the edge computing attacks recently reported by Statista [34]. Researchers thought of best effort per hop mechanism for link layer reliability for point-to-point communication wired links [36]. Other researchers did literature reviews of synchronization and publish-subscribe protocols [37]. Other authors discussed security in edge computing [38] and the device authentication mechanisms and processes [39].

II. Conclusions

In this paper, we presented a survey of edge computing research works. We hope that the community will find this survey useful.

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