Edge Computing, IoT and Future Internet

Wan Yan Zhengzhou University
He Li Zhengzhou University
Bo Chan Zhengzhou University

Abstract—In this paper, we discuss researches in Edge Computing, Internet of Things (IoT), and Future Internet Technologies (ICN and NDN). We chose these areas because they are hot topics in today research.

1 INTRODUCTION

Researchers studied Future Internet, specifically Information-Centric Networking (ICN) and Named Data Networking (NDN) [1]. Their researches are important and we describe existing researches in ICN and NDN in this work. We think that ICN and NDN are the future of the Internet.

2 EXISTING RESEARCHES IN ICN AND NDN

2.1 Caching

There are many researches in caching in NDN and ICN. In [2], routers in a NDN domain share cached data and coordinate to make caching decisions, entitled cooperative caching, and make it a optimization problem. The Lagrangian relaxation and primal-dual decomposition method is applied to fix the optimization problem into object placement subproblems and object locating subproblems. [3], [4] finds difficult to improve cache efficiency for a distributed approach, thus a lot of cooperative caching methods have been proposed to enhance the cache efficiency. Authors researched a distributed cache management, which is based Push-based Traffic-Aware distributed Cache management (P-TAC). P-TAC improves cache hit rate by using the links having a margin in a transmission band for push traffic. In [5], [6], researchers show a caching strategy of Named Data Networking that segments each file and spreads them among NDN caches, and: (1) It reduces redundant copies and cache pollution by unpopular content. (2) It reduces the number of futile checks on caches, thus reducing the delay from memory accesses. (3) It increases hit rates in the core without reducing hit rates at the edge (thus improving overall hit rates) and balances the load among caches. (4) It decouples the caches, so there is a simple analytical performance model for the network of caches. Many more works have been done [7], [8], [9]. In [10], [11], solving cache pollution attacks is a prerequisite for the deployment of NDN, which is considered to be the basis for the future Internet and present CoMon++, a framework for lightweight coordination that protects from cache pollution and further attacks in NDN. In [12], [13], normal users take more time to obtain contents due to the attack. There are some countermeasures against cache pollution attack in NDN, but most of them focus on full content names. Using full names needs a large amount of storage cost. In this paper, we propose a cache protection method against cache pollution attack based on hierarchy of content name prefixes in Named Data Networking (CPMH).

2.2 Edge Computing

Edge computing and NDN is a hot research field. Researches have been done in edge computing and NDN. In [14], the Building Management Systems (BMS) faces nowadays scalability challenges related to the scale of the new buildings. Researchers propose approach that combines NDN and edge to provide a scalable, distributed, and optimized solution that can support extreme scale buildings requirements. In [15], [16], the paper discusses three main edge computing challenges, namely service discovery, service invocation, and user mobility management, to highlight NDN's architectural advantages for edge computing systems. In [17], authors impelement framework based on architecture and comprises of three main Tiers. The NDN is located at the Tier1 (Things/end devices) and comprises of all the basic functionalities that connect Internet of Things (IoT) devices with Tier 2 (Edge Computing), where we have deployed our Edge node application. The Tier 2 is then further connected with Tier 3 (Cloud Computing), where our Cloud node application is deployed on cloud. In [18], researchers design and prototype Information-Centric edge (ICedge). ICedge runs on top of named-data networking, a realization of the information-centric networking vision, and handles the "low-level" network communication on behalf of applications. ICedge features a fully distributed design that: 1) enables users to get seamlessly onboarded onto an edge network; 2) delivers application invoked tasks to edge nodes for execution in a timely manner; and 3) offers naming abstractions and network-based mechanisms to enable (partial or full) reuse of the results of already executed tasks among users [19].

Algorithms for data reduction in time series (one of the most common types of data in IoT) need to be developed to work posteriori upon big datasets, but they cannot make decisions for each incoming data item. Also the state of the art lacks systems that can apply any of the possible data reduction methods without adding significant delays or major reconfigurations. [20], [21], [22]. In [23], [24], [25], researchers collaborated to talk about the current networking challenges both quantitatively (by analyzing AR/VR network interactions of head-mounted displays) and quantitatively (by distributing a targeted community survey among AR/VR researchers). Enabling ICN with edge computing in Radio Access Network (RAN) can improve the efficiency of content distribution and communication performance by reducing the distance between users and services. In line with this assertion, in this paper, we propose an ICN-capable RAN architecture for 5G edge computing environments that offers device to device communication and ICN application layer support at base stations. Computation reuse has also been explored [26], [27].

2.3 Sync and Pub-Sub

In [28], researchers investigate ICN as a publisher-subscriber communication enabler, and present its challenges and limitations. Based on the observations, we propose a group-based subscription architecture, which enables not only a seamless publisher-subscriber model, but also authentication, access control, and group management features, without modifying ICN principles. In [29], authors discuss the benefits that a publish/subscribe protocol such as MQTT or its recently proposed enhancement MQTT+ could bring into the picture. However, deploying pub/sub brokers with advanced caching and aggregation functionalities in a distributed fashion poses challenges in protocol design and management of communication resources. In [30], authors researched this problem is caused by a semantic overloading on Sync Interests: a Sync Interest is used both to detect state inconsistency (by embedding the dataset state digest in the Interest name) and to retrieve update (resulting in the update being named under a specific digest). In this report, we first use a simple case study to analyze the behavior of ChronoSync under simultaneous data publications, and then introduce RoundSync, a revision to ChronoSync to fix the overloading problem. In [31], the paper presents a sensor as a service platform to host live content streams (video, data) from a diverse set of input streams including UAVs, city cameras, loop detectors, etc., and to make the data available to a broad range of customers using a novel data dissemination layer. The data-dissemination layer is a content-oriented system based on information-centric networking, a new paradigm that puts content first, and which inherently enables content mobility and content security (through encryption on demand) [32]. In [33], Content-based networking has been proposed to address such demands with the advantage of increased efficiency, network load reduction, low latency, and energy efficiency. The publish/subscribe (pub/sub) communication paradigm is the most complex and mature example of such a network. Another example is Information Centric Networking (ICN), a global-scale version of pub/sub systems that aims at evolving the Internet from its host-based packet delivery to directly retrieving information by name. In [34], gateways acting as producers need to allocate network resources to send IoT data to consumers. In this paper, it is proposed a Publish/-Subscribe (PubSub) quality of service (QoS) aware framework (PSIoT-Orch) that orchestrates IoT traffic and allocates network resources between aggregates and consumers for massive IoT traffic. PSIoT-Orch schedules IoT data flows based on its configured QoS requirements. Additionally , the framework allocates network resources (LSP/ bandwidth) over a controlled backbone network with limited and constrained resources between IoT data users and consumers [35], [36], [37].

2.4 NDN BitTorrent and peer-to-peer

In [38], massive multiplayer online games (MOG) have become increasingly popular over the past decade. Peer-to-peer structures were explored for commercial online games. However, maintaining security and availability while scaling users has driven most multiplayer online games towards a client-server or client-super peer architecture. In [39], [40], peer-to-peer file sharing applications envision a world, where peers will communicate in terms of the data that they are looking for. In this world, peers will be able to retrieve the desired data from any other peer that can provide it, without the need of specifying the location that this data can be found. Some peer-to-peer applications, such as BitTorrent, also provide data-centric security primitives by verifying the integrity of the downloaded data through cryptographic hashes. However, the current point-to-point TCP/IP network architecture poses a number of challenges to the design and implementation of peer-to-peer systems both in infrastructure-based and mobile ad-hoc networks. Specifically, in infrastructure-based networks, peers have to select others (identified by an IP address) to download data from, estimate the quality of each connection, and constantly try to find peers that can provide higher bandwidth. In [41], it is important to design a network that can maintain a normal service using the remaining network resources, such as base stations and user terminals, even if the central servers are no longer available because of disconnections among servers. [42] present a peer-to-peer application for live streaming of video content encoded at multiple bit rates. The application enables a small set of neighbouring cellular/Wi-Fi devices to increase the quality of video playback by using the Wi-Fi network to share the portion of the live stream downloaded by each peer via the cellular network.

2.5 Provider Mobility

In [43], in ICN, name-based addressing and in-network caching allow content to be efficiently distributed/accessed. These properties of ICN have been researched in the arena of wireless domain to implement light-weighted communication protocols. Specifically, researchers present an ICN-based content delivery scheme for Internet-of-Things (IoT), and show how the proposed scheme support seamless hand-off. In [44], the mobility support for ICN was generally divided into three categories, the consumer mobility, producer mobility and network mobility. Producer mobility is the support for the mobile content provider, source or producer to relocate without disrupting content consumer and intermediate router for content name and its location. Researchers reviews an analysis of producer mobility support in some popular ICN approaches and summarizes some of its features, which provide support during mobility. In [45], [46], the Broadcasting Approach is proposed as a solution to the problem of the mobile producer in NDN. Consequently, the result may solve the inherited problems of triangular routing in NDN network mobility and have significant implication to support the integration of 5G, Mobile Ad hoc Networks (MANET), Delay-Tolerant Network, Vehicular Ad hoc Networks (VANET).

2.6 Simulation Tool

In [47], [48], despite this wide interest in ICN, there is a shortage of publicly-available tools suitable for evaluating the performance of caching systems effectively. In fact, all available simulators or emulators are either bound to a specific architecture or cannot execute simulations at the scale required and within a reasonable time-frame. To address these issues, we present Icarus, a Python-based caching simulator for ICN. Icarus allows users to evaluate caching strategies for any ICN implementation and also provides modelling tools useful for caching research. NDNsim is popular simulation for NDN.

3 Conclusions

We presented researches done by researchers in Information-Centric Networking (ICN) and Named Data Networking (NDN). These researches presented in categories to inform community about them. In future, we will research more works and present them to others, and develop trends in future internet for ICN and NDN.

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