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Monitoring and deploying services on edge devices

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[1] https://github.com/joaomlourenco/novathesis [2] http://www.di.fct.unl.pt

Resumo

Lorem ipsum em Português.

Palavras-chave: Palavras-chave (em Português) ...

Abstract

Lorem ipsum in english.

Keywords: Keywords (in English) . . .

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Capítulo 1

Introduction

1.1 Context

Nowadays, the Cloud Computing paradigm is the standard for development, deployment and management of services, it has proven to have massive economic benefits that make it very likely to remain permanent in future of the computing landscape. It provides the ilusion of unlimited resources available to services, and has changed the way developers, users and businesses rationalize about applications [1].

Currently, most software present in our everyday life such as Google Apps, Amazon, Twitter, among many others is deployed on some form of cloud service. However, currently, the rise in popularity of mobile applications and IoT applications differs from the centralized model proposed by the Cloud Computing paradigm. With recent advances in the IoT industry, it is safe to assume that in the future almost all consumer eletronics will play a role in producing as well as consuming data. As number of devices at the edge and the data they produce increases rapidly, transporting the data to be processed in the Cloud will become unfeasable.

Systems that require real-time processing of data may not even be feasible with Cloud Computing. When the volume of data increases, transporting the data in real time to a Data Center is impossible, for example, a Boeing 787 will create around 5 gygabytes of data per second [2], and Google's self-driving car generates 1 Gygabyte every second [4], which is infeasible to transport to the DC for processing and responding in real-time.

When all computations reside in the data center (DC), far from the source of the data, problems arise: from the physical space needed to contain all the infrastructure, the increasing ammount of bandwidth needed to support the information exchange from the DC to the client, the latency in communication from the client to the DC as well as the security aspects that arise from offloading data storage and computation, have directed us into a post-cloud era where a new computing paradigm emerged, Edge Computing.

Edge computing takes into consideration all the computing and network resources that act as an "edge"along the path between the data source and the DC and addresses the increasing need for supporting interaction between cloud computing systems and mobile or IoT applications [5]. However, when accounting for all the devices that are external to the DC, we are met by a huge increase in hetereogeneity of devices: from Data Centers to private servers, desktops and mobile devices to 5G towers and ISP servers, among others.

1.2 Motivation

The aforementioned hetereogeneity implies that there is a broad spectrum of computational, storage and networking capabilities along the edge of the network that can be leveraged upon to perform computations that rely on the individual characteristics of the devices performing the tasks, which can vary from from generic computations to aggregation, summarization, and filtering of data. [3]

There have been efforts to move computation towards the Edge of the network, Fog Computing [6], which is an extension of cloud computing from the core of the network to the edge of the network, has shown to benefit web application performance [7], additionally, Content Distribution Networks [] and Cloudlets [] are an extension of this paradigm and are extensibly used nowadays.

To fully materialize the Edge Computing paradigm, applications need to be split into small services that cooperate to fulfill applicational needs. Additionally, tools must be developed that allow service and resource discovery as well as service and device monitoring. All of this performed over the inherent scale considered by the infrastructure of the Edge Computing paradigm.

paragrafo com sobre para quem e que isto e (e.g. Google, Amazon, Smart City, Smart Country ?? also porque e que isto e diferente do que ja existe

These tools must be based on protocols that are able to federate all the devices and aggregate massive ammounts of device data in order to perform efficient service deployment and management. Additionally, they must handle the churn and network instability that arises when relying on devices that do not have the same infrastructure as those in Data Centers.

1.3 Expected Contribution

To achieve this, we propose to create a new novel algorithm which employs a hierarchical topology that resembles the device distribution of the Edge Infrastructure. This topology is created by assigning a level to each device and leveraging on gossip mechanisms to build a structure resembling a FAT-tree [].

The levels of the tree will be determined by ...undecided... and will the tree be used to employ efficient aggregation and search algorithms. Each level of the tree will be composed by many devices that form groups among themselves, the topology of the groups ...undecided...

The purpose of this algorithm is to allow:

1. Efficient resource monitoring to deploy services on.
2. Offloading computation from the cloud to the Edge and vice-versa through elastic management of deployed services.
3. Service discovery enabled by efficiently searching over large ammount of devices
4. Federate large ammount of heterogeneous devices and use hetereogeneity as an advantage for building the topology.

We plan to research existing protocols (both for topology management and aggregation) and enumerate their trade-offs along with how they behave across different environments. Then, employ a combination of different techniques according to their strengths in a unique way that is tailored for this topology.

1.4 Document Structure

The document is structured in the following manner:

Chapter 2 focuses on the related work, first section covers the different types of topology management protocols, with an emphasis on random and self-adapting overlays, second section studies the different types of aggregation and popular implementations for each aggregation type. Third section adresses resource discovery and how to perorm efficient searches over networks composed by a large number of devices. Finally,fourth section discusses recent approaches towards enabling Edge Computing along with discussion about Fog, Mist and Osmotic Computing.

Chapter 3 further explains the proposed contribution along with the work plan for the remainder of the thesis.

Capítulo 2

Related Work

2.1 Peer to Peer

The Peer to Peer (P2P) paradigm has been extensibly used to implement distributed, scalable, fault-tolerant services, it overcomes limitations such as scalability and fault-tolerance that arise from the client-server model.

Members of a peer-to-peer system may contribute with a portion of their resources (such as computing, memory or network bandwidth) available to other participants as well as consume resources from other peers in the system. This contrasts with the traditional client-server paradigm where the consumption and supply of resources is decoupled. Collaboration is the foundation of P2P systems, peers perform tasks that contribute towards a common goal which is benefitial for all peers, this enables P2P systems that acomplish tasks would otherwise be impossible by an individual server.

There are many

2.2 Topology Management

Topology management consists in the creation and management of an **overlay network**, which consists in a logical network built on top of another network (usually the internet). Elements of overlays are connected through virtual links that are a combination of one or more underlying physical links.

2.2.1 Random overlays

2.2.2 Structured overlays

2.2.3 Self-adapting overlays

2.3 Aggregation

2.3.1 Types of aggregation

2.3.2 Relevant aggregation protocols

2.4 Resource Discovery

2.5 Offloading computation to the edge

Capítulo 3

Proposed Solution

Capítulo 4

Planning

4.0.1 Proposed solution

4.0.2 Scheduling

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Apêndice A

Appendix 2 Lorem Ipsum

Anexo I

Annex 1 Lorem Ipsum