Project Design Phase – Part 2

Determine The Requirements (Customer Journey Maps)

Team ID	NM2023TMID04427
Project Name	Project – Tracking Public Infrastructure And Toll Payment Using Blockchain

ABSTRACT

Blockchains are a fairly new technology with few real-world applications beyond Bitcoin, the first mainstream cryptocurrency. Road tolling is a rather widely used method of monetizing transportation infrastructure projects by collecting payments from the infrastructure users. In Norway, there is a road tolling system called AutoPASS, of which multiple companies are a part of, working together and some providing essentially the same service. This can cause data redundancy and creates a need to transfer data between companies efficiently. This raised the question whether this could be done in a decentralized manner using blockchains. In this thesis the feasibility of blockchain technology in a road toll architecture was evaluated on a high level.

INTRODUCTION

In the last decade or so blockchain technology has paved its way into people's awareness, but there are still few widely adopted applications based on blockchains, excluding for example the cryptocurrency Bitcoin, which, while very well known, has yet to become the widely used means of trade it was hoped to be. Banks, health institutions, and governments have investigated the possibilities provided by blockchain technology, which tells us there is real interest in the technology. For example, in Finland it has been researched whether blockchains could be utilized in the planned social and health service renewal (Salonen, Halunen, Korhonen, Lähteenmäki, Pussinen, Vallivaara, Väisänen & Ylén, 2018), and in the United States blockchain technology has been piloted in voting (Palermo, 2018).

Motivation

In this study the combination of road toll systems and blockchain technology is examined, with the aim of seeing how well these two concepts could fit together. The subject domain was chosen due to two reasons: first, the potential of blockchains in real-world use cases is still not fully clear since widely adopted realworld applications are still quite rare. Also, as a technology with potential in privacy and verifiability aspects, blockchains should be researched further. Second, despite – yet also because – of blockchains having been the subject of considerable hype in the media and road tolls being a frequent topic of public discussion in Finland (Sito Oy, 2016; Helpinen, 2016; Lempinen, 2017), I consider the subject to be quite current and above all interesting.

Research Questions

The hypothesis is that blockchain technology can propose features for data security, openness, and transparency not presented by commonly used database structures today. Therefore, the research questions are as follow:

- How could blockchain technology be utilized in a road toll system?
  - Is decentralized technology suitable for a road toll architecture?
  - What could the architecture of a road toll system utilizing blockchain technology be like?
  - Is using blockchain technology in a road toll system justified?

Research Methods

The research was done as a literature review combined with constructive research: articles and research papers about databases, peer-to-peer networks, and blockchains were gathered to provide understanding of the technologies.

1. problem identification and motivation

2. objectives of a solution

3. design and development

4. demonstration

5. evaluation and

6. communication.

Databases

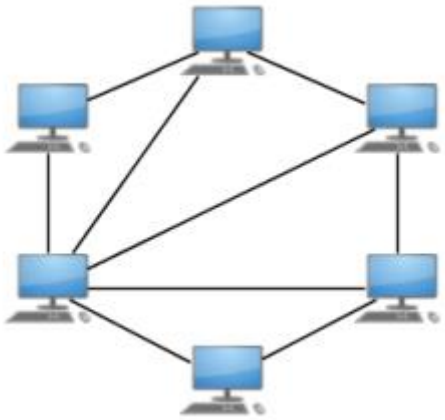
Nowadays practically all data you will ever access is stored and organized in some form of database, and O'Brien and Marakas (2010) suggest that if you find yourself asking "Should I use a database?" the question should instead be "What kind of database should I use?".

Data Concepts

A character can be a single alphabetic, numeric, or other symbol. It is the most fundamental data element. This is the logical view as opposed to the physical or hardware view of data, according to which the bit or byte is the most basic element. So, from the user's viewpoint, a character is the most basic data element to be manipulated and observed. (O'Brien & Marakas, 2010.)

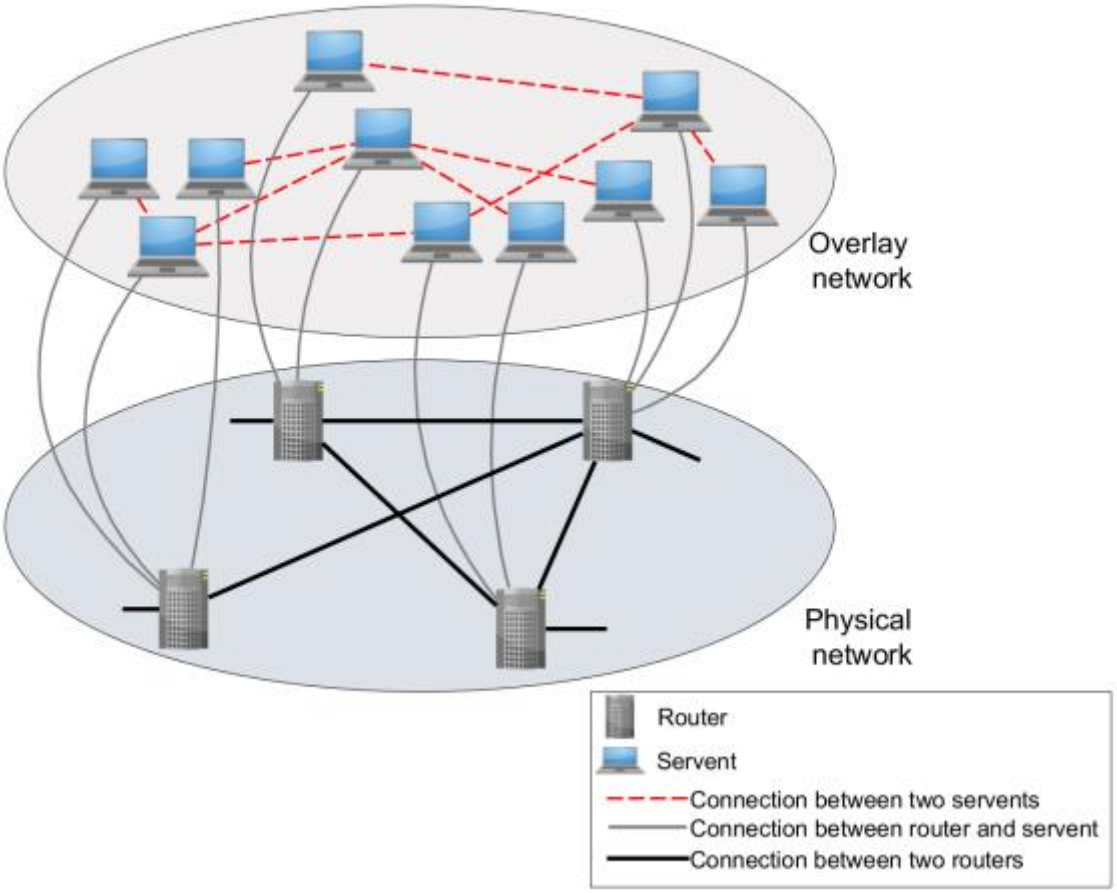
Technology

A peer-to-peer network is a network of interconnected nodes (i.e. independent computers, clients) that share data between one another with no need for a centralized administrative system such as a central server (figure 2). This differs significantly from the client-server network model (figure 3), in which individual clients (independent computers) connect to centralized servers.



Simplified network structure based on the P2P model in which resources are shared by interconnected nodes ("peers" or "servents") without a central entity such as a server. The computer icons depict network nodes, and the black lines depict connections between nodes.

An overlay network is a network in which links between peers are based on logical relationships in a virtual network built on top of physical communication infrastructure (figure 4). The overlay is a logical depiction that does not necessarily follow the actual physical network topology. (Dunaytsev, Moltchanov, Koucheryavy, Strandberg & Flinck, 2012; Eberspächer, Schollmeier, Zöls & Kunzmann, 2004.)



An earlier study by Schollmeier (2002) suggests a simpler division of P2P networks than that of Zhu's (2010): according to his paper, P2P networks can be simply divided into two sub-definitions – the hybrid and the pure P2P network structures – without first categorizing them into structured or unstructured types. In Schollmeier's (2002) division, the centralized P2P and hybrid P2P structures are essentially the same, and the concept of the super-peer was introduced by Zhu in 2010.

Autonomy In P2P Networks

As previously with databases, we should consider the concept of autonomies also in P2P networks by investigating how the different autonomy types (organizational, design, communication, and execution autonomy) manifest themselves in P2P networks