**Current Situation**

Microservices is still a new concept, although some companies have already migrated to the Microservices architecture. There are many companies facing many issues that could be solved by this new architecture but still are hesitant in moving forward and migrating their application to the Microservices architecture.

This hesitation doesn’t come from one or two reasons but the idea of refactoring an existing application into a new one built using another architecture is not easy and brings with it many challenges that are still waiting to be addressed. The process of migration itself is still not clear.

How can an application be divided into smaller parts? What norms and standards should be followed when making a decision about such division? How big can be any microservice? How can Microservices interact with each other and exchange data? How can those microservices be merged together? What if the Frontend is becoming also complex and needs to be divided into Micro Frontends? How can Micro Frontends and microservices work together? How can microfrontends work together and send and receive data? How should a microfrontends interact with a microservice? How can microservices trust each other? What if the developers had to use ready-made microservices solutions? How can each microservice trust the behavior of a ready-made microservice? How can sensitive data such as credentials exchanged securely among those small parts of the application? And many more.

Questions are many and numerous when it comes to migrating an existing application into a Microservices architecture, so many questions are waiting to be answered. The architecture itself is new and a great deal of research is needed to help those who want to move their application into a Microservice architecture or even if developers want to build their applications from scratch based on the Microservices architecture.

There are still no standard definition of Microservice architecture and there’s no clear guideline of how an application based on Microservices should be built. Over the last few years some characteristics for a microservices-based application have been developed and some general basic outlines are now commonly used.

* A Microservices-based application should consist of more than one component: Unlike monolithic-based applications, a system built using Microservices architecture should be composed of multiple components, each component is self-contained. This way the application can be changed, updated and modified whenever is needed since each change will be applied to only the concerned component itself and not the entire application.
* Simple Routing: Components in a Microservice-based application will have a simple workflow, they will take an input process it and then forwards the result. But one should not forget that there are complications and challenges regarding interaction and securities between microservices.
* Decentralization: An application based on Microservice architecture is built out of many different components and each has its role, but the application in total is not a one unit and there’s no on big unit moderating the communications between the microservices.
* Different technology stack: The development cycle of a Microservices-based application involves having different teams working on different microservices. Since each microservice is a self-contained component, each team can then choose the most suitable development technologies and tools that are most suitable for their own microservice.

**Motivation**

The idea behind creating a web application from smaller application is still very new. The current architecture that’s used heavily in building web application is composed of layers built on top of each other. Each layer is responsible for a field or a big part of the application. How many layers an application can have is still dynamic and up to the developers to decide. This architecture is called monolithic architecture. It usually consists of three layers on top of each other’s, the User Interface, then underneath comes the Logic Layer and finally the Backend [x]. Moreover some applications could end up having their logic layers divided further into more layers.

Although monolithic web application are divided into layers but the application is still very tightly coupled. There’s a great amount of connections between the layers, and during the development, developers would divide the Application into two parts: A frontend and a backend. With each part different tools and technologies are used. This results in having the development divided into only two parts where the logic layer is merged or shifted to be sometimes considered as part of the backend. Such scenario would result in a highly linked system. The two parts or layers of the application will have many interconnections. Although there’s a big possibility in having each layer developed by a different toolset and even a different development team, yet having a failure in one layer will drive the whole system to shut down and break completely.

As a consequence, the system, of course, will be hard to operate, maintain and update. Each problem in the backend will make the system useless, where no information could be processed or stored in the database. On the other hand, each problem in the frontend will make the application unusable, and data can’t flow from the frontend to the backend.

Finding the problem when the system fails is a big challenge. The first step is the easiest one, developers first need to decide if the problem comes from the frontend or the backend. Once this has been identified, the real challenge starts. Each part is one big unit and in order to find why the system fails many tests should be run and sometimes thousands of lines of codes should be reviewed to find and fix the problem. Sometimes, this situation could lead to even a worse one. In some cases fixing the issue is not possible until some modification is performed to suit the new changes. This lead to the problems of updating the system.

Updating a monolithic-based application is another big problem faces developers and owners. The application behaves as a one big unit, when needing new features or updates to fix newly discovered issues, developers could find themselves trapped between not being able to achieve the wanted updates and fixes as much as they’re supposed to, and between having to perform huge system modifications and changes to accommodate the new desired features or to be able to add new pieces to the application which could help to solve the existing problems.

This kind of situation happens frequently and usually costs money, time and lots of efforts. Microservices architecture was developed to make applications more flexible. With Microservice-based application, the system is now more accepting for changes. Developers don’t need to make great modification for the system to adapt a new feature. When a system failure happens or when a problem is discovered, developers have the ability to isolate the problem and fix it quickly.

Under Microservices, the application is not just one big unit, nor is it a three-layer architecture. The system is a groups of smaller systems. Each small system is a self-contained unit. Those units can be developed and deployed independently. Moreover, each unit can be developed by a different development team, hence creating a team of small number of developers a possible choice.

The concept of Microservices is further projected into the other side of the web application. Microservices is not just concerned with the backend side of the system, but it can be also applied to the frontend as well. When microservices concept is applied to the frontend it is called Micro frontends[x].

With Micro frontends, the frontend of the application is composed of many different small self-contained applications. Instead of having the frontend as a one unit written in one framework such as Angular or React JS, which could suffers once the application grow. With Micro frontends the frontend is written and developed as a sum of smaller frontends. Each small frontend performs a very specific task and can be called or rendered whenever it is needed.

The point of creating the frontend based on the Micro frontends architecture is to make the application more flexible and more adaptable. A frontend could start having problems once the application requires more features. In such case, developers might need to apply many alternations to help the system be able to accept the newly added features. When a problem is discovered, sometimes big revisions and improvements are needed to get the system to the desired working state.

In Micro frontends architecture, each part of the application is developed independently, as a standalone application. This means that developers could choose Angular for one micro frontend and then choose React JS or Vue.js for another part. Each development team can focus on their micro frontend. This division also helps with separation of concerns, designers of the system will be able to divide it into small tasks and then assign the development of those small tasks into different teams. At this point, each team will not have to bother with interacting with other teams. They could focus on their task, its functionality, problems, and its deadline.

Microservices and Micro frontends architecture helps to solve many pressing problems for the development of web application. At the same time such architecture brings its own challenges and problems.

Putting all the small parts together is not an easy task. One question would be: How can Microservices interact with each other? Or how can Microservices exchange sensitive data among each other? Once every essential Microservice is created they need to be grouped together to form the final system. What technologies should be used to group those services? When thinking about the whole system, one need to think also about the frontend. How can the frontend interact with the Microservices? There are different ways to try to answer such question. Would the best solution be by creating Micro frontends for each Microservice when needed? But then this solution brings its own set of questions that would need to be answered.

Having this architecture in its early days means that not many resources are available and not enough research is done yet to help developers find answers for their problems. Moreover, security concerns are a big challenge under Microservices architecture. How would Microservices exchange particular sensitive information such as passwords or bank details? What if Microservices were not all developed inside the same company? Such scenario could rise when small companies want to build their applications using Microservices architecture. In this case, when having a small team of available developers, one could think of using ready-made solutions. Developers could use already written Microservices to save time and money. But doing this imposes more security concerns. In this situation how could Microservices trust each other? How could the existing Microservices trust the newly added ready-made solutions? The kind of trust discussed here is related to the behavior of each Microservice. After all, malicious or harmful Microservices could hide their true intentions by expressing different behavior while a harmful one is practiced behind the scenes.

This thesis will try to fill the gap that still exist in the literature regarding some of the mentioned concerns. The focus will be on building a system out of Microservices and Micro frontends while providing a solution for the security concerns, in particular content-trust among Microservices.