Project Cloud Computing

1 Outline

This semester you will work on different topics from the field of **Cloud** and/or **Edge Computing**. The main theme will be the migration of virtual resources from the cloud to an end device (e.g. client). Therefore you will have to investigate on recent topics from research! Following you will find themes and directions for your investigations. The references will help you on getting a clearer understanding of the topic and should be used as a starting point for your investigations!

Offline-first strategy in Cloud Computing

Cloud Computing enables the use of virtualized resources over a network in a scalable manner. However the operation of instances and the interaction with the cloud makes continues network connections necessary. This necessity has a huge influence on the service usage, since bandwidth and latency influence the service quality and the experience for the end user. One way of coping with this phenomenon is to run the services offline! A framework which focuses on this aspect is the emerging research field of Osmotic Computing [3, 4]. It studies the migration and deployment of services from cloud to edge and IoT (Internet of Things) environments. Another research field that is associated with this concept is pervasive cloud computing [1, 2]. These concepts make heavy use of Software-Defined Networking [5].

An interesting application for osmotic computing in a cloud service context would be the operation of workloads on clients offline. This way the conceptual framework of Desktop as a Service offerings could be enhanced by the (in parts) distribution of services to end-devices.

Investigate this trend in research and work on a concept of implementing this framework into the cloud computing ecosystem!

The following tasks should be covered:

- Research on Osmotic computing and investigate the application fields.
- Research on the use of Osmotic computing in an offline-first concept.
- Develop a conceptual framework for the use of Osmotic computing in an offline-first setting.
- Develop a prototypical showcase for the implementation of your conceptual framework.

Service migration in heterogeneous and distributed virtualized environments

Cloud computing makes use of homogeneous infrastructure components (hypervisor, network, storage, etc.). By distributing the resources to end devices it is unavoidable to use heterogeneous devices and components. Another challenge, that arises from the distribution is the use of heterogeneous configurations [9, 10]. Therefore a common scheme for distributing and operating workloads is needed in order to efficiently and reliably run applications on end devices. But in order to achieve this the workloads (virtual machines, containers) need to be migrated to the end device over network boundaries (Local Area Network to Wide Area Network – LAN to WAN) [6, 11]. This introduces challenges, which somehow need to be addressed and solved.

An interesting application for service migration in a cloud service context would be the operation of workloads on clients. So that virtualized workloads are transported over WAN to clients and in the same time communicate to and cooperate with services operated in the cloud. This leads to an extension of the cloud service on the client side with beneficial effects on the service by reducing network latency.

Investigate on how to efficiently and reliably distribute workloads from the cloud to end devices!

The following tasks should be covered:

- Research on service migration and investigate the application fields.
- Research on the use of service migration in an offline-first concept.
- Develop a conceptual framework for the use of service migration in an offline-first setting.
- Develop a prototypical showcase for the implementation of your conceptual framework.

Service quality awareness for migration of workloads

Virtual machine migration is heavily used inside of data center environments. It increases the efficiency of operation by locating virtual workloads on host machines, which run idle or in suboptimal states [9]. However forecasting the influence of the service relocation by migrating virtual workloads (virtual machines, containers) is a challenging task [12]. Even harder is the challenge on investigating the influence under the aspect of migrating workloads to clients over the internet with energy-efficiency in mind [7, 8]. Therefore a scheme and mechanism for reliably forecasting the influence on the applications running inside the virtual environments in real-time is important.

An interesting application for the real-time measuring of service quality awareness is the relocation of services to a client. In this application the relocation decision needs to be made on different metrics of the service itself, so that a reliable decision can be made. In order to achieve this the metrics from the operating system (or container) need to be evaluated.!

Investigate on how to reliably forecast the influence of migration on the quality of service inside virtual environments!

The following tasks should be covered:

- Research on methods to measure service quality and investigate the application fields.
- Research tools to measure the service quality and its application in an offline first concept.
- Develop a conceptual framework for the use of service quality measurement in an offline-first setting.
- Develop a prototypical showcase for the implementation of your conceptual framework.

2 Project organization

- Form groups of minimum **5 people**!
- Choose one group leader per team!
- Active participation in the exercises with stand up meeting!
- Show your progress in a two weekly cycle with a **one page report**!
- Submit your two weekly reports, presentations and final report via e-mail to `cocos@fb2.fra-uas.de`!
- You can use **GitHub** for your code submissions!

3 Prototypical Implementation

Provide a prototypical implementation for your research project and make real world experiments! Show a demo on the application of your prototype and use the results for your **final report and presentation**!

4 Examination

The examination will be (in part) a written scientific report in the style of an IEEE journal with a range of **12-15 pages** on your project and a presentation of at least **30 minutes**! The details of the grading of the course can be found in a separate document[1]!

[1] Final report and examination criteria: `www.henrycocos.de/vorlesungen/Cloud_Computing_WiSe23/cloud_computing_wise23.html`

References

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