Topics for theses
Bachelors/Masters thesis

Projekt SKY CONTROL

Problem statement

Sky Computing [1] is a new paradigm for the provision, consolidation and operation of services in the cloud computing context. The Sky Computing concept [1] introduces an abstraction layer - the **Intercloud Broker** – between cloud providers and end-user workloads to solve interoperability issues in multi-cloud configurations.

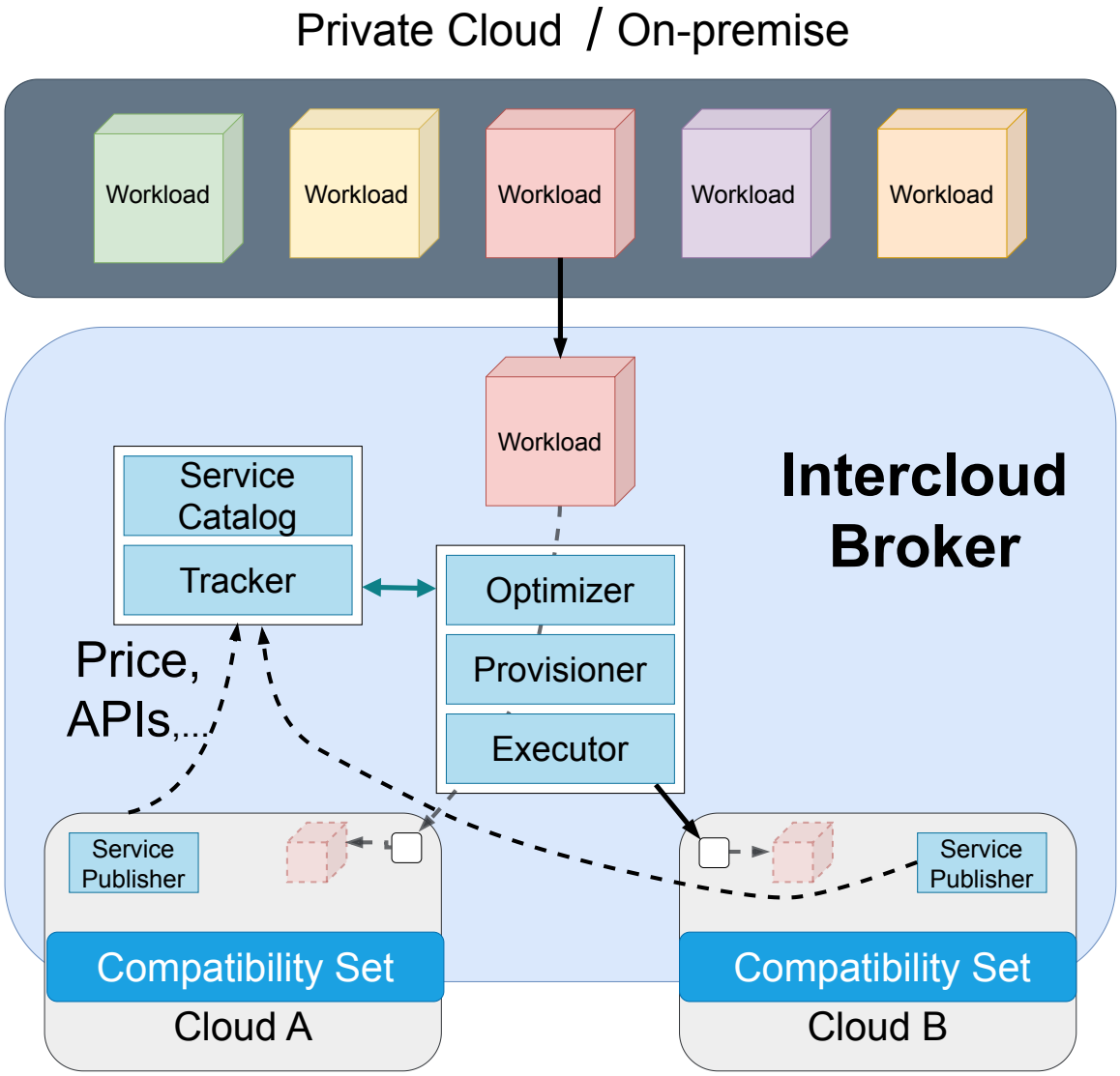

Figure 1: The Intercloud Broker [2]

The **Service Catalog** records available instances and services, including locations, pricing and APIs, while the **Tracker** monitors pricing and resource availability across multiple providers. Using this data, the **Optimizer** evaluates workload requirements, checks availability and pricing and determines optimal service placement. The **Executor** manages application execution by aggregating tasks and deploying workloads based on allocated resources. In addition, **Compatibility Sets** leverage existing services and APIs from different cloud

providers, ensuring seamless, standardized connectivity without the need for re-implementation. The term *"Cloud of Clouds"* summarizes this concept as it creates a unified, interoperable layer across multiple clouds. Sky Computing thus provides a solid foundation for implementing our proposed framework and leveraging the benefits of unified multi-cloud environments for SMEs (Small and Medium-sized Enterprises).

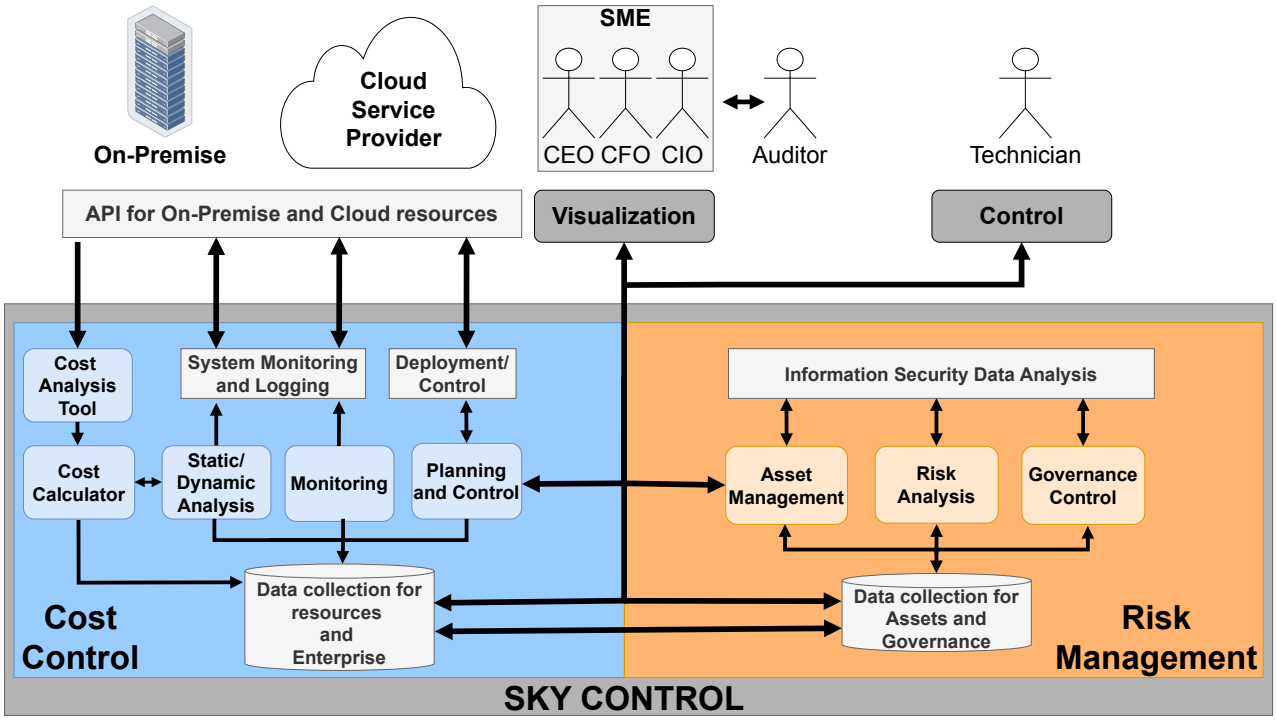

Figure 2: SKY CONTROL architecture [3]

The distributed nature of multi-cloud environments offers many benefits for SMEs, but also brings significant challenges in managing workloads across different cloud service provider (CSP) platforms. Keeping track of the cost of services to the business is a challenge and there are significant drawbacks to choosing such architectures. Another critical aspect is the overview and analysis of potential security risks and the management of assets. SKY CONTROL [3] addresses the challenges faced by SMEs when using multi-cloud implementations. Figure 2 shows the architecture of SKY CONTROL, along with the desired functionalities needed to meet the requirements of customers' cloud services.

The key components of the SKY CONTROL framework are

- **Cost management module:** Analyzes, calculates and visualizes costs for both on-premise and cloud sources. It performs static analysis (e.g. resource IDs, hardware specifications) and dynamic analysis (e.g. CPU/memory usage, network bandwidth). Pricing and forecasts are derived from this data. A control and planning tool provides insights into resource usage across multiple cloud providers, with visualization and for easier understanding.
- **Risk Management Module:** Manages customer assets, gathers detailed insights and performs risk analysis. It assesses risks based on asset criticality, data sensitivity and compliance standards such as C5 (Cloud Computing Compliance Criteria Catalogue) for German SMEs. This helps companies meet governance requirements and improves compatibility with larger organizations. The module also provides risk and asset visualization for CIOs performing audits and risk mitigation.

Possible Topics

Sky Computing – Presentation and explanation of the trend

This thesis aims to review the sky computing paradigm through a detailed literature review and present its origins and key requirements. In their work, Stoica et al. draw a comparison with the Internet and the standards, methods and technologies used therein. In this paper, this comparison will be analyzed and processed in detail.

SASE (Secure Access Service Edge) – Presentation and explanation of the trend and experimental setup

This thesis is intended to review the SASE (Secure Access Service Edge) [4] through a detailed literature research and present its origins and central requirements. Based on the literature research carried out, a prototypical implementation and experimental setup should demonstrate SASE in practice and illustrate its application in the environment of Sky Computing! For this purpose, solutions for the implementation of the prototype should be analyzed – ideally open source solutions.

Cost Control in Multi-Cloud Environments – Presentation and Analysis of the Problem

This thesis aims to review the current state of the art and science through a detailed analysis of the cost structures for different services in multi-cloud environments and to present its origins and key requirements. Based on the literature research conducted, a prototype implementation and experimental setup will demonstrate a possibility for cost control in multi-cloud environments in practice and present its application in the environment of Sky Computing! For this purpose, solutions for the implementation of the prototype should be analyzed – ideally open source solutions.

Risk Management in Multi-Cloud Environments – Presentation and Analysis of the Problem

This thesis aims to analyze the current state of the art and science through a detailed analysis of compliance policies and governance for various services in multi-cloud environments and to present key requirements. Based on the literature research carried out, the relevant documentation for governance, e.g. General Data Protection Regulation (GDPR), IT Security Act, Telecommunications and Telemedia Acts, etc., will be reviewed and analyzed. Security guidelines, e.g. BSI C5 (Cloud Computing Compliance Criteria Catalog), SOC 2, ISO 27001, etc. will also be analyzed in this thesis. The aim of the work is to derive relevant questions, identify measures and guidelines for multi-cloud setups (Germany-wide and international) and analyze them in a targeted manner for the SKY CONTROL project!

Connecting Local Workloads to Sky Computing in Multi-Cloud Environments – Presentation and Analysis of the Problem and Experimental Setup

This thesis aims to analyze and present the current state of the art and science through a detailed investigation of the possibility of relocating workloads between different CSPs in multi-cloud environments. To this end, this thesis will analyze the technological requirements in multi-cloud environments for moving workloads and investigate different dimensions of scaling – vertical (adding resources), horizontal (adding service instances) and geographical scaling (placing services closer to users). Based on the literature review, a prototype implementation and experimental setup will demonstrate the migration of workloads in practice and its application in the sky computing environment! For this purpose, solutions for the implementation of the prototype should be analyzed – ideally open source solutions.

Requirements

To complete the Bachelors/Masters thesis, you should bring the following with you:

- Interest in distributed systems, computer networks and cloud computing.
- Linux shell knowledge and enthusiasm for cloud platforms.
- Interest in literature research and enthusiasm for familiarizing with new topics of current research.

The processing time of the Bachelors/Masters thesis is **9 weeks or 22 weeks**.

First Steps

If you are interested in a topic for your Bachelors/Masters thesis, please send an e-mail with a short synopsis (1-2 pages) on which you briefly outline your project.

Content of the synopsis:

1. **Research topic** – short summary of your topic.
2. **Objective** – What do you want to achieve in your work?
3. **Concept** – What should your work look like? (e.g., overview diagram, methods, technologies, etc.)
4. **Preliminary outline** - Brief outline of your thesis.

References

[1] I. Stoica and S. Shenker, "From cloud computing to sky computing," in *Proceedings of the Workshop on Hot Topics in Operating Systems*, HotOS '21, (New York, NY, USA), p. 26–32, Association for Computing Machinery, 2021.

[2] Z. Yang, Z. Wu, M. Luo, W.-L. Chiang, R. Bhardwaj, W. Kwon, S. Zhuang, F. S. Luan, G. Mittal, S. Shenker, and I. Stoica, "SkyPilot: An intercloud broker for sky computing," in *20th USENIX Symposium on Networked Systems Design and Implementation (NSDI 23)*, (Boston, MA), pp. 437–455, USENIX Association, Apr. 2023.

[3] H. Cocos, C. Baun, and M. Kappes, "The Evolution of Cloud Computing Towards a Vendor Agnostic Market Place Using the SKY CONTROL Framework," in *Proceedings of the 15th International Conference on Cloud Computing and Services Science - CLOSER*, pp. 211–218, INSTICC, SciTePress, 2025.

[4] M. N. Islam, R. Colomo-Palacios, and S. Chockalingam, "Secure access service edge: A multivocal literature review," in *2021 21st International Conference on Computational Science and Its Applications (ICCSA)*, pp. 188–194, 2021.

Contact

If you are interested, please contact:

Henry-Norbert Cocos, M.Sc
Frankfurt University of Applied Sciences
Raum 1-230
☎ 069 1533-2699
✉ `cocos@fra-uas.de`
`www.henrycocos.de`