

Managing Service Dependency for Cloud Reliability: The Industrial Practice

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Abstract—Interactions between cloud services result in service dependencies. Evaluating and managing the cascading impacts caused by service dependencies is critical to the reliability of cloud systems. This paper summarizes the dependency types in cloud systems and demonstrates the design of the Dependency Management System (DMS), a platform for managing the service dependencies in the production cloud system. DMS features the full-lifecycle support for service reliability (i.e., initial service deployment, service upgrade, proactive architectural optimization, and reactive failure mitigation) and refined characterization of the intensity of dependencies.

Index Terms—cloud computing, software reliability, AIOps, service dependency

I. BACKGROUND AND MOTIVATION

Modern cloud systems, including Huawei Cloud, are often constructed from a complex and large-scale hierarchy of distributed software modules. The common practice is to develop and deploy these software modules as *cloud microservices* that collectively comprise multiple *cloud services* [1], e.g., resource allocation, virtual network management, and virtual machine management. Different microservices serve different functionalities. The microservices communicate through well-defined APIs and respond to external requests as a whole through service invocations.

Such an architecture benefits scalability, robustness, and agility but also complicates system reliability engineering. However, the interactions between services cause dependencies, resulting in the cascading impact on the system. Despite various fault-tolerance mechanisms introduced, it is still possible for minor anomalies to magnify their impacts and escalate into system outages. When a cloud service or microservice enters an anomalous status, the anomaly can cascadingly propagate through the service-calling structure, causing a degraded user experience or even a service outage [2].

The cascading impacts hinder system operation and maintenance, deteriorating customer satisfaction. For instance, during the initial service deployment or service upgrade, all the services it relies on should be ready. During the failure mitigation and recovery, the cascading impact will slow the



Fig. 1. The architecture of DMS.

recovery. Therefore, evaluating and managing the cascading impacts caused by service dependencies is crucial.

II. KEY INNOVATIONS

This paper classifies the dependency types in cloud systems and demonstrates the design of the Dependency Management System (DMS), an end-to-end platform for managing the service dependencies in the production cloud system. DMS supports the full-lifecycle support for service reliability, i.e., initial service deployment, service upgrade, proactive architectural optimization, and reactive failure mitigation. DMS integrates our previous study on the aggregated intensity of service dependency [2] to characterize the degree of cascading impacts and provides a refined characterization of dependencies. In addition, DMS also features automatic configuration parsing and multi-source dependency fusion for practicality.

III. DEPENDENCY TYPES

The dependency relations in a cloud system are diverse. In Huawei Cloud, we categorize the dependencies according to the architectural level, i.e., service-level dependencies and microservice-level dependencies.

1) *Service-level dependency*: If the dependency is between two cloud services, we call it a service-level dependency. Service-level dependency can be further divided into the following three subtypes, i.e., deployment dependency, runtime dependency, and operational dependency.

Deployment dependency indicates dependency during the deployment of a cloud service. The deployment phase may rely on some cloud services to create and configure resources. For example, the elastic computing service depends on the API management service to register public APIs. The elastic computing service also depends on the block storage service to allocate the required resource.

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