

## PREFACE

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The rising demand for cloud services witnesses massive expansions in cloud data center infrastructure globally. This unprecedented increase of cloud data centers results in high energy consumption and carbon emissions into the environment. Due to the excessive energy consumption of data centers, there has been a need for developing energy-efficient approaches in the clouds to minimize energy utilization. Cloud service providers have been practicing various energy management strategies to reduce energy consumption to maximize Return On Investment (ROI) and to improve the environment.

This thesis investigates energy-aware workflow task scheduling and Virtual Machine (VM) consolidation techniques in Infrastructure as a service (IaaS) clouds. The scientific workflows with precedence constrained tasks are high-level complex applications that demand high computing power and takes a long time to complete execution. As consequence, cloud data centers consume more electrical energy. The scheduling algorithms efficiently manage cloud resources (VMs) while executing workflow applications to minimize power utilization. The VM consolidation reduces the number of physical servers by switching off the idle machines and consolidate VMs for load balancing. It uses live VM migrations while executing the tasks so that underloaded physical servers can be switched off by migrating all VMs running on it to a normally loaded server(s). The VM consolidation in the cloud environment is a well-known NP-hard problem.

Workflow scheduling and VM consolidation techniques presented in this thesis address fundamental challenges that arise from the multi-tenant, resource-abundant, and elastic resource model and are competent in satisfying a set of Quality-of-Service (QoS) requirements.

The major contributions of this thesis to advances in energy-aware workflow scheduling and VM consolidation as follows:

- A review of the energy-aware workflow scheduling algorithms for IaaS clouds.
- A heuristic-based energy-efficient and cost-aware scheduling algorithm with deadline constraints.
- A heuristic-based scheduling algorithm for energy and reliability optimization.
- A meta-heuristic-based virtual machine consolidation algorithm.
- A hybrid scheduling algorithm with virtual machine consolidation.