

SHANGHAI JIAO TONG UNIVERSITY

**学士学位论文**

BACHELOR’S THESIS



论文题目： Latency Impact of Docker Containers: A Closer Look

学生姓名: 章佐铭

学生学号: 5120309626

专 业: 计算机科学与技术

指导教师: 李超

学院(系): 电子信息与电气工程学院

毕业设计（论文）题目，Times New Roman, 10号字。

**二甲醚清洁燃料均质压燃燃烧数值模拟研究**

中文题目，三号黑体居中，加粗，上下各空一行。

四号黑体居中

摘要

摘要正文五号宋体，首行缩进二个字符，单倍行距。300-500字。

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均质充量压缩着火（HCCI）燃烧，作为一种能有效实现高效低污染的燃烧方式，能够使发动机同时保持较高的燃油经济性和动力性能，而且能有效降低发动机的NOx和碳烟排放。此外HCCI燃烧的一个显著特点是燃料的着火时刻和燃烧过程主要受化学动力学控制，基于这个特点，发动机结构参数和工况的改变将显著地影响着HCCI发动机的着火和燃烧过程。本文以新型发动机代用燃料二甲醚（DME）为例，对HCCI发动机燃用DME的着火和燃烧过程进行了研究。研究采用由美国Lawrence Livermore国家实验室提出的DME详细化学动力学反应机理及其开发的HCT化学动力学程序，且DME的详细氧化机理包括399个基元反应，涉及79个组分。为考虑壁面传热的影响，在HCT程序中增加了壁面传热子模型。采用该方法研究了压缩比、燃空当量比、进气充量加热、发动机转速、EGR和燃料添加剂等因素对HCCI着火和燃烧的影响。结果表明，DME的HCCI燃烧过程有明显的低温反应放热和高温反应放热两阶段；增大压缩比、燃空当量比、提高进气充量温度、添加H2O2、H2、CO使着火提前；提高发动机转速、采用冷却EGR、添加CH4、CH3OH使着火滞后。

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关键词：均质充量压缩着火，化学动力学，数值模拟，二甲醚，EGR

小四号黑体

五号宋体，逗号分开，最后一个关键字后面无标点符号。

**OPTICAL PROPERTIES OF COMPOSITE MATERIALS MADE FROM HYDROGEL AND BUTTERFLY WING SCALES**

题目Times New Roman, 16号字加粗居中，上下各空一行。

摘要正文Times New Roma.n, 12号字，左右对齐。1.5倍行距。

**ABSTRACT**

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Traditionally, many web services are held on virtual machines (VMs) provided by cloud computing suppliers. Since VMs bring about dramatic performance degradation compared to bare metal, the quality of service (QoS) is affected. Among all the QoS features, service latency is of crucial importance. With the prevalence of Docker, containers, also called “lightweight VM”, offer another choice to deploy web applications on the cloud. This paper takes the first to thoroughly analyze the impact of different Docker configurations on service latency. We conclude that the CPU quota configuration might lead to a long tail latency. Docker bridge could lead to a fixed amount of latency degradation instead of a percentage fallen. Using AUFS could bring about extra latency when opening a file or traversing the file system, and have no effect on writing data to a file.

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**Key words:** Biomedical Sensor, Lepidoptera scales, Nature photonics, Optical sensor/indicator, Electric field sensitive, pH condition sensitive, Interpenetrating polymer network

关键字Times New Roma.n, 12号字，左右对齐。1.5倍行距，

“Key words”加粗；关键字逗号分开，最后一个关键字后面无标点符号。

**Contents**

Times New Roma.n, 12号字单倍行距。

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# Introduction

Began from an open-source advanced container engine of dotCloud, a Platform-as-a-Service (PaaS) supplier, Docker is becoming one of the most promising virtualization platform. It significantly shortens the process of packing, shipping and running applications ([1], Merkel D., 2014: 2.). By packing all the dependencies of the application into several image layers, you can carry the package around and run it with simple commands on almost every laptop, personal computer, and even cloud center as long as running a Linux operating system.

Unlike traditional virtual machines, which use hardware-level virtualization, Docker containers employ system-level virtualization and share the same kernel with the host machine\cite{soltesz2007container}. Many researches\cite{felter2015updated, kratzke2015microservices} have proved that containers have a better performance in most cases than VMs. Due to these performance reasons, many companies are trying to move services from virtual machines to containers\cite{he2012elastic}. However, containers do add additional layers compared to bare-metal hardware, which leads to certain degree of performance degradation.

Docker was born to replace virtual machines to some extent. Nowadays, the widely known Infrastructure-as-a-Service (IaaS) platforms like Amazon EC2 uses virtual machines to run applications like cache and database. Most of these applications not only focus on throughput, but also favor real-time low latency. However, most related work of Docker focus mostly on containers? influence on throughput instead of the latency degradation. Since Docker provides many choices of resource isolation, in this paper, we will do research on how these parameters will affect the latency performance of real time applications.

# Background & Motivation

LXC\cite{helsley2009lxc} and Docker libcontainer\cite{vspavcek2015docker} use Linux Namespaces\cite{wright2003linux} together with Control Groups (CGroups)\cite{menage2007linux} to realize resource isolation and limitation. Resources like CPU, memory and process id (PID) are no longer global, but belongs to a particular namespace. Processes outside a namespace are transparent to ones inside the namespace. Inside processes also has no access to outside resources, thus providing certain level of security.

## Linux Bridge

Bridge mode is the default network setting of Docker, which makes use of the Linux bridge feature\cite{tseng2011network}. When using this mode, each container is allocated a network namespace and separate IP. Once the Docker daemon starts, it creates a virtual network bridge named docker0 on the host machine. All Docker containers created on this machine will be connected to docker0. Virtual network bridge works like a physical switch, thus all containers on the host machine are connected in a two-layer network through the switch. Docker chooses a private IP different from the host IP and allocate it to docker0. It also selects a sub net defined in RFC1918. Each container on the host machine is assigned an unused IP from this sub net pool.

**2.2 AUFS**

Another Union File System (AUFS) is a kind of Union File System\cite{pendry1997union}. Frankly speaking, it is a file system that supports to mount different directories to a single virtual filesystem. Further deep inside, AUFS supports to set the readonly, readwrite, whiteout-able authority of every member category, just like Git Branch. Also, the layer concept in AUFS supports to logically and incrementally modify the readonly branch without affecting the readonly part. Generally speaking, there are two uses of Union FS. On one hand, it can mount multiple disks to a single directory without the help of LVM\cite{hasenstein2001logical} or RAID\cite{gibson1992redundant}. On the other hand, it enables the cooperation of a readonly branch and a writeable branch. Docker uses AUFS to build container images.

**REFERENCE**

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1. Merkel D. Docker: lightweight linux containers for consistent development and deployment[J]. Linux Journal, 2014, 2014(239): 2.

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