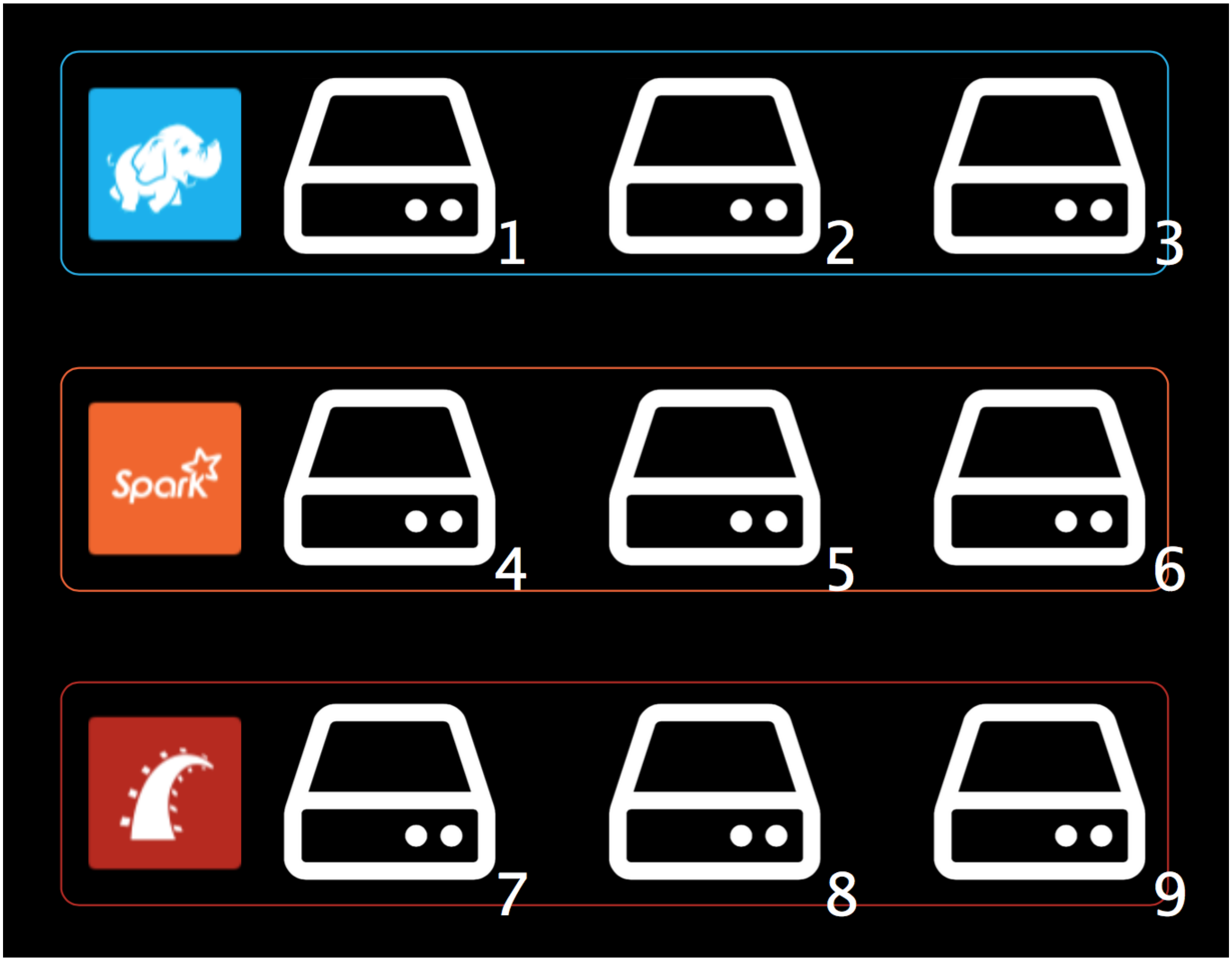
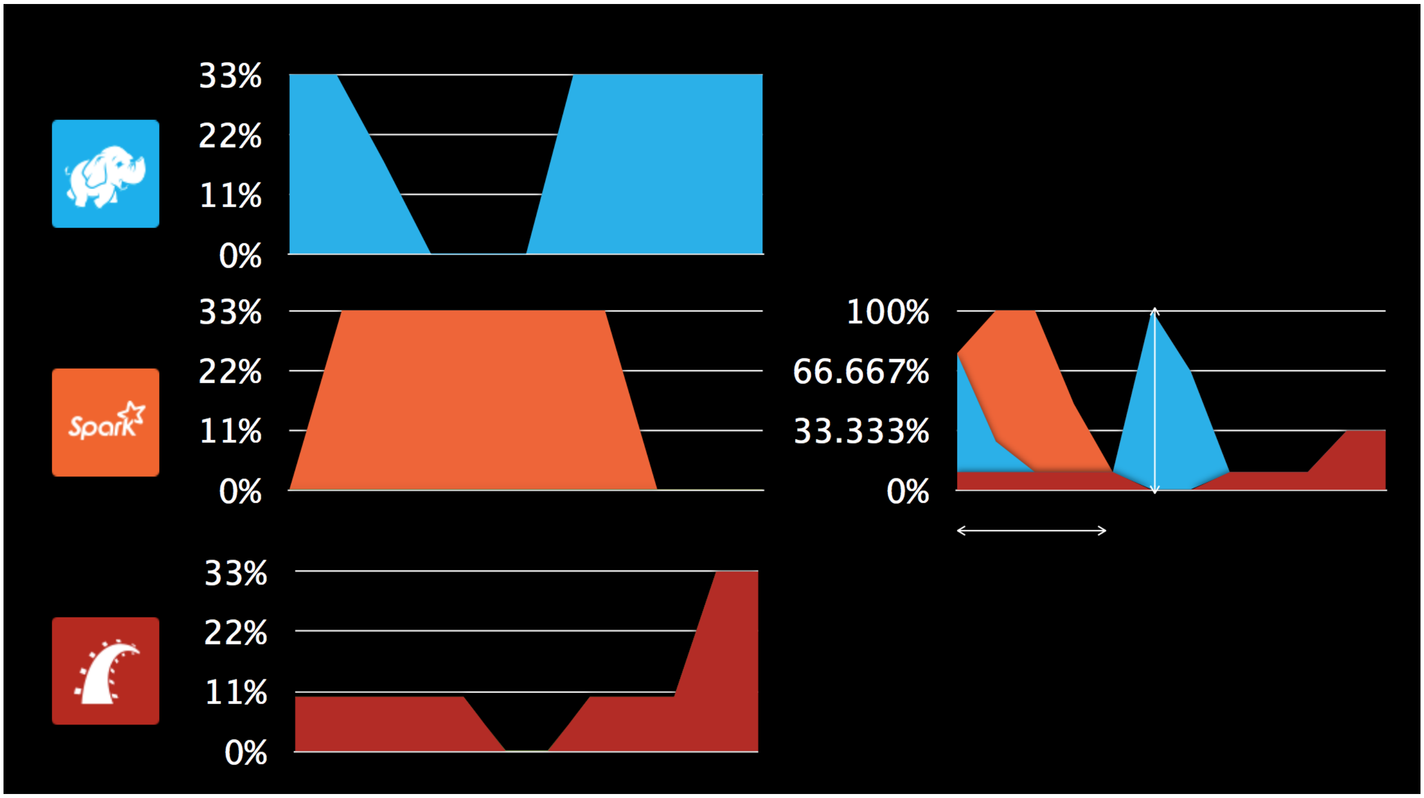
Mesos是什么

官网

问题1. 集群部署主要在VM或者在物理层静态的进行资源划分, 如下图, 划分每3台主机作为一个集群运行各自的应用

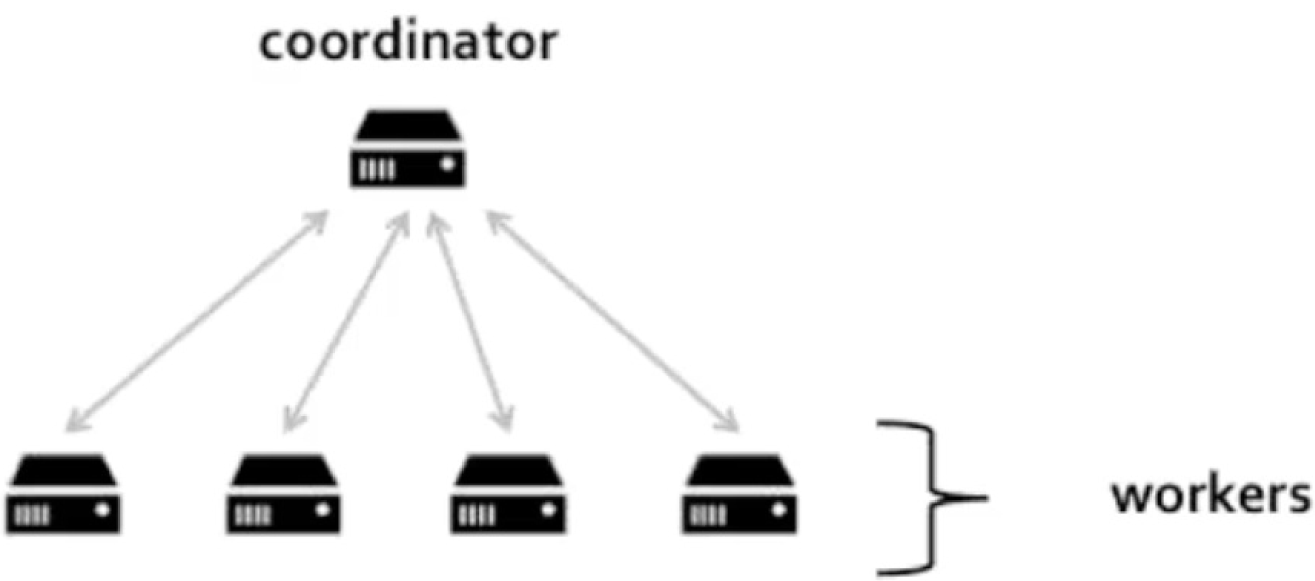


此时从时间维度观察3个集群的资源利用情况, 如下图



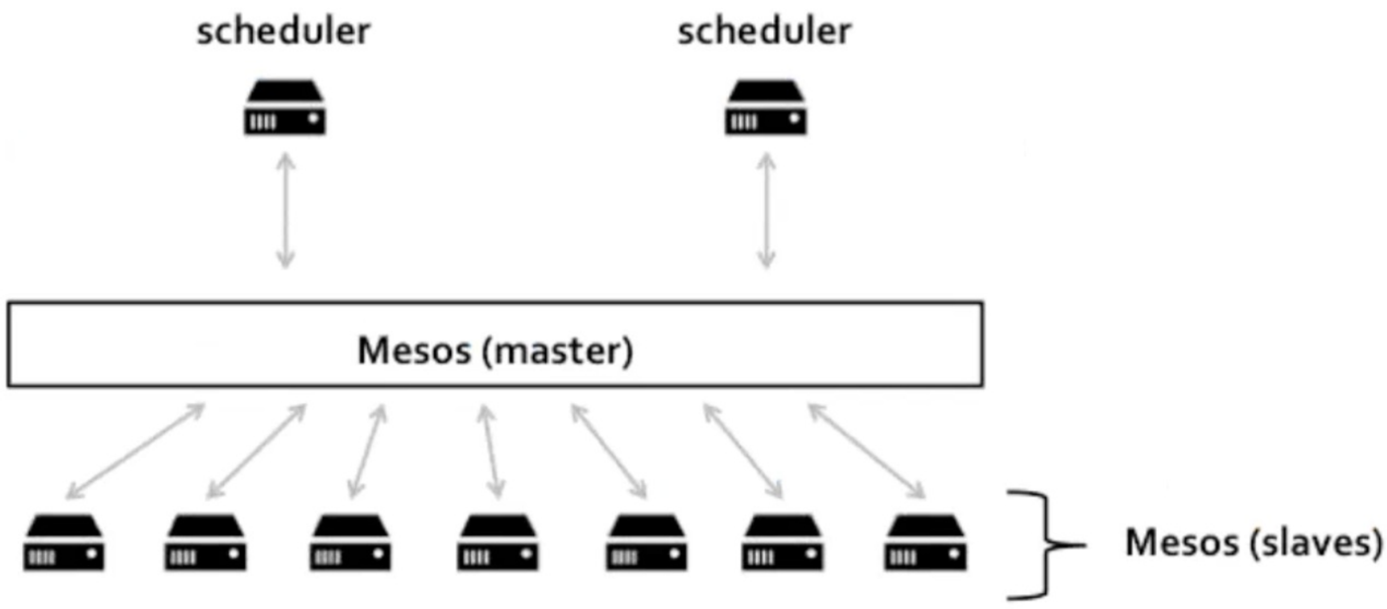
可以观察到整个时间轴上, 整体资源利用率并不很高, 但是假设9台机器组成共享资源池, 每个应用在执行过程中从资源池中申请需要的资源并执行, 此时整体资源利用率相对提高

问题2. 分布式系统通过联合调度进行任务的执行，由协调器(负责协调在集群中执行想要运行的代码)和Worker(具体的功能代码)组成



在分布式系统中, 协调器与具体业务功能无关且各系统的协调器功能类似, 是否可以将协调器进行抽象并统一负责协调所有集群的任务执行, 实现一个分布式的协调系统

Mesos是一个分布式的集群管理框架, 宗旨为尝试和提高集群的利用率和性能、提供通用的分布式系统框架.

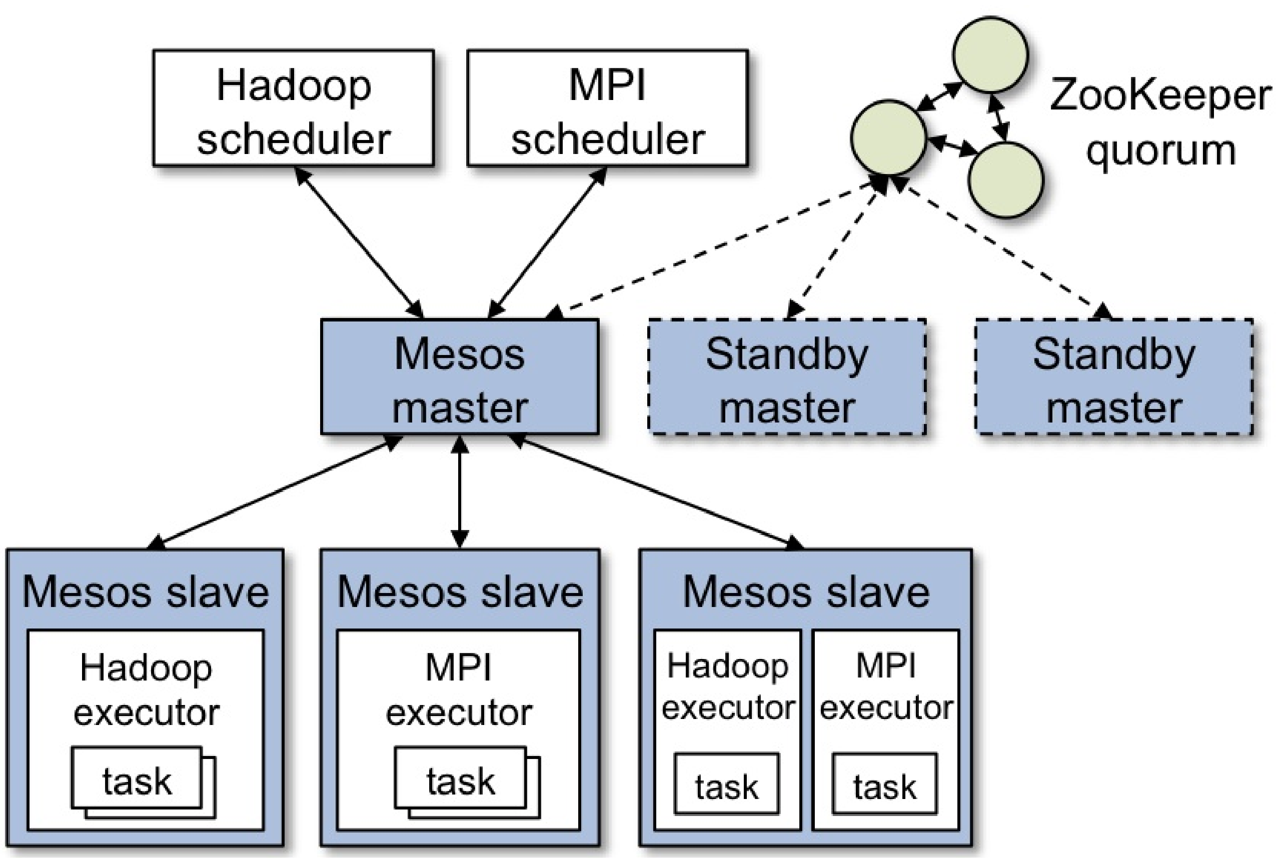


Mesos框架本身只负责资源的分配，而不负责资源的调度，每个业务功能的调度器和mesos master API进行通信，mesos master根据剩余资源调度mesos slave执行相应的任务

好处：

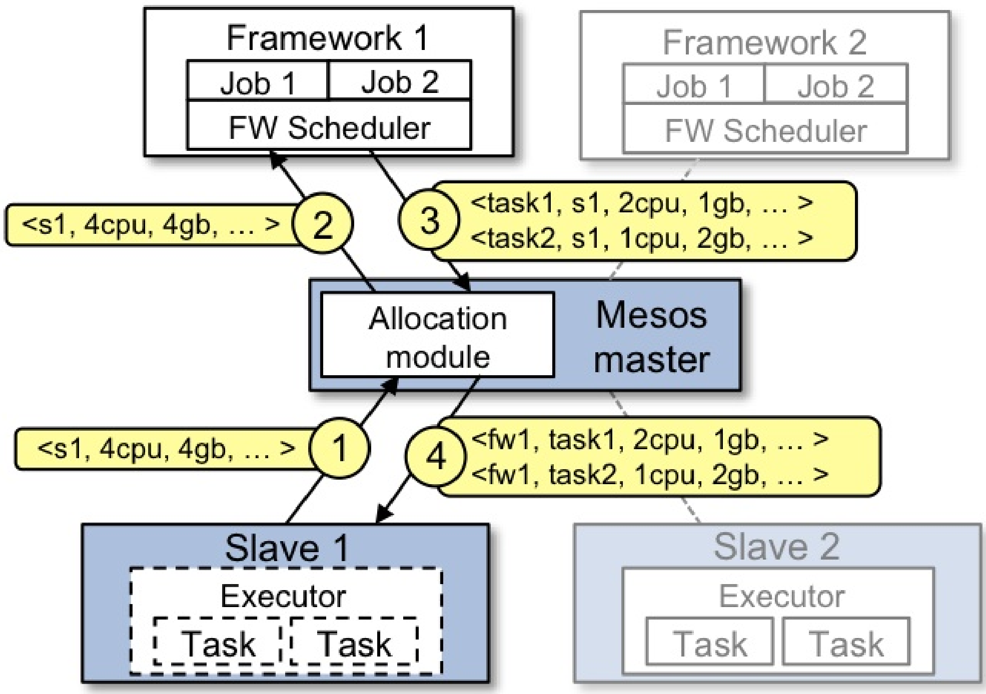
1. 可以在一批机器上部署执行多个分布式系统，动态划分(解决静态资源划分问题)和共享资源，并且不用为每个分布式实现一套协调功能
2. 提供统一的分布式功能集(故障检测、分布式任务、任务启动、任务监控、结束任务、清理任务等)

架构



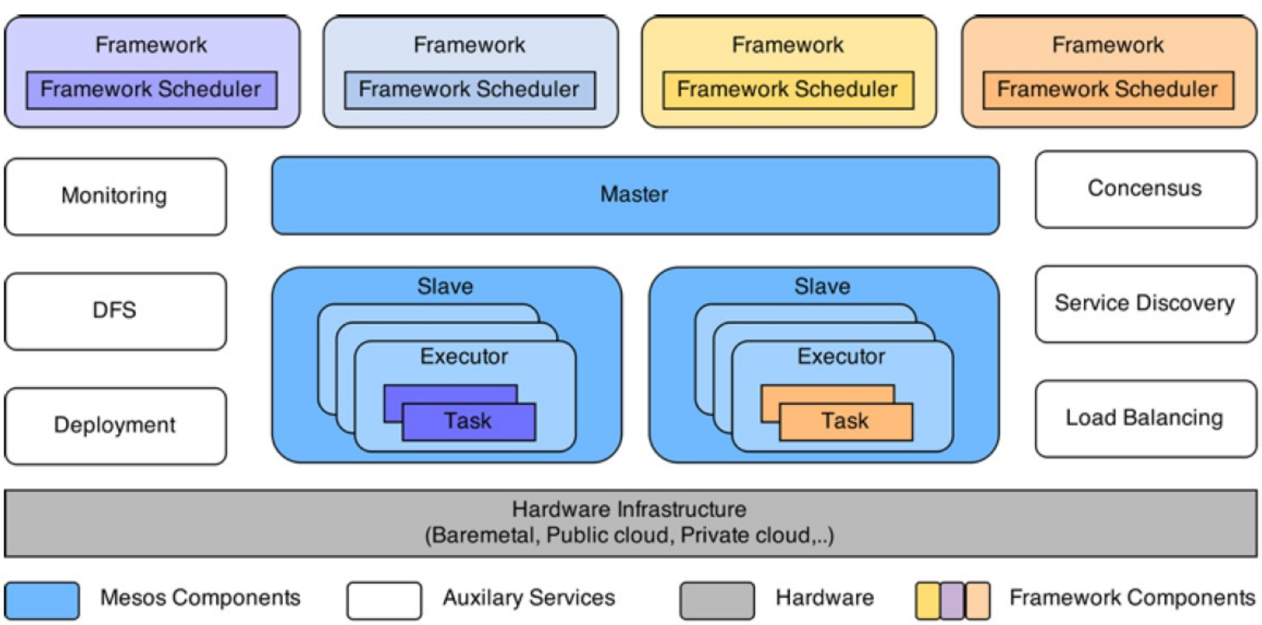
说明：

1. mesos由framework、master、slave组成, fromework由调度器和执行器组成, 使用zookeeper来维护集群的高可用性和配置信息
2. mesos提供资源的抽象提供双层调度系统, master主要负责从slave收集资源并根据资源分配算法以resource offer(list)的方式提供的框架的调度器, 调度器接收resource offer并决定如何使用, 可以选择接受或者拒绝资源, 当全责接收资源时则发送TaskInfo()信息给master，master经过检查下发给slave并由slave调用TaskInfo中指定的执行器来执行具体的任务。 流程图如下图：



Mesos用来干什么

先看下Mesos架构图:



将Mesos生态组件和Linux操作系统对比:

	Linux OS	Distributed OS
资源管理	Linux Kernel	Mesos
进程管理	Linux Kernel	Docker
任务调度	init.d, cron	Marathon, Chronos
进程间通讯	Pipe, Socket	RabbitMQ, Kafka
文件系统	ext4	HDFS, Ceph

可以用来构建分布式的操作"系统", 即数据中心操作系统(DCOS), mesosphere公司使用mesos构建了Mesosphere DCOS

版本

预言使用版本为: 0.24.0 (9月2日)
目前最新release版为: 0.24.1 (9月25日)
目前最新rc版为: 0.25.rc2 (10月6日)

每10天一个测试版, 每20天一个修正版本, 每40天一个子版本

开发语言&协议

开发语言: C++
协议: Apache License Version 2.0
Mesos扩展模块开发: C++ 若想使用Python,Java,GO等其他语言，需要使用C++实现代理
框架开发: Python, Java, Go等

安装

系统要求: 64位的linux或mac系统

安装:

1.源码编译安装(centos 7.0)

- 编译环境准备

```
yum install -y tar wget

wget http://repos.fedorapeople.org/repos/dchen/apache-maven/epel-apache-maven.repo -O /etc/yum.repos.d/epel-apache-maven.repo

yum groupinstall -y "Development Tools"
echo "[WANdiscoSVN]" > /etc/yum.repos.d/wandisco-svn.repo
echo "name=WANdisco SVN Repo 1.9" >> /etc/yum.repos.d/wandisco-svn.repo
echo "enabled=1" >> /etc/yum.repos.d/wandisco-svn.repo
echo "baseurl=http://opensource.wandisco.com/centos/7/svn-1.9/RPMS/x86_64/" >> /etc/yum.repos.d/wandisco-svn.repo
echo "gpgcheck=1" >> /etc/yum.repos.d/wandisco-svn.repo
echo "gpgkey=http://opensource.wandisco.com/RPM-GPG-KEY-WANdisco" >> /etc/yum.repos.d/wandisco-svn.repo

yum groupinstall -y "Development Tools"
```

```
yum install -y apache-maven python-devel java-1.7.0-openjdk-devel zlib-devel libcurl-devel openssl-devel cyrus-sasl-devel cyrus-sa

gcc --version
```

说明:
a. 在编译>=0.21版本的mesos时c++编译器必须完全支持c++11即gcc>=4.8.0
b. 在编译>=0.21版本的mesos需要使用subversion>=1.8的devel包, 而在centos中不提供, 需要手动添加svn源
c. mesos在运行中需要使用cyrus-sasl-md5和subversion

- mesos编译&检查&安装

```
# 下载tar.gz包
wget http://apache.fayea.com/mesos/0.24.0/mesos-0.24.0.tar.gz

# 解压
tar zvxf mesos-0.24.0.tar.gz

# 编译准备
cd mesos-0.24.0
./boostrap

# 创建编译目录
mkdir build && cd build

# 生成编译配置
../configure

# 编译
make -j4

# 检查，可能需要使用sudo make check
make check

# 安装
make install

# 启动
cd bin && ./mesos-master.sh --ip=127.0.0.1 --work_dir=/tmp/test_mesos
cd bin && ./mesos-slave.sh --master=127.0.0.1:5050
# 待安装后也可以使用mesos-local进行启动，该命令会在本地启动一个master和一个slave

# 测试
cd src && ./test-framework --master=localhost:5050
cd src/examples/java && ./test-framework localhost:5050
cd src/examples/python && ./test-framework localhost:5050

# 访问webui
# http://localhost:5050
# mesos通过iptables限制其访问权限, 若不能访问需要查看并修改iptables的策略
```

- 若需要使用mesos contraintorizer 的网络隔离功能则需要安装libnl-3.2.26

```
#下载 libnl-3.2.25
wget https://codeload.github.com/tgraf/libnl/tar.gz/libnl3_2_26rc1 -O libnl3_2_26rc1.tar.gz

tar zvxf libnl3_2_26rc1.tar.gz
cd libnl-libnl3_2_26rc1
./autogen.sh
./configure
make -j4
make install

# 在生成mesos的编译文件时添加network参数,
```

```
../configure --with-network-isolator
```

2.通过mesosphere提供的rpm或deb安装包进行安装(centos 7.0)

下载地址: https://open.mesosphere.com/downloads/mesos/

```
# mesos依赖包subversion, cyrus-sasl-md5需要提前安装
yum install subversion cyrus-sasl-md5

# 下载安装包&安装
wget http://downloads.mesosphere.io/master/centos/7/mesos-0.24.0-1.0.27.centos701406.x86_64.rpm

rpm -i mesos-0.24.0-1.0.27.centos701406.x86_64.rpm
```

说明:
a. 使用rpm安装包安装后, 会自动添加到启动服务中并随机器启动，可以通过systemctl命令进行控制

```
systemctl stop mesos-master.service
systemctl stop mesos-slave.service

systemctl start mesos-master.service
systemctl start mesos-slave.service
```

b. 在安装后mesos的配置文件会放置在/etc/mesos, /etc/mesos-master, /etc/mesos-slave三个目录下和/etc/default/mesos, /etc/defautl/mesos-master, /etc/default/mesos-slave三个文件

在mesos-master启动会检查messo和mesos-master配置文件中的ULIMIT, ZK, IP, PORT, CLUSTER, LOGS六个参数,并从加载/etc/mesos-master目录下的配置文件
在mesos-slave启动时会检测时umesos和mesos-slave配置文件中ULIMIT, MASTER, IP, LOGS, ISOLATION五个参数并从加载/etc/mesos-slave目录下的配置文件

在/etc/mesos/目录下只有zk配置文件用来配置zookeeper的地址, 由/etc/default/mesos-master和/etc/default/mesos-slave导入

在/etc/mesos-master和/etc/mesos-slave目录下分别是针对master和slave命令的参数进行配置，每一个文件对应一个参数, 文件名为参数名, 文件内容为参数值, 若参数无参数值则文件名使用?开头

3.通过mesosphere提供的源进行安装, 参考

配置

可以通过mesos-master --help和mesos-slave --help查看master和slave支持的参数

master配置参数:

参数名	参数值	默认值
--acls	授权控制	
--advertise_ip		
--advertise_port		
--allocation_interval	将resource offer发送给framewrok的间隔	1s
--allocator	资源调度算法, 可通过modules进行扩展	HierarchicalDRF
--[no-]authenticate	是否对框架进行认证	false
--[no-]authenticate_slaves	是否对slave进行认证	false
--authenticator	framework和slave的认证方式,可通过modules进行扩展	crammd5
--authorizers	授权方式指定默认为local, 可以通过modules方式扩展, 此时--acls将不起效, 目前不能同时支持多种授权方式	

--cluster	集群的名称, 显示在webui上	
--credentials	用户认证配置	
--external_log_file	指定日志文件, 用于记录webui和http api的相关日志	
--firewall_rules	设置http api接口的访问限制	
--framework_sorter	frame资源分配的策略	drf
--[no-]help	显示帮助信息	
--hooks	配置hook扩展	
--hostname	设置master或slave对外的主机名	
--[no-]initialize_driver_logging	是否自动初始化framework执行器的日志	
--ip	master绑定的IP地址	
--ip_discovery_command		
--[no-]log_auto_initialize	是否自动初始化relicated log, 若禁用, 则必须手动初始化	true
--log_dir	日志文件路径	
--logbufsecs	log刷新时间间隔	0s
--logging_level	日志级别，可配置为'INFO', 'WARNING', 'ERROR'	INFO
--max_slave_ping_timeouts	设置slave响应master ping命令失败的次数,若超过次数则移除slave	5s
--modules	加载的模块信息	
--offer_timeout	master发送offer的回收时间	
--port	master监听的端口号	5050
--[no-]quiet	关闭日志到标准错误输出	false
--quorum	决策人数量当记录replicated log的master数量大于quorum是则成功, 配置一般大于master数量的一半, 若master为1却不适用zk则不用配置	
--rate_limits	配置framework接口调用的限速	
--recovery_slave_removal_limit	故障恢复时刻移除的slave最大比例	100%
--registry	register使用的持久化策略，可以选择replicated_log或in_momory	replicated_log
--registry_fetch_timeout	当fetch失败时再次发起fetch的时间	1min
--registry_store_timeout	当store失败时再次发起store的时间	5s
--[no-]registry_strict	是否拒绝slave重新注册或移除	false
--roles	配置集群就角色信息	
--[no-]root_submissions	是否允许root提交框架	true
--slave_ping_timeout	设置slave响应master ping命令的超时时间	15s
--slave_removal_rate_limit	slave移除速率	
--slave_reregister_timeout	master重新选举后, slave重新注册的超时时间	10min

--user_sorter	用户资源分配策略	drf
--[no-]version	显示版本信息	
--webui_dir	web ui的文件目录	
--weights	用来配置角色获取资源的权重信息	
--whitelist	配置可接受offer的slave, 默认全部接受	
--work_dir	控件工作的目录和replication log存放的路径	
--zk	zookeeper地址zk://ip:password/mesos	
--zk_session_timeout	zookeeper会话超时时间	10s
--max_executors_per_slave	设置每个slave上运行制执行器的最大个数	

slave的配置参数:

参数名	参数值	默认值
--appc_store_dir		
--attributes	设置slave节点的属性列表, 调度器可以根据属性值作为调度的限制条件	
--authenticatee	slave用来向master的认证方式	crammd5
--[no-]cgroups_cpu_enable_pids_and_tids_count		
--[no-]cgroups_enable_cfs	开启cfs带宽限制特征对cpu进行硬件限制	false
--cgroups_hierarchy	cgroups的根路径	/sys/fs/cgroup
--[no-]cgroups_limit_swap	开启内测和交换区的限制	false
--cgroups_root	根cgroups的名字	mesos
--container_disk_watch_interval	周期检查容器磁盘配合的时间间隔,posix/disk隔离器使用该配置	15s
--containerizer_path	设置外部容器的可执行文件, 需要和--isolation=external一起作用	
--containerizers	设置使用的容器机支持mesos,external,docker, 在启动时会按照顺序进行尝试启动, 若使用docker则需要在启动时设置为docker,mesos	mesos
--credential	master认证的用户信息配置文件	
--default_container_image	设置外部容器及使用的默认镜像，需要和--isolation=external一起作用	
--default_container_info	在ExecutorInfo中未显示指定ContainerInfo时使用的默认ContainerInfo	
--default_role	在--resouces中角色的默认值	*表示所有角色都有访问资源的权限
--disk_watch_interval	周期性检查磁盘使用率的时间间隔	1min
--docker	Docker可执行文件位置	docker
--[no-]docker_kill_orphans		
--docker_mesos_image		

--docker_remove_delay	在删除Docker容器前的等待时间	6h
--docker_socket		
--docker_stop_timeout	docker停止实例的超时时间, 如果实例在时间内未停止则kill掉	0s
--[no-]enforce_container_disk_quota	开启容器磁盘配额功能, posix/disk隔离器使用该配置	false
--executor_environment_variables		
--executor_registration_timeout	执行器和slave注册的超时时间	1min
--executor_shutdown_grace_period	执行器关闭时间	5s
--external_log_file		
--fetcher_cache_dir		
--fetcher_cache_size		
--firewall_rules	设置http api接口的访问限制	
--frameworks_home	附加在执行器相对URI前的路径	
--gc_delay	执行器工作目录的垃圾回收时间,当磁盘使用率低时可能提前回收	1week
--gc_disk_headroom	执行器目录回收时间每隔disk_watch_interval时间目录的课存储时间则更新gc_delay * max(0, 1-gc_disk_headroom - disk_usage)	0.1
--hadoop_home	设置hadoop_home的路径, 用来从hdfs获取执行器	
--[no-]help	显示帮助信息	
--hooks	设置hook模块	
--hostname	设置master的主机信息	
--[no-]initialize_driver_logging		
--ip	设置绑定的ip地址	
--ip_discovery_command		
--isolation	设置使用的隔离机制可以选择posix/cpu,posix/mem，若使用cgroup则需要设置为cgroup/cpu,cgroup/mem	posix/cpu,posix/mem
--launcher_dir	mesos二进制文件位置	/usr/local/bin/mesos
--log_dir	设置log目录	
--logbufsecs	设置log刷新时间	0s
--logging_level	设置log级别	INFO
--master	设置master的地址或zookeeper的地址	
--modules	设置加载的模块	
--oversubscribed_resources_interval		
--perf_duration	每次性能状态的采集时间, 必须小余perf_interval	10s
--perf_events	pref_event隔离器使用的容器性能采集事件	
--perf_interval	性能状态采集的时间间隔	1min

--port	设置监听端口号	5050
--provisioners		
--qos_controller		
--qos_correction_interval_min		
--[no-]quiet	设置是否关闭日志到标准错误输出	false
--recover	设置恢复策略, 可以设置为重新连接和清理, 重连指slave与运行的执行器重新连接, 清理是指关闭所有的执行器并以一个新的slave向master注册	reconnect
--recovery_timeout	等待slave恢复的超时时间，若超过时间则所有的执行器则自杀	15min
--registration_backoff_factor	在slave启动后随机等待[0, registration_backoff_factor]时间后再向master发起注册信息	1s
--resource_estimator		
--resource_monitoring_interval	执行器资源使用监控的时间间隔	1s
--resources	设置为每个角色提供的资源信息，格式为resouce(role):value, 多个资源之间用分号分割	
--[no-]revocable_cpu_low_priority	false	
--sandbox_directory	沙盒目录映射到容器内目录的路径	/mnt/mesos/sandbox
--slave_subsystems	slave运行时的cgroup子系统包括memory,cpuacct等，使用逗号分割	
--[no-]strict	检查恢复过程	true
--[no-]switch_user	检查是以提交任务的用户身份还是slave运行的身份执行任务	true
--[no-]version	显示版本信息	
--work_dir	设置框架工作目录	/tmp/mesos
--ephemeral_ports_per_container	网络隔离器分配给每个容器临时端口数量，必须为2的幂次	1024
--eth0_name	设置公共网络接口名称	
--lo_name	设置环回网络接口名称	
--egress_rate_limit_per_container	限制容器的出口网络流量，单位为b/s, 如果未指定或设置为0表示不限制	
--[no-]network_enable_socket_statistics_summary	fallse	
--[no-]network_enable_socket_statistics_details	false	

认证、授权

用户: 用于master对framework和slave的认证
角色:

1. 将framework分类
   在框架注册时，必须指定框架注册的角色信息，在资源分配是作为框架的属性进行影响分配结果
2. 将用户分类
   用于定义某(些)用户对框架的操作信息, 比如注册、下线等

3. 将资源分类
   在slave上配置, 用于指定资源只能由某角色使用
   操作: 主要用于限制framework的注册(register_frameworks)，运行(run_tasks)，下线(shutdown_frameworks)三种操作对应
   框架名称: 在框架向master注册时设置其名称

任务执行用户: 在slave上执行任务的系统用户

使用:

master启动:

```
mesos-master --ip=192.168.56.101 --zk=zk://localhost:2181/mesos --quorum=1 --work_dir=/var/lib/mesos --log_dir=/var/log/mesos --ho
```

参数说明:

1. --authenticators=crammd5
   设置认证方式
2. --credentials=/root/run/credentials
   设置用户名密码
   文件内容:

   ```
   user1 password1
   user2 password2
   marathon_user marathon_password
   chronos_user chronos_password
   framework_user framework_password
   ```

   每行对应一个用户名和密码信息

3. --authenticate=true
   设置在framewrok注册时对用户进行认证

4. --authenticate_slaves=true
   设置在slave注册时对用户进行认证
5. --roles=marathon_role,chronos_role
   设置角色列表
6. --acls=/root/run/acls.json
   设置访问权限
   文件内容:

   ```
   {
    "permissive" : false,
    "register_frameworks" : [
        {
            "principals" : {
                "values" : ["marathon_user"]
            },
            "roles" : {
                "values" : ["marathon_role"]
            }
        },
        {
            "principals" : {
                "values" : ["chronos_user"]
            },
            "roles" : {
                "values" : ["chronos_role"]
            }
        }
    ],
    "run_tasks" : [
        {
            "principals" : {
   ```

```
            "values" : ["marathon_user", "chronos_user"]
        },
        "users" : {
            "values" : ["root"]
        }
    }
],
"shutdown_frameworks" : [
    {
        "principals": {
            "values": ["framework_user"]
        },
        "framework_principals": {
            "type": "ANY"
        }
    }
]
}
```

解释：

7. 框架只能由用户marathon_user以marathon_role角色或用户chronos_user以chronos_role角色像master发起注册
8. 框架只能使用用户只能使用marathon_user和chronos_user且以root系统用户运行任务
9. 只允许framework_user通过restapi关闭所有的框架下线
10. 在json配置中有value有两种设置可以是values或者type，values对应具体的用户名、角色、框架名称、系统用户。type对应范式匹配可设置为NONE或ANY，分别表示没有任何值和所有值

slave启动

```
mesos-slave --ip=192.168.56.102 --hostname=192.168.56.102 --master=zk://192.168.56.101:2181/mesos --containerizers=docker,mesos --
```

参数说明：

1. --authenticatee=crammd5
   设置认证方式
2. --credential=credential
   设置用户名密码信息
   文件内容:

   ```
   user2 password2
   ```

框架启动需要指定参数(以marathon, chronos为例)：
marathon:

```
./start --master zk://localhost:2181/mesos --zk zk://localhost:2181/marathon --hostname 192.168.56.101 --framework_name marathon -
```

1. --framework_name marathon
   设置框架名称
2. --mesos_user root
   设置框架创建任务在slave上运行的系统用户
3. --mesos_role marathon_role
   设置框架的角色
4. --mesos_authentication_principal marathon_user
   设置框架的认证用户名
5. --mesos_authentication_secret_file /root/marathon-0.10.0/bin/mesos_secret
   设置框架的认证用户密码，需要注意文件中只能包含名称，不能包含换行字符和空格

chronos:

```
./start-chronos.bash --master zk://localhost:2181/mesos --zk_hosts zk://localhost:2181 --http_port 8081 --mesos_framework_name chr
```

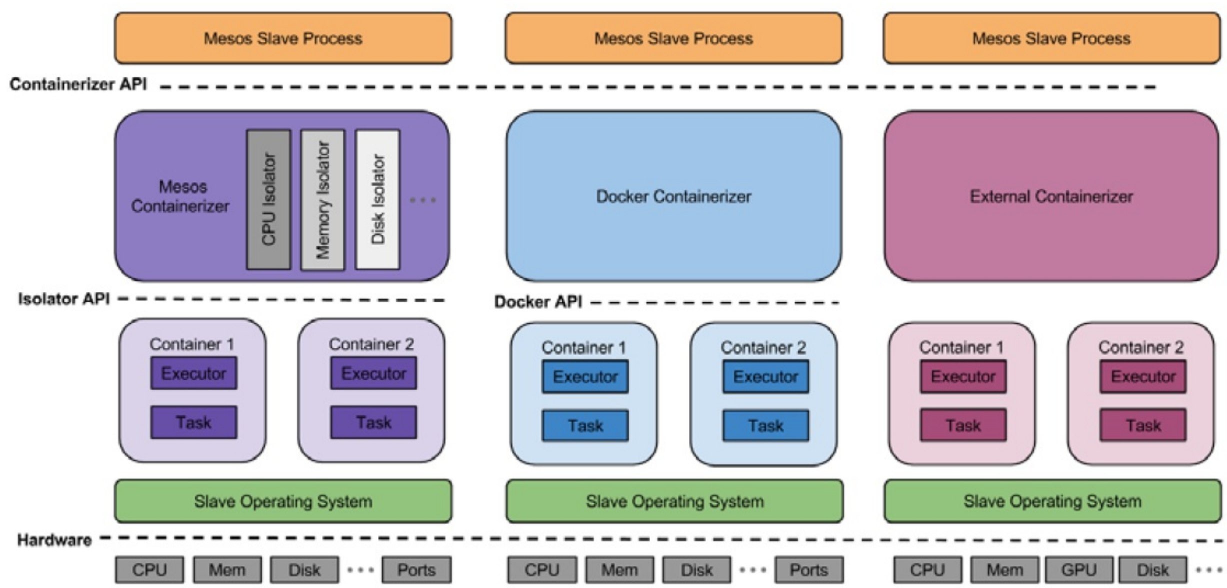
1. --mesos_framework_name chronos
   设置框架名称
2. --user root
   设置框架创建的任务在slave上运行的系统用户
3. --mesos_role chronos_role
   设置框架角色
4. --mesos_authentication_principal chronos_user
   设置框架的认证用户名
5. --mesos_authentication_secret_file /root/chronos-2.4.0/bin/mesos_secret
   设置框架的认证密码，需要注意文件中只能包含名称，不能包含换行字符和空格

使用curl下线框架的示例

```
curl -XPOST "http://192.168.56.101:5050/master/teardown" --login-options AUTH=CRAM-MD5 --user "framework_user:framework_password"
```

资源隔离

mesos采用插件的方式提供多种隔离机制, 以便为不同的任务提供沙盒环境



Mesos slaves with different isolation mechanisms

说明:
mesos以Containerizer API的方式支持不同的容器机实现, 目前mesos支持mesos containerizer, docker containerizer和external containerizer, 默认使用mesos containerizer, 通过external containerizer我们可以自己实现自己的容器机和隔离器

- mesos containerizer

mesos containerizer是mesos自己实现的容器机, 提供两种类型的隔离器: 基于posix系统的进程级别格式和基于linux内核特性cgroups隔离，containerizer通过isolator api对两种隔离器进行控制。

cgroups本身提供cpu和mem的隔离，在mesos containerizer还另外提供了磁盘隔离，共享文件系统隔离和PID namespace隔离

- docker containerizer

mesos>=0.20原生支持docker, docker containerizer主要工作是将任务或执行器的启动和销毁过程翻译成对应的Docker CLI命令(docker可支持remote api操作)

使用:

1. 在slave节点安装docker cli

2. 在启动slave时在参数containerizers中添加docker或直接设置为docker
3. 设置iptables
   `iptables -A INPUT -s 172.17.0.0/16 -i docker0 -p tcp -j ACCEPT`
4. docker镜像可以以任务或者执行器的方式启动

- external containerizer

资源的隔离由开发者进行实现和管理, 由外部容器机和外部容器机程序，外部容器机在mesos中已经提供并提供了基于mesos slave外部插件的容器API，程序员需要实现外部容器机程序，外部容器使用shell方式调用外部容器机, 参数通过stdin和stdout传递

需要在启动slave时指定--isolation=external和--containerizer_path=/path/to/external/containterizer

容错

framework-->master-->(slave->executor->task)

1. framework宕机(调度器)
   a. framework挂掉不会影响已有任务的执行
   b. 若master实现故障恢复功能, 会重新向master注册并获取所有任务的状态信息

2. master宕机
   a. mesos使用zookeeper作为选举服务
   b. master使用选举leader保证高可用, 当leader挂掉, 会根据选举算法选出新的leader, 所有framework和slave会向重新新的master进行注册, 而不影响以后框架调度器、slave、执行器和任务不受影响

3. slave宕机:
   a. master发送slave宕机事件给framework, framewrok决定是否调度任务到健康的slave上
   b. slave恢复后，会向master重新注册

4. slave进程挂掉
   a. 不会影响执行器, 待slave重启后会恢复任务, 若执行器检查slave恢复时间超过限制则自杀

5. 执行器或者任务挂掉
   a. 执行器挂掉或者任务挂掉，slave会给master反馈任务执行失败, framework会接收到master发回的事件, 决定任务重新调度

故障

mesos集群通过与zookeeper的连接是否超时判断组件的故障状态, 可将mesos组件分为竞争者和观察者, 框架和slave是观察者, master即使观察者又是竞争者, 默认配置为10s

1. slave与zookeeper连接超时, slave不会接收任何master发送的任务消息, 当连接恢复slave会重新接收和处理master发送的信息, 在过程中master无论是否重新选举
2. framewrok调度器驱动和zookeeper连接超时, 则调度器驱动会通知调度器, 由调度器决定
3. master与zookeeper连接超时
   a. master为leader, 则自杀, 其他守护模式的master进行重新选举, 可以用daemon的方式将master进行守护
   b. master为守护模式, 则等待
4. master和slave连接超时, master会将slave设置为未激活状态, 设置任务LOST, 将任务状态返回给框架调度器， 为激活状态的slave不会像master重新注册并且会被之后的消息要求主动关闭可以用daemon的方式将slave进行守护)

问题：

1. slave在master故障时出错, 新选举的master并不值得slave和运行在slave上任务的存在, 导致framework不能正常知道任务的状态信息(框架认为任务正常，而master不清楚任务在历史上的存在)
2. master在slave故障时出错, slave在master leader选举成功后恢复, 此时新的master并不值得slave的存在允许其以一个新的身份注册, 导致framework和master信息不一致(framework并不知道slave上已经运行的任务)

mesos使用registry持久化已经注册的slave信息, 当slave在注册、重新注册和删除时会查看和修改registry数据，目前实现为内存(zookeeper)、LevelDB、Replicatedlog三种方式

若slave的信息不存在于registery中时不允许器重新注册

资源分配&调度

mesos采用双层调度方案, master决定将多少资源分配给framework, 如何使用由framework决定, 流程：

1. 框架向master注册
2. master从slave获取资源offer，调用分配模块函数决定将资源分配给哪个框架
3. 框架调度器接收资源offer，检查offer是否合适，若合适接受offer并发送task列表给master，若不合适则拒绝该offer
4. master得到框架的接受、拒绝消息，若接受则并做相应的检查后将task信息发送给对应的slave
5. slave分配所请求的资源并运行任务执行器，执行器运行框架下的任务
6. 框架调度器接收任务任务运行状态，同时框架调度器继续接收offer并在合适的时机启动任务
7. 框架注销后不在接收任何offer

Mesos通过支配资源公平算法(DRF)进行资源分配
概念：
最大-最小资源公平算法：
支配资源：在总资源比例最大的资源类型
支配比例：支配资源所在总资源的比例
例如：总资源为<8 CPU, 32 G>，框架A申请<2CPU, 1G>， 则支配资源为max([2/8, 1/32])，即cpu为支配资源，其支配比例为25%
DRF算法是在每个框架的支配资源上在利用最大-最小资源公平算法进行资源分配

Mesos FrameworkInfo中的用户角色可以用来决定资源的分配，可以每个用户或者每个框架一个角色，或者多个用户和框架共享一个角色，若未显示设置，则为运行框架调度器的用户

加权DRF：
在Mesos master启动时可以通过--weights和--roles设置加权DRF, --weights后接角色/权重列表格式为role1=weight1,权重为非整数，且roles中设置的角色必须都在weights设置权重

静态预留：
在slave上可以通过resource参数设置某部分资源只能由某角色使用，格式为name(role)value的列表，若没有指定角色的资源和未出现的资源将被划分到默认角色下, 例如
--resources="cpus:4;mem:2048;cpus(product):8;mem(product):4096"
指将8个cpu，4096M内存的slave预留给product角色
修改resources属性后需要重启slave

动态预留:
在framework接受到offer可以发送Offer::Reserve和Offer::Unreserve管理预留资源
也可以通过/reserve和/unreserve两个restapi对资源预留进行管理，此时不需要重启slave

开发

mesos扩展

代码位置: /include/mesos/module

1. 认证
   见authenticatee.hpp, authorizer.hpp
   用于扩展第三方鉴权机制

2. 资源分配
   用于扩展资源分配机制，可以扩展资源分配算法和为内建层级分配器实现新的排序算法(用户和框架)

   代码接口详见/include/mesos/master/allocator.hpp(hirerarchical.hpp实现默认分配算法)

```
class Allocator
{
public:
// Attempts either to create a built-in DRF allocator or to load an
// allocator instance from a module using the given name. If Try
// does not report an error, the wrapped Allocator* is not null.
static Try<Allocator*> create(const std::string& name);
```

```
Allocator() {}

virtual ~Allocator() {}

//初始化分配器
virtual void initialize(
   const Duration& allocationInterval,
   const lambda::function<
       void(const FrameworkID&,
            const hashmap<SlaveID, Resources>&)>& offerCallback,
   const lambda::function<
       void(const FrameworkID&,
            const hashmap<SlaveID, UnavailableResources>&)>&
     inverseOfferCallback,
   const hashmap<std::string, RoleInfo>& roles) = 0;

//在分配机制中添加框架
virtual void addFramework(
   const FrameworkID& frameworkId,
   const FrameworkInfo& frameworkInfo,
   const hashmap<SlaveID, Resources>& used) = 0;

//从分配机制中移除框架
virtual void removeFramework(
   const FrameworkID& frameworkId) = 0;

//激活指定框架
// Offers are sent only to activated frameworks.
virtual void activateFramework(
   const FrameworkID& frameworkId) = 0;

//暂停指定框架
virtual void deactivateFramework(
   const FrameworkID& frameworkId) = 0;

//更新框架信息
virtual void updateFramework(
   const FrameworkID& frameworkId,
   const FrameworkInfo& frameworkInfo) = 0;

// Note that the 'total' resources are passed explicitly because it
// includes resources that are dynamically "checkpointed" on the
// slave (e.g. persistent volumes, dynamic reservations, etc). The
// slaveInfo resources, on the other hand, correspond directly to
// the static --resources flag value on the slave.

//在分配机制中添加slave
virtual void addSlave(
   const SlaveID& slaveId,
   const SlaveInfo& slaveInfo,
   const Option<Unavailability>& unavailability,
   const Resources& total,
   const hashmap<FrameworkID, Resources>& used) = 0;

//从分配机制中移除slave
virtual void removeSlave(
   const SlaveID& slaveId) = 0;

// Note that 'oversubscribed' resources include the total amount of
// oversubscribed resources that are allocated and available.
// TODO(vinod): Instead of just oversubscribed resources have this
// method take total resources. We can then reuse this method to
// update slave's total resources in the future.

//更新slave信息
virtual void updateSlave(
   const SlaveID& slave,
```

```
  const Resources& oversubscribed) = 0;

//激活指定的slave
// Offers are sent only for activated slaves.
virtual void activateSlave(
  const SlaveID& slaveId) = 0;

//暂停指定的slave
virtual void deactivateSlave(
  const SlaveID& slaveId) = 0;

//更新slave白名单列表
virtual void updateWhitelist(
  const Option<hashset<std::string>>& whitelist) = 0;

//当框架接收指定资源请时触发的动作
virtual void requestResources(
  const FrameworkID& frameworkId,
  const std::vector<Request>& requests) = 0;

//更新指定框架在指定slave上的资源分配
virtual void updateAllocation(
  const FrameworkID& frameworkId,
  const SlaveID& slaveId,
  const std::vector<Offer::Operation>& operations) = 0;

//
virtual process::Future<Nothing> updateAvailable(
  const SlaveID& slaveId,
  const std::vector<Offer::Operation>& operations) = 0;

// We currently support storing the next unavailability, if there is one, per
// slave. If `unavailability` is not set then there is no known upcoming
// unavailability. This might require the implementation of the function to
// remove any inverse offers that are outstanding.
virtual void updateUnavailability(
  const SlaveID& slaveId,
  const Option<Unavailability>& unavailability) = 0;

// Informs the allocator that the inverse offer has been responded to or
// revoked. If `status` is not set then the inverse offer was not responded
// to, possibly because the offer timed out or was rescinded. This might
// require the implementation of the function to remove any inverse offers
// that are outstanding. The `unavailableResources` can be used by the
// allocator to distinguish between different inverse offers sent to the same
// framework for the same slave.
virtual void updateInverseOffer(
  const SlaveID& slaveId,
  const FrameworkID& frameworkId,
  const Option<UnavailableResources>& unavailableResources,
  const Option<InverseOfferStatus>& status,
  const Option<Filters>& filters = None()) = 0;

// Retrieves the status of all inverse offers maintained by the allocator.
virtual process::Future<
  hashmap<SlaveID, hashmap<FrameworkID, mesos::master::InverseOfferStatus>>>
 getInverseOfferStatuses() = 0;

//从指定框架回收资源触发
// Informs the Allocator to recover resources that are considered
// used by the framework.
virtual void recoverResources(
  const FrameworkID& frameworkId,
  const SlaveID& slaveId,
  const Resources& resources,
  const Option<Filters>& filters) = 0;
```

```
  //框架想要重新获得之前所排查的资源offer
  // Whenever a framework that has filtered resources wants to revive
  // offers for those resources the master invokes this callback.
  virtual void reviveOffers(
     const FrameworkID& frameworkId) = 0;

  // 资源offer分配超时
  // Informs the allocator to stop sending resources for the framework
  virtual void suppressOffers(
     const FrameworkID& frameworkId) = 0;
  };
```

使用: --allocator指定资源分配模块

代码详见: /src/master/allocator/sorter/sorter.hpp(drf/sorter.hpp中实现公平分配并支持带权值优先级)

```
class Sorter
{
public:
  virtual ~Sorter() {}

  //从分配算法中增加某个client
  // Adds a client to allocate resources to. A client
  // may be a user or a framework.
  virtual void add(const std::string& client, double weight = 1) = 0;

  //从分配算法删除某个client
  // Removes a client.
  virtual void remove(const std::string& client) = 0;

  //从排序器增加某个client
  // Readds a client to the sort after deactivate.
  virtual void activate(const std::string& client) = 0;

  //从排序器移除某个client
  // Removes a client from the sort, so it won't get allocated to.
  virtual void deactivate(const std::string& client) = 0;

  // Specify that resources have been allocated to the given client.
  virtual void allocated(
      const std::string& client,
      const SlaveID& slaveId,
      const Resources& resources) = 0;

  // Updates a portion of the allocation for the client, in order to
  // augment the resources with additional metadata (e.g., volumes)
  // This means that the new allocation must not affect the static
  // roles, or the overall quantities of resources!
  virtual void update(
      const std::string& client,
      const SlaveID& slaveId,
      const Resources& oldAllocation,
      const Resources& newAllocation) = 0;

  // Specify that resources have been unallocated from the given client.
  virtual void unallocated(
      const std::string& client,
      const SlaveID& slaveId,
      const Resources& resources) = 0;

  // Returns the resources that have been allocated to this client.
  virtual hashmap<SlaveID, Resources> allocation(const std::string& client) = 0;

  // Returns the clients that have allocations on this slave.
  virtual hashmap<std::string, Resources> allocation(
      const SlaveID& slaveId) = 0;
```

```
  //返回分配给某个client的资源
  // Returns the given slave's resources that have been allocated to
  // this client.
  virtual Resources allocation(
      const std::string& client,
      const SlaveID& slaveId) = 0;

  //在资源池中添加slave资源
  // Add resources to the total pool of resources this
  // Sorter should consider.
  virtual void add(const SlaveID& slaveId, const Resources& resources) = 0;

  //在资源池中移除slave资源
  // Remove resources from the total pool.
  virtual void remove(const SlaveID& slaveId, const Resources& resources) = 0;

  ////更新资源池中slave资源
  // Updates the total pool of resources.
  virtual void update(const SlaveID& slaveId, const Resources& resources) = 0;

  //按排序算法对client进行排序
  // Returns a list of all clients, in the order that they
  // should be allocated to, according to this Sorter's policy.
  virtual std::list<std::string> sort() = 0;

  // Returns true if this Sorter contains the specified client,
  // either active or deactivated.
  virtual bool contains(const std::string& client) = 0;

  // Returns the number of clients this Sorter contains,
  // either active or deactivated.
  virtual int count() = 0;
};
```

1. 隔离
   见isolator.hpp
   提供新的隔离方式和监控机制

2. 匿名
   见anonymous.hpp
   与master和slave启动时被加载, 与父进程共同存在, 不会扩展或替代mesos已有的功能

3. hook
   见/include/mesos/hook.hpp
   通过hook扩展组件的功能

   使用--hooks选项设置hook列表

模块通过在master和slave时通过参数--modules指定json文件来设置模块加载及配置, json文件格式:

```
{
    "libraries" : [
        {
            "file" : "",
            "name" : "",
            "modules" : [
                {
                    "name" : "",
                    "parameters" : [
                        {
                            "key" : "",
                            "value" : ""
                        }
                    ]
                }
```

```
        ]
      }
    ]
}
```

mesos开发

消息

mesos各组件之间使用protocol buffer定义发送的消息，所有消息格式见代码/include/mesos/mesos.proto

框架

```
+ 调度器 & 调度驱动
    负责管理框架所获得的资源，代码见/include/mesos/scheduler/scheduler.hpp
```

```
class Scheduler
{
public:
  // Empty virtual destructor (necessary to instantiate subclasses).
  virtual ~Scheduler() {}

  //mesos进行注册时被回调
  // Invoked when the scheduler successfully registers with a Mesos
  // master. A unique ID (generated by the master) used for
  // distinguishing this framework from others and MasterInfo with the
  // ip and port of the current master are provided as arguments.
  virtual void registered(
      SchedulerDriver* driver,
      const FrameworkID& frameworkId,
      const MasterInfo& masterInfo) = 0;

  //当重新选举mesos master后，被回调重新进行注册
  // Invoked when the scheduler re-registers with a newly elected
  // Mesos master. This is only called when the scheduler has
  // previously been registered. MasterInfo containing the updated
  // information about the elected master is provided as an argument.
  virtual void reregistered(
      SchedulerDriver* driver,
      const MasterInfo& masterInfo) = 0;

  //在调度器和master被断开时被回调
  // Invoked when the scheduler becomes "disconnected" from the master
  // (e.g., the master fails and another is taking over).
  virtual void disconnected(SchedulerDriver* driver) = 0;

  //在master向framework提供资源offer时调用
  // Invoked when resources have been offered to this framework. A
  // single offer will only contain resources from a single slave.
  // Resources associated with an offer will not be re-offered to
  // _this_ framework until either (a) this framework has rejected
  // those resources (see SchedulerDriver::launchTasks) or (b) those
  // resources have been rescinded (see Scheduler::offerRescinded).
  // Note that resources may be concurrently offered to more than one
  // framework at a time (depending on the allocator being used). In
  // that case, the first framework to launch tasks using those
  // resources will be able to use them while the other frameworks
  // will have those resources rescinded (or if a framework has
  // already launched tasks with those resources then those tasks will
  // fail with a TASK_LOST status and a message saying as much).
  virtual void resourceOffers(
      SchedulerDriver* driver,
      const std::vector<Offer>& offers) = 0;

  /根据不同的分配器，可能将一个资源分配给多个框架，但是第一个响应master的framework会得到资源，其他framework会被回调表示master撤销某资源offer, 若f
  // Invoked when an offer is no longer valid (e.g., the slave was
  // lost or another framework used resources in the offer). If for
```

```
  // whatever reason an offer is never rescinded (e.g., dropped
  // message, failing over framework, etc.), a framework that attempts
  // to launch tasks using an invalid offer will receive TASK_LOST
  // status updates for those tasks (see Scheduler::resourceOffers).
  virtual void offerRescinded(
      SchedulerDriver* driver,
      const OfferID& offerId) = 0;

  //任务状态发生变化回调
  // Invoked when the status of a task has changed (e.g., a slave is
  // lost and so the task is lost, a task finishes and an executor
  // sends a status update saying so, etc). If implicit
  // acknowledgements are being used, then returning from this
  // callback _acknowledges_ receipt of this status update! If for
  // whatever reason the scheduler aborts during this callback (or
  // the process exits) another status update will be delivered (note,
  // however, that this is currently not true if the slave sending the
  // status update is lost/fails during that time). If explicit
  // acknowledgements are in use, the scheduler must acknowledge this
  // status on the driver.
  virtual void statusUpdate(
      SchedulerDriver* driver,
      const TaskStatus& status) = 0;

  //向调度器传递执行器发送的消息，调度器可以访问执行器和slavede Id, 以及调度器所发送的数据
  // Invoked when an executor sends a message. These messages are best
  // effort; do not expect a framework message to be retransmitted in
  // any reliable fashion.
  virtual void frameworkMessage(
      SchedulerDriver* driver,
      const ExecutorID& executorId,
      const SlaveID& slaveId,
      const std::string& data) = 0;

  //当slave丢失时回调
  // Invoked when a slave has been determined unreachable (e.g.,
  // machine failure, network partition). Most frameworks will need to
  // reschedule any tasks launched on this slave on a new slave.
  virtual void slaveLost(
      SchedulerDriver* driver,
      const SlaveID& slaveId) = 0;

  //执行器丢失是回调
  // Invoked when an executor has exited/terminated. Note that any
  // tasks running will have TASK_LOST status updates automagically
  // generated.
  virtual void executorLost(
      SchedulerDriver* driver,
      const ExecutorID& executorId,
      const SlaveID& slaveId,
      int status) = 0;

  //当发送错误时调用，常用于清理工作
  // Invoked when there is an unrecoverable error in the scheduler or
  // scheduler driver. The driver will be aborted BEFORE invoking this
  // callback.
  virtual void error(
      SchedulerDriver* driver,
      const std::string& message) = 0;
};


// Abstract interface for connecting a scheduler to Mesos. This
// interface is used both to manage the scheduler's lifecycle (start
// it, stop it, or wait for it to finish) and to interact with Mesos
// (e.g., launch tasks, kill tasks, etc.). See MesosSchedulerDriver
// below for a concrete example of a SchedulerDriver.
```

```
class SchedulerDriver
{
public:
  // Empty virtual destructor (necessary to instantiate subclasses).
  // It is expected that 'stop()' is called before this is called.
  virtual ~SchedulerDriver() {}

  //启动调度器
  // Starts the scheduler driver. This needs to be called before any
  // other driver calls are made.
  virtual Status start() = 0;

  //停止驱动
  // Stops the scheduler driver. If the 'failover' flag is set to
  // false then it is expected that this framework will never
  // reconnect to Mesos. So Mesos will unregister the framework and
  // shutdown all its tasks and executors. If 'failover' is true, all
  // executors and tasks will remain running (for some framework
  // specific failover timeout) allowing the scheduler to reconnect
  // (possibly in the same process, or from a different process, for
  // example, on a different machine).
  virtual Status stop(bool failover = false) = 0;

  // Aborts the driver so that no more callbacks can be made to the
  // scheduler. The semantics of abort and stop have deliberately been
  // separated so that code can detect an aborted driver (i.e., via
  // the return status of SchedulerDriver::join, see below), and
  // instantiate and start another driver if desired (from within the
  // same process). Note that 'stop()' is not automatically called
  // inside 'abort()'.
  virtual Status abort() = 0;

  //等待驱动退出发送abort和stop动作
  // Waits for the driver to be stopped or aborted, possibly
  // _blocking_ the current thread indefinitely. The return status of
  // this function can be used to determine if the driver was aborted
  // (see mesos.proto for a description of Status).
  virtual Status join() = 0;

  //依次执行start和join
  // Starts and immediately joins (i.e., blocks on) the driver.
  virtual Status run() = 0;

  //向mesos请求资源并将资源提供给调度器
  // Requests resources from Mesos (see mesos.proto for a description
  // of Request and how, for example, to request resources from
  // specific slaves). Any resources available are offered to the
  // framework via Scheduler::resourceOffers callback, asynchronously.
  virtual Status requestResources(const std::vector<Request>& requests) = 0;

  //在offer上启动一组任务
  // Launches the given set of tasks. Any resources remaining (i.e.,
  // not used by the tasks or their executors) will be considered
  // declined. The specified filters are applied on all unused
  // resources (see mesos.proto for a description of Filters).
  // Available resources are aggregated when multiple offers are
  // provided. Note that all offers must belong to the same slave.
  // Invoking this function with an empty collection of tasks declines
  // offers in their entirety (see Scheduler::declineOffer).
  virtual Status launchTasks(
      const std::vector<OfferID>& offerIds,
      const std::vector<TaskInfo>& tasks,
      const Filters& filters = Filters()) = 0;


  // DEPRECATED: Use launchTasks(offerIds, tasks, filters) instead.
  virtual Status launchTasks(
```

```
    const OfferID& offerId,
    const std::vector<TaskInfo>& tasks,
    const Filters& filters = Filters()) = 0;

//kill任务
// Kills the specified task. Note that attempting to kill a task is
// currently not reliable. If, for example, a scheduler fails over
// while it was attempting to kill a task it will need to retry in
// the future. Likewise, if unregistered / disconnected, the request
// will be dropped (these semantics may be changed in the future).
virtual Status killTask(const TaskID& taskId) = 0;

//接受资源offer
// Accepts the given offers and performs a sequence of operations on
// those accepted offers. See Offer.Operation in mesos.proto for the
// set of available operations. Available resources are aggregated
// when multiple offers are provided. Note that all offers must
// belong to the same slave. Any unused resources will be considered
// declined. The specified filters are applied on all unused
// resources (see mesos.proto for a description of Filters).
virtual Status acceptOffers(
    const std::vector<OfferID>& offerIds,
    const std::vector<Offer::Operation>& operations,
    const Filters& filters = Filters()) = 0;

//拒绝资源offer
// Declines an offer in its entirety and applies the specified
// filters on the resources (see mesos.proto for a description of
// Filters). Note that this can be done at any time, it is not
// necessary to do this within the Scheduler::resourceOffers
// callback.
virtual Status declineOffer(
    const OfferID& offerId,
    const Filters& filters = Filters()) = 0;

//删除所有过滤器
// Removes all filters previously set by the framework (via
// launchTasks()). This enables the framework to receive offers from
// those filtered slaves.
virtual Status reviveOffers() = 0;

// Inform Mesos master to stop sending offers to the framework. The
// scheduler should call reviveOffers() to resume getting offers.
virtual Status suppressOffers() = 0;

// Acknowledges the status update. This should only be called
// once the status update is processed durably by the scheduler.
// Not that explicit acknowledgements must be requested via the
// constructor argument, otherwise a call to this method will
// cause the driver to crash.
virtual Status acknowledgeStatusUpdate(
    const TaskStatus& status) = 0;

//从框架向执行器发送消息
// Sends a message from the framework to one of its executors. These
// messages are best effort; do not expect a framework message to be
// retransmitted in any reliable fashion.
virtual Status sendFrameworkMessage(
    const ExecutorID& executorId,
    const SlaveID& slaveId,
    const std::string& data) = 0;

//获取任务状态
// Allows the framework to query the status for non-terminal tasks.
// This causes the master to send back the latest task status for
// each task in 'statuses', if possible. Tasks that are no longer
// known will result in a TASK_LOST update. If statuses is empty,
```

```
  // then the master will send the latest status for each task
  // currently known.
  virtual Status reconcileTasks(
      const std::vector<TaskStatus>& statuses) = 0;
};


// Concrete implementation of a SchedulerDriver that connects a
// Scheduler with a Mesos master. The MesosSchedulerDriver is
// thread-safe.
//
// Note that scheduler failover is supported in Mesos. After a
// scheduler is registered with Mesos it may failover (to a new
// process on the same machine or across multiple machines) by
// creating a new driver with the ID given to it in
// Scheduler::registered.
//
// The driver is responsible for invoking the Scheduler callbacks as
// it communicates with the Mesos master.
//
// Note that blocking on the MesosSchedulerDriver (e.g., via
// MesosSchedulerDriver::join) doesn't affect the scheduler callbacks
// in anyway because they are handled by a different thread.
//
// Note that the driver uses GLOG to do its own logging. GLOG flags
// can be set via environment variables, prefixing the flag name with
// "GLOG_", e.g., "GLOG_v=1". For Mesos specific logging flags see
// src/logging/flags.hpp. Mesos flags can also be set via environment
// variables, prefixing the flag name with "MESOS_", e.g.,
// "MESOS_QUIET=1".
//
// See src/examples/test_framework.cpp for an example of using the
// MesosSchedulerDriver.
class MesosSchedulerDriver : public SchedulerDriver
{
public:
  // Creates a new driver for the specified scheduler. The master
  // should be one of:
  //
  //     host:port
  //     zk://host1:port1,host2:port2,.../path
  //     zk://username:password@host1:port1,host2:port2,.../path
  //     file:///path/to/file (where file contains one of the above)
  //
  // The driver will attempt to "failover" if the specified
  // FrameworkInfo includes a valid FrameworkID.
  //
  // Any Mesos configuration options are read from environment
  // variables, as well as any configuration files found through the
  // environment variables.
  //
  // TODO(vinod): Deprecate this once 'MesosSchedulerDriver' can take
  // 'Option<Credential>' as parameter. Currently it cannot because
  // 'stout' is not visible from here.
  MesosSchedulerDriver(
      Scheduler* scheduler,
      const FrameworkInfo& framework,
      const std::string& master);

  // Same as the above constructor but takes 'credential' as argument.
  // The credential will be used for authenticating with the master.
  MesosSchedulerDriver(
      Scheduler* scheduler,
      const FrameworkInfo& framework,
      const std::string& master,
      const Credential& credential);
```

```
// These constructors are the same as the above two, but allow
// the framework to specify whether implicit or explicit
// acknowledgements are desired. See statusUpdate() for the
// details about explicit acknowledgements.
//
// TODO(bmahler): Deprecate the above two constructors. In 0.22.0
// these new constructors are exposed.
MesosSchedulerDriver(
    Scheduler* scheduler,
    const FrameworkInfo& framework,
    const std::string& master,
    bool implicitAcknowledgements);

MesosSchedulerDriver(
    Scheduler* scheduler,
    const FrameworkInfo& framework,
    const std::string& master,
    bool implicitAcknowlegements,
    const Credential& credential);

// This destructor will block indefinitely if
// MesosSchedulerDriver::start was invoked successfully (possibly
// via MesosSchedulerDriver::run) and MesosSchedulerDriver::stop has
// not been invoked.
virtual ~MesosSchedulerDriver();

// See SchedulerDriver for descriptions of these.
virtual Status start();
virtual Status stop(bool failover = false);
virtual Status abort();
virtual Status join();
virtual Status run();

virtual Status requestResources(
    const std::vector<Request>& requests);

// TODO(nnielsen): launchTasks using single offer is deprecated.
// Use launchTasks with offer list instead.
virtual Status launchTasks(
    const OfferID& offerId,
    const std::vector<TaskInfo>& tasks,
    const Filters& filters = Filters());

virtual Status launchTasks(
    const std::vector<OfferID>& offerIds,
    const std::vector<TaskInfo>& tasks,
    const Filters& filters = Filters());

virtual Status killTask(const TaskID& taskId);

virtual Status acceptOffers(
    const std::vector<OfferID>& offerIds,
    const std::vector<Offer::Operation>& operations,
    const Filters& filters = Filters());

virtual Status declineOffer(
    const OfferID& offerId,
    const Filters& filters = Filters());

virtual Status reviveOffers();

virtual Status suppressOffers();

virtual Status acknowledgeStatusUpdate(
    const TaskStatus& status);

virtual Status sendFrameworkMessage(
```

```
      const ExecutorID& executorId,
      const SlaveID& slaveId,
      const std::string& data);

  virtual Status reconcileTasks(
      const std::vector<TaskStatus>& statuses);

protected:
  // Used to detect (i.e., choose) the master.
  internal::MasterDetector* detector;

private:
  void initialize();

  Scheduler* scheduler;
  FrameworkInfo framework;
  std::string master;

  // Used for communicating with the master.
  internal::SchedulerProcess* process;

  // URL for the master (e.g., zk://, file://, etc).
  std::string url;

  // Mutex for enforcing serial execution of all non-callbacks.
  std::recursive_mutex mutex;

  // Latch for waiting until driver terminates.
  process::Latch* latch;

  // Current status of the driver.
  Status status;

  const bool implicitAcknowlegements;

  const Credential* credential;

  // Scheduler process ID.
  std::string schedulerId;
};
```

```
+ 执行器 & 执行驱动
    负责启动任务并执行调取分配的任务，代码见/include/mesos/scheduler/executor.hpp
```

```
class Executor
{
public:
  // Empty virtual destructor (necessary to instantiate subclasses).
  virtual ~Executor() {}

  //在执行驱动器执行成功后和slave连接后调用
  // Invoked once the executor driver has been able to successfully
  // connect with Mesos. In particular, a scheduler can pass some
  // data to its executors through the FrameworkInfo.ExecutorInfo's
  // data field.
  virtual void registered(
      ExecutorDriver* driver,
      const ExecutorInfo& executorInfo,
      const FrameworkInfo& frameworkInfo,
      const SlaveInfo& slaveInfo) = 0;

  //向重启的slave重新注册
  // Invoked when the executor re-registers with a restarted slave.
  virtual void reregistered(
      ExecutorDriver* driver,
```

```
    const SlaveInfo& slaveInfo) = 0;

  //在执行器与slave断开连接时调用
  // Invoked when the executor becomes "disconnected" from the slave
  // (e.g., the slave is being restarted due to an upgrade).
  virtual void disconnected(ExecutorDriver* driver) = 0;

  //在任务在当前执行器上启动时被调用
  // Invoked when a task has been launched on this executor (initiated
  // via Scheduler::launchTasks). Note that this task can be realized
  // with a thread, a process, or some simple computation, however, no
  // other callbacks will be invoked on this executor until this
  // callback has returned.
  virtual void launchTask(
      ExecutorDriver* driver,
      const TaskInfo& task) = 0;

  //当任务被kill时调用
  // Invoked when a task running within this executor has been killed
  // (via SchedulerDriver::killTask). Note that no status update will
  // be sent on behalf of the executor, the executor is responsible
  // for creating a new TaskStatus (i.e., with TASK_KILLED) and
  // invoking ExecutorDriver::sendStatusUpdate.
  virtual void killTask(
      ExecutorDriver* driver,
      const TaskID& taskId) = 0;

  //当接到框架执行器发送的消息到达时被调用
  // Invoked when a framework message has arrived for this executor.
  // These messages are best effort; do not expect a framework message
  // to be retransmitted in any reliable fashion.
  virtual void frameworkMessage(
      ExecutorDriver* driver,
      const std::string& data) = 0;

  //通知执行器结束所有运行中的任务
  // Invoked when the executor should terminate all of its currently
  // running tasks. Note that after a Mesos has determined that an
  // executor has terminated any tasks that the executor did not send
  // terminal status updates for (e.g., TASK_KILLED, TASK_FINISHED,
  // TASK_FAILED, etc) a TASK_LOST status update will be created.
  virtual void shutdown(ExecutorDriver* driver) = 0;

  //当制执行或执行器驱动发送错误时被调用
  // Invoked when a fatal error has occured with the executor and/or
  // executor driver. The driver will be aborted BEFORE invoking this
  // callback.
  virtual void error(
      ExecutorDriver* driver,
      const std::string& message) = 0;
};


// Abstract interface for connecting an executor to Mesos. This
// interface is used both to manage the executor's lifecycle (start
// it, stop it, or wait for it to finish) and to interact with Mesos
// (e.g., send status updates, send framework messages, etc.). See
// MesosExecutorDriver below for a concrete example of an
// ExecutorDriver.
class ExecutorDriver
{
public:
  // Empty virtual destructor (necessary to instantiate subclasses).
  virtual ~ExecutorDriver() {}

  //对驱动进行初始化
  // Starts the executor driver. This needs to be called before any
```

```
  // other driver calls are made.
  virtual Status start() = 0;

  //对驱动进行清理
  // Stops the executor driver.
  virtual Status stop() = 0;

  //在驱动异常退出时调用
  // Aborts the driver so that no more callbacks can be made to the
  // executor. The semantics of abort and stop have deliberately been
  // separated so that code can detect an aborted driver (i.e., via
  // the return status of ExecutorDriver::join, see below), and
  // instantiate and start another driver if desired (from within the
  // same process ... although this functionality is currently not
  // supported for executors).
  virtual Status abort() = 0;

  //等待驱动停止或异常停止
  // Waits for the driver to be stopped or aborted, possibly
  // _blocking_ the current thread indefinitely. The return status of
  // this function can be used to determine if the driver was aborted
  // (see mesos.proto for a description of Status).
  virtual Status join() = 0;

  //启动驱动并阻塞后调用join操作
  // Starts and immediately joins (i.e., blocks on) the driver.
  virtual Status run() = 0;

  //想调度器发送任务状态更新
  // Sends a status update to the framework scheduler, retrying as
  // necessary until an acknowledgement has been received or the
  // executor is terminated (in which case, a TASK_LOST status update
  // will be sent). See Scheduler::statusUpdate for more information
  // about status update acknowledgements.
  virtual Status sendStatusUpdate(const TaskStatus& status) = 0;

  //发送消息给framework
  // Sends a message to the framework scheduler. These messages are
  // best effort; do not expect a framework message to be
  // retransmitted in any reliable fashion.
  virtual Status sendFrameworkMessage(const std::string& data) = 0;
};


// Concrete implementation of an ExecutorDriver that connects an
// Executor with a Mesos slave. The MesosExecutorDriver is
// thread-safe.
//
// The driver is responsible for invoking the Executor callbacks as it
// communicates with the Mesos slave.
//
// Note that blocking on the MesosExecutorDriver (e.g., via
// MesosExecutorDriver::join) doesn't affect the executor callbacks in
// anyway because they are handled by a different thread.
//
// Note that the driver uses GLOG to do its own logging. GLOG flags
// can be set via environment variables, prefixing the flag name with
// "GLOG_", e.g., "GLOG_v=1". For Mesos specific logging flags see
// src/logging/flags.hpp. Mesos flags can also be set via environment
// variables, prefixing the flag name with "MESOS_", e.g.,
// "MESOS_QUIET=1".
//
// See src/examples/test_executor.cpp for an example of using the
// MesosExecutorDriver.
class MesosExecutorDriver : public ExecutorDriver
{
public:
```

```
  // Creates a new driver that uses the specified Executor. Note, the
  // executor pointer must outlive the driver.
  explicit MesosExecutorDriver(Executor* executor);

  // This destructor will block indefinitely if
  // MesosExecutorDriver::start was invoked successfully (possibly via
  // MesosExecutorDriver::run) and MesosExecutorDriver::stop has not
  // been invoked.
  virtual ~MesosExecutorDriver();

  // See ExecutorDriver for descriptions of these.
  virtual Status start();
  virtual Status stop();
  virtual Status abort();
  virtual Status join();
  virtual Status run();
  virtual Status sendStatusUpdate(const TaskStatus& status);
  virtual Status sendFrameworkMessage(const std::string& data);

private:
  friend class internal::ExecutorProcess;

  Executor* executor;

  // Libprocess process for communicating with slave.
  internal::ExecutorProcess* process;

  // Mutex for enforcing serial execution of all non-callbacks.
  std::recursive_mutex mutex;

  // Latch for waiting until driver terminates.
  process::Latch* latch;

  // Current status of the driver.
  Status status;
};
```

```
+ 启动器
   用于启动调度器驱动
```

framework调度器示例：

```
#!/usr/bin/env python
#encoding: utf-8

import Queue
import logging
import threading
import time


from pesos.scheduler import PesosSchedulerDriver
from pesos.vendor.mesos import mesos_pb2

from mesos.interface import Scheduler


_logger = logging.getLogger(__name__)

class TestScheduler(Scheduler):

    TASK_CPU = 0.1
    TASK_MEM = 2

    def __init__(self, queue):
        self.tasks = queue
```

```
        self.terminal = 0
        self.total_tasks = queue.qsize()

    def registered(self, driver, frameworkId, masterInfo):
        _logger.info('Registered framework %s', frameworkId)

    def reregistered(self, driver, masterInfo):
        _logger.info('Connected with master %s', masterInfo.ip)

    def disconnected(self, driver):
        _logger.info('Disconnected from master')

    def resourceOffers(self, driver, offers):
        _logger.info('Recived %s offers', len(offers))

        def handle_offers():
            declined = []

            for offer in offers:
                offer_cpu = 0
                offer_mem = 0

                if self.tasks.empty():
                    declined.append(offer.id.value)
                    continue

                for resource in offer.resources:
                    if resource.name == 'cpus':
                        offer_cpu = resource.scalar.value
                    if resource.name == 'mem':
                        offer_mem = resource.scalar.value

                _logger.info('offer:%s, cpu:%s, mem:%s', offer.id.value, offer_cpu, offer_mem)
                tasks = []

                while offer_mem >= self.TASK_MEM and offer_cpu >= self.TASK_CPU\
                    and not self.tasks.empty():
                    offer_cpu -= self.TASK_CPU
                    offer_mem -= self.TASK_MEM

                    executor_id, task_id, args = self.tasks.get()
                    self.tasks.task_done()
                    _logger.info('Queue task %s:%s', executor_id, task_id)
                    tasks.append(self._build_task(offer, executor_id, task_id, args))
                if tasks:
                    driver.launch_tasks([offer.id.value], tasks)
            for offerid in declined:
                driver.decline_offer(offerid)

        th = threading.Thread(target=handle_offers)
        th.start()

    def _build_task(self, offer, executor_id, task_id, args):
        task = mesos_pb2.TaskInfo()
        task.name = "Test Task of Silence"

        cpus = task.resources.add()
        cpus.name = "cpus"
        cpus.type = mesos_pb2.Value.SCALAR
        cpus.scalar.value = self.TASK_CPU

        mem = task.resources.add()
        mem.name = "mem"
        mem.type = mesos_pb2.Value.SCALAR
        mem.scalar.value = self.TASK_MEM

        task.executor.command.value = "ping %s -c 20" % args[0]
```

```
        '''
        task.executor.command.user.value = 'root'

        # TODO LIST
        environment = mesos_pb2.Environment()
        variable = environment.variables.add()
        variable.name = key
        variable.value = value

        uri = task.executor.uris.add()
        uri.value = p_uri
        uri.executable = False
        uri.extract = True
        '''

        '''
        cpus = task.executor.resources.add()
        cpus.name = "cpus"
        cpus.type = mesos_pb2.Value.SCALAR
        cpus.scalar.value = self.TASK_CPU

        mem = task.executor.resources.add()
        mem.name = "mem"
        mem.type = mesos_pb2.Value.SCALAR
        mem.scalar.value = self.TASK_MEM
        task.executor.source = None
        task.executor.data = None

        '''

        task.task_id.value = "%d:%d" % (executor_id, task_id)
        task.slave_id.MergeFrom(offer.slave_id)

        task.executor.executor_id.value = str(executor_id)
        task.executor.framework_id.value = offer.framework_id.value

        return task

    def offerRescinded(self, driver, offerId):
        _logger.info('Offer rescinded %s', offerId.value)

    def statusUpdate(self, driver, taskStatus):
        statuses = {
            mesos_pb2.TASK_STAGING: "STAGING",
            mesos_pb2.TASK_STARTING: "STARTING",
            mesos_pb2.TASK_RUNNING: "RUNNING",
            mesos_pb2.TASK_FINISHED: "FINISHED",
            mesos_pb2.TASK_FAILED: "FAILED",
            mesos_pb2.TASK_KILLED: "KILLED",
            mesos_pb2.TASK_LOST: "LOST",
        }

        _logger.info("Received status update for task %s (%s)", taskStatus.task_id.value, statuses[taskStatus.state])

        if taskStatus.state == mesos_pb2.TASK_FINISHED or taskStatus.state == mesos_pb2.TASK_FAILED or \
            taskStatus.state == mesos_pb2.TASK_KILLED or taskStatus.state == mesos_pb2.TASK_LOST:
            self.terminal += 1

        if self.terminal == self.total_tasks:
            driver.stop()

    def frameworkMessage(self, driver, executorId, slaveId, data):
        _logger.info('Message from executor %s and slave %s : %s', executorId.value, slaveId.value, data)

    def slaveLost(self, driver, slaveId):
        _logger.info('Slave %s has been lost', slaveId.value)
```

```
    def executorLost(self, dirver, executorId, slaveId, exitCode):
        _logger.info('Executor %s has been lost on slave %s with exit code %s', executorId.value, slaveId.value, exitCode)

    def error(self, driver, message):
        _logger.info('There was an error:%s', message)



if __name__ == '__main__':
    logging.basicConfig(level=logging.DEBUG)

    num_tasks = 50
    num_executors = 5

    tasks = Queue.Queue()
    for task in xrange(num_tasks):
        for executor in xrange(num_executors):
            tasks.put((executor, task, ["www.360.cn"]))

    master_uri = 'master@192.168.56.101:5050'

    framework = mesos_pb2.FrameworkInfo()
    framework.name = "Test Python Framework of Silence"
    framework.user = "root"

    driver = PesosSchedulerDriver(
        TestScheduler(tasks),
        framework,
        master_uri
    )

    _logger.info('Starting driver')
    driver.start()

    _logger.info('Joining driver')
    driver.join()
```

mesos 提供的 restapi

master:
可以使用http://192.168.56.101:5050/help查看restapi提供的接口帮助信息

命令	用途
/**processes**/	列出集群中的所有进程
/files/browse.json	
/files/debug.json	
/files/download.json	
/files/read.json	
/logging/toggle	在短时间内开启某级别的日志
/master/health	master状态检查, 200状态码表示正常
/master/observe	接收用逗号分割的主机主机名，监控器名，监控等级所代表的主机的健康状态信息列表
/master/redirect	重定向到当前master
master/roles.json	获取当前所有已赋值的角色

/master/slaves	获取所有slave的信息
/master/state-summary	获取当前集群使用情况的总结报告
/master/state.json	获取当前集群使用情况的详细报告
/master/tasks.json	获取所有正在运行的任务
/master/teardown	关闭指定的框架
/metrics/snapshot	获取监控信息
/profiler/start	开启mesos剖析器
/profiler/stop	关闭mesos剖析器
/registrar(1)/registry	获取所有的注册信息
/system/stats.json	获取系统的状态信息

备注:
1.在0.25版本, /files/X.json修改为/files/X
/master/state.json修改为/master/state
/master/tasks.json修改为/master/tasks

slave:
可以使用http://192.168.56.102:5051/help查看restapi提供的接口帮助信息

命令	用途
/processes/	列出集群中的所有进程
/files/browse.json	
/files/debug.json	
/files/download.json	
/files/read.json	
/logging/toggle	在短时间内开启某级别的日志
/metrics/snapshot	获取监控信息
/monitor/statistics.json	获取统计信息
/profiler/start	开启mesos剖析器
/profiler/stop	关闭mesos剖析器
/slave(1)/health	slave健康状态
/slave(1)/state.json	获取当前slave使用情况的详细报告
/registrar(1)/registry	获取所有的注册信息
/system/stats.json	获取系统的状态信息

备注:
1.在0.25版本, /files/X.json修改为/files/X
/slave(1)/state.json修改为/slave(1)/state
/monitor/statistics.json修改为/monitor/statistics
2.对于mesos master和slave的监控主要通过/metrics/snapshot接口完成

部署&运行

可以使用dockerindocker的方式进行slave部署并运行，或者使用mesos提供的工具进行部署

dockerindocker方式需要在性能和功能上进行验证

其他

1. API限速
   --rate-limits
2. slave恢复
3. 限制slave移除速率
   --recovery_slave_removal_limit
   --slave_removal_rate_limit
4. 维护状态
   /maintenance/schedule和/maintenance/unscheduled两个restapi

已可以运行的框架整理

1. 持久性任务

- Aurora
- Marathon
- Singularity
- SSSP

1. 批处理任务

- Chronos
- Jenkins
- JobServer

1. 大数据任务

- Cray
- Dpark
- Exelixi
- Hadoop
- Hama
- MPI
- Spark
- Storm

1. 存储任务

- Cassandra
- ElasticSearch
- Hypertable

市场docker云的成型品

- DaoCloud 上海道客网络科技有限公司
- 时速云 时速云
- 灵雀云 云雀科技
- 希云 云栈科技
- 数人云 数人科技

部署方式上Daocloud、时速云、灵雀云均提供云存储和外部主机管理, 通过安装agent到外部主机添加到云端管理中, 下载agent时携带用户Token信息.
希云提供企业级私有云管理，通过证书控制agent的数量，使用docker-in-docker模式部署contronller和agent节点
主要功能基本类似，如下：

1. 添加代码仓库(git等)并设置授权和webhooks
2. 创建镜像 ==> 镜像构建、管理、存储、dockerhub加速 (DaoCloud)
3. 部署服务 ==> 调度、服务的可绑定其他服务、服务自动迁移和伸缩(有状态类服务不做自动迁移)
4. 使用webhooks做持续集成入口，自动创建镜像、自动化测试、自动部署服务
5. 管理客户主机和云主机, 主要以agent方式部署管理节点
6. 集群管理
7. 服务编排 ==> 服务发现, 负载均衡
8. 应用数据的备份 ==> docker外数据持久化
9. 计费 ==> 计时、包月
10. web term for docker
11. docker监控网络、cpu、内存等
12. 提供基础服务, mysql、redis、mongodb、卷存储等

文章

1.Mesos介绍

- Mesos: A Platform for Fine-Grained Resource Sharing in the Data Center
- 谈谈Apache Mesos和Mesosphere DCOS：历史、架构、发展和应用
- Apache Mesos的真实使用场景
- CNUTCon全球容器技术大会
- 基于Mesos和Docker的分布式计算平台
- Mesos的设计架构
- Mesos DRF算法的论文阅读
- 董西成博客
- mesos论文阅读
- mesos学习之cgroup接口封装
- Mesos资源调度器的实现分析

2.Mesos使用经验

- Mesos在去哪儿网的应用
- MesosCon总结 | 苹果、彭博、Netflix的Mesos使用经验分享
- 在生产环境中使用Apache Mesos和Docker
- 持续交付系列（一）：使用Docker、Mesos实现持续交付
- 持续交付系列（二）：使用Docker、Mesos实现持续交付
- 弹性集成Apache Mesos与Apache Kafka框架
- Fenzo：来自Netflix基于Java语言的Mesos调度器
- Mesos+ZooKeeper+Marathon+Docker分布式部署打造PaaS云平台实践
- SAMI：来自三星的基于Docker和Mesos的容器解决方案（二）
- SAMI：来自三星的基于Docker和Mesos的容器解决方案（一）
- Docker、Mesos和Marathon剖析以及入门实战
- Yelp是如何利用Mesos和Docker搭建混合云的？

3.Mesos对比

- Kubernetes和DCOS，朋友还是对手？
- 剖析Docker Swarm和Mesos：是什么？如何结合？有什么优势？
- Mesos、Omega和Borg三个系统有什么区别？
- YARN & Mesos，论集群资源管理所面临的挑战
- 在Google使用Borg进行大规模集群的管理 1-2
- 在Google使用Borg进行大规模集群的管理 3-4
- 在Google使用Borg进行大规模集群的管理 5-6
- 在Google使用Borg进行大规模集群的管理 7-8

4.Mesos使用

- Mini-Mesos：一个Mesos的测试基础框架
- Mesos框架对比：Marathon 和 Aurora

- Mesos持久化存储初探
- 通过Mesos、Docker和Go，使用300行代码创建一个分布式系统

5.其他

- 国内Docker服务和产品初探
- Mesos DRF算法的论文阅读

下一步了解问题方向

1. slave部署问题, 用户使用私有云或自己的主机，且在资源分配问题，用户自己的主机只能为自己服务
2. slave与master通信使用加密方式(目前在master+slave, fromwork+master中可使用ssl传输层加密, webUI也可以使用https进行访问)
3. 跨机房
4. 对不同用户部署不同的集群及其管理
5. mesos周边调度框架swarm, marathon, chronos, bamboo, haproxy, mesos-dns等
6. kubernetes
7. docker服务编排