# MySQL5.6双机热备高可用方案配置手册

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> - Descrition: MySQLHA-Keepalived-2Nodes

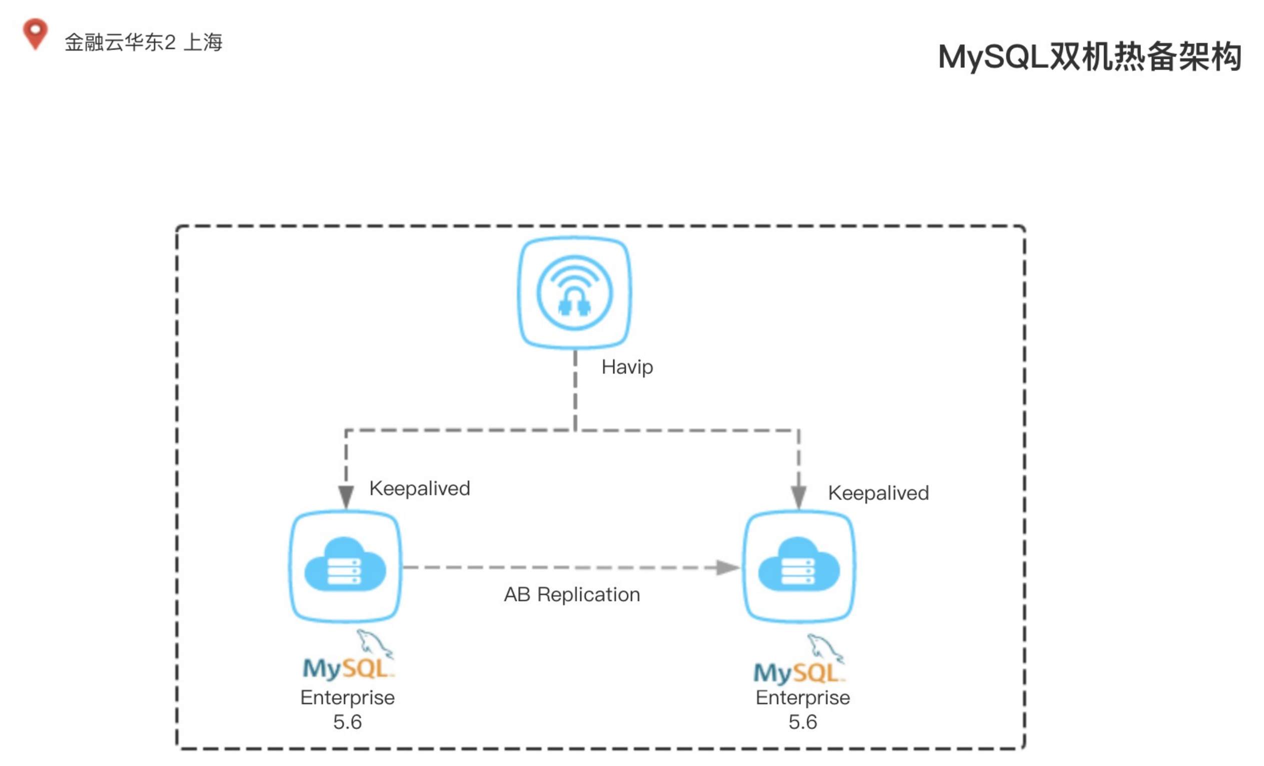
# 概述

## 方案说明

MySQL双机热备是一种只有两个节点的高可用集群。高可用性>=99.95%，一年内累计不能超过4个小时的不可服务时间。

基于MySQL 5.6的半同步复制 Semisynchronous Replication，加Keepalived 构建的高可用结构 。

集群中两台服务器互为备份，当一台服务器出现故障时，可由另一台服务器承担服务任务，从而在无人工干预的情况下，自动保证系统能持续对外提供服务。



| 技术 | 说明 |
|---|---|
| MySQL AB Replication | MySQL官方主从复制技术是一种非常简单、便捷的解决方案，在高可用集群中，MySQL主从保证两台MySQL 数据的一致性 |
| Keepalived | 实现MySQL故障时的自动切换 |
| Havip | 阿里云产品，利用可在ECS进行私网IP宣告的功能，可以实现VRRP协议的高可用 |

## 环境说明

| HOSTNAME | IP | PORT | ROLE |
|---|---|---|---|
| node1 | 192.168.14.128 | 3306 | Master |
| node2 | 192.168.14.129 | 3306 | Slave |
| vip | 192.168.14.88 | | |

## 软件版本

| 软件 | 版本 | 软件包 | 官网 |
|---|---|---|---|
| MySQL | 5.6 | mysql-5.6.45-linux-glibc2.12-x86_64.tar.gz | MySQL |
| KeepAlived | 2.0.18 | keepalived-2.0.18.tar.gz | Keepalived |

## 自动安装配置脚本

联系驻云DBA

# MySQL 主从搭建

## 主机配置

### *双机hosts文件配置*

双机hosts文件配置，需要在两台主机上分别修改/etc/hosts文件，如下所示：

```
192.168.14.128 node1
192.168.14.129 node2
```

### *双机NTP时钟同步*

生产环境要求主备机，必须进行时钟同步。

### *双机互信配置*

node1上执行：

```
ip=192.168.14.129
yes | ssh-keygen -f $HOME/.ssh/id_rsa -t rsa -N ''
ssh-copy-id root@$ip
```

node2上执行：

```
ip=192.168.14.128
yes | ssh-keygen -f $HOME/.ssh/id_rsa -t rsa -N ''
ssh-copy-id root@$ip
```

验证：

```
ssh root@$ip hostname
```

不需要使用密码则说明配置成功。

# 数据库配置

## *数据库基础安装*

运行mysql-5.6.46.sh安装脚本

配置文件中有以下参数需要提前与客户确认：

1. 字符集，默认utf8mb4
2. 事务隔离级别，默认RC

```
cat > /etc/my.cnf <<END
#my.cnf
[client]
port            = 3306
socket          = /tmp/mysql3306.sock

[mysql]
prompt="\\u@\\h [\\d]>"
no-auto-rehash

[mysqld]

user = mysql
basedir = /alidata/mysql
datadir = /alidata/mysql/data
port = 3306
socket = /tmp/mysql3306.sock
event_scheduler = 0

tmpdir = /alidata/mysql/tmp
#timeout
interactive_timeout = 28800
wait_timeout = 28800

#character set
character-set-server = utf8mb4

open_files_limit = 65535
max_connections = 1000
max_connect_errors = 100000
lower_case_table_names =1

#symi replication

#rpl_semi_sync_master_enabled=1
#rpl_semi_sync_master_timeout=1000 # 1 second
#rpl_semi_sync_slave_enabled=1
```

```
#logs
log-output=file
slow_query_log = 1
slow_query_log_file = /alidata/mysql/data/slow.log
log-error = /alidata/mysql/data/error.log
log_warnings = 2
pid-file = mysql.pid
long_query_time = 1
#log-slow-admin-statements = 1
#log-queries-not-using-indexes = 1
log-slow-slave-statements = 1

#binlog
binlog_format = row
server-id = 2003306
log-bin = /alidata/mysql/log/mysql-bin
binlog_cache_size = 4M
sync_binlog = 1
expire_logs_days = 10
#procedure
log_bin_trust_function_creators=1

# gtid
gtid-mode = on
enforce-gtid-consistency=1


#relay log
skip_slave_start = 1
max_relay_log_size = 128M
relay_log_purge = 1
relay_log_recovery = 1
relay-log=relay-bin
relay-log-index=relay-bin.index
log_slave_updates
#slave-skip-errors=1032,1053,1062
#skip-grant-tables


#buffers & cache
table_open_cache = 2048
table_definition_cache = 2048
table_open_cache = 2048
max_heap_table_size = 96M
sort_buffer_size = 128K
join_buffer_size = 128K
thread_cache_size = 200
query_cache_size = 0
query_cache_type = 0
query_cache_limit = 256K
query_cache_min_res_unit = 512
```

```
thread_stack = 192K
tmp_table_size = 96M
key_buffer_size = 8M
read_buffer_size = 2M
read_rnd_buffer_size = 16M
bulk_insert_buffer_size = 32M

#myisam
myisam_sort_buffer_size = 128M
myisam_max_sort_file_size = 10G
myisam_repair_threads = 1

#innodb
innodb_buffer_pool_size = $(num1=`cat /proc/meminfo | sed -n '1p'|awk '{print
$2}'`;awk 'BEGIN{printf "%.0f\n",'$num1'*1024*0.75}')
innodb_buffer_pool_instances = 8
innodb_buffer_pool_load_at_startup = 1
innodb_buffer_pool_dump_at_shutdown = 1
innodb_data_file_path = ibdata1:1G:autoextend
innodb_flush_log_at_trx_commit = 1
innodb_log_buffer_size = 32M
innodb_log_file_size = 2G
innodb_log_files_in_group = 2

# mem bug
performance_schema_max_table_instances=600


[mysqldump]
quick
max_allowed_packet = 32M

END
```

## 数据库安全加固

1. 修改root用户密码
2. 清除所有不安全账号

```
mysql_bin=/alidata/mysql/bin/
root_pwd=Zyadmin123
keepalived_user=keepalived
keepalived_pwd=Keepalived@123
${mysql_bin}/mysqladmin -uroot password $root_pwd
${mysql_bin}/mysql -uroot -p$root_pwd -e "delete from mysql.user where
user='' or host='' or password='';"
${mysql_bin}/mysql -uroot -p$root_pwd -e "grant all on *.* to
'${keepalived_user}'@'%' identified by '${keepalived_pwd}';"
```

## 半同步复制配置

```
install plugin rpl_semi_sync_master soname 'semisync_master.so';
install plugin rpl_semi_sync_slave soname 'semisync_slave.so';

rpl_semi_sync_master_enabled=1
rpl_semi_sync_master_timeout=1000 # 1 second
rpl_semi_sync_slave_enabled=1
```

主库:

```
mysql_bin=/alidata/mysql/bin/
root_pwd=Zyadmin123
${mysql_bin}/mysql -uroot -p$root_pwd -e "install plugin rpl_semi_sync_master
soname 'semisync_master.so';"
${mysql_bin}/mysql -uroot -p$root_pwd -e "install plugin rpl_semi_sync_slave
soname 'semisync_slave.so';"
${mysql_bin}/mysql -uroot -p$root_pwd -e "set global sync_binlog=1;set global
innodb_flush_log_at_trx_commit=1;"
sed -i "s/^server-id.*$/server_id=1003306/" /etc/my.cnf
sed -i "s/#rpl_semi_sync_master_enabled=1/rpl_semi_sync_master_enabled=1/"
/etc/my.cnf
sed -i "s/#rpl_semi_sync_master_timeout=1000 # 1
second/rpl_semi_sync_master_timeout=1000 # 1 second/" /etc/my.cnf
sed -i "s/#rpl_semi_sync_slave_enabled=1/rpl_semi_sync_slave_enabled=1/"
/etc/my.cnf
```

从库:

```
mysql_bin=/alidata/mysql/bin/
root_pwd=Zyadmin123
${mysql_bin}/mysql -uroot -p$root_pwd -e "install plugin rpl_semi_sync_master
soname 'semisync_master.so';"
${mysql_bin}/mysql -uroot -p$root_pwd -e "install plugin rpl_semi_sync_slave
soname 'semisync_slave.so';"
${mysql_bin}/mysql -uroot -p$root_pwd -e "set global sync_binlog=0;set global
innodb_flush_log_at_trx_commit=0;"
sed -i "s/^server-id.*$/server_id=2003306/" /etc/my.cnf
sed -i "s/#rpl_semi_sync_master_enabled=1/rpl_semi_sync_master_enabled=1/"
/etc/my.cnf
sed -i "s/#rpl_semi_sync_master_timeout=1000 # 1
second/rpl_semi_sync_master_timeout=1000 # 1 second/" /etc/my.cnf
sed -i "s/#rpl_semi_sync_slave_enabled=1/rpl_semi_sync_slave_enabled=1/"
/etc/my.cnf
```

## 服务启动和停止命令

```
/etc/init.d/mysqld start
/etc/init.d/mysqld stop
/etc/init.d/mysqld restart
```

# 自定义脚本

## *脚本语言和版本*

| 语言 | 版本 |
|---|---|
| Python | 2.7.4 |

```
#!/bin/bash

install_epel(){
  cd /aliyun/install
  rpm -ivh epel-release-latest-7.noarch.rpm
  yum clean all
  yum make cache
}

python_reqiure(){
  yum install -y python-pip  python-devel
  pip install --upgrade pip
  pip install pymysql
  pip install filelock
}

install_epel
python_reqiure
```

# *数据库健康检查*

check_mysql.py 为了检查数据库服务是否正常的脚本，如果判断服务异常，则自动把keepalived进程kill，让VIP进行漂移;

## 检测算法

1. 判断数据库是否能够正常连接
2. 判断监听端口为3306的mysqld_safe进程是否存在
3. 判断监听端口是否存在

若 数据库能够正常连接； 则 返回数据正常;

否则 判断进程和端口是否存在:

- 若此时进程和端口均存在，则连续check 5次 数据库连接情况是否正常，每次check后等待1秒；若5次check后都无法正常连接数据库，则返回数据库异常；若在完成5次check前恢复数据库连接，则返回数据库正常。
- 若此时进程不存在 or 监听端口 不存在 ； 则直接返回数据库异常；

## 检测脚本

### config.py

```
#!/usr/bin/python

dbhost='192.168.14.131'
dbport=3306
dbuser='keepalived'
dbpassword='Keepalived@123'
log_dir="/alidata//keepalived-2.0.18/logs"
other_node='192.168.14.132'
```

### mysql_helper.py

```
# -*- coding:utf8 -*-

import sys
import pymysql
import json


class MysqlHelper:
    def __init__(self, **kwargs):
        self.url = kwargs['url']
        self.port = kwargs['port']
        self.username = kwargs['username']
        self.password = kwargs['password']
        self.dbname = kwargs['dbname']
        self.charset = "utf8"
        self.conn = pymysql.connect(host=self.url, user=self.username,
passwd=self.password, port=self.port,
                                    charset=self.charset, db=self.dbname)
        self.cur = self.conn.cursor(cursor=pymysql.cursors.DictCursor)

    def col_query(self, sql):
        """
        打印表的列名
        :return list
        """
        self.cur.execute(sql)
        return self.cur.fetchall()

    def commit(self):
        self.conn.commit()

    def close(self):
        self.cur.close()
        self.conn.close()

if __name__ == "__main__":
    print("This is mysql api.")
```

## check_mysql.py

```
#!/usr/bin/python
# coding: utf-8

import time
import sys
import os
import logging
import json

# Third-part
import mysql_helper
import filelock
import config

preSlaveSQL = "set global read_only=1;"
preMasterSQL = "set global read_only=0;"
log_dir = config.log_dir

logging.basicConfig(level=logging.DEBUG,
                    format='%(asctime)s %(filename)s[line:%(lineno)d] %
(levelname)s %(message)s',
                    datefmt='%a, %d %b %Y %H:%M:%S',
                    filename='{0}/notify.log'.format(log_dir),
                            filemode='a',
                            maxBytes=10485760,  # 10MB 设置日志文件的大小
                            backupCount=20,  # 文件最大的个数
                            encoding='utf8')


class DBase:
    def __init__(self, **kwargs):
        self.params = kwargs["mysql"]
        self.keepalived = kwargs["keepalived"]
        self.other_node = kwargs["other_node"]
        try:
            self.conn = mysql_helper.MysqlHelper(**self.params)
        except Exception as e:
            logging.info("数据库连接异常 " + str(e))
            exit(1)

    def alert(self):
        print("{}".format(self.keepalived))

    def make_master(self):
        """
        将从库切换为主库
        1. 获取从库slave状态
        2. 判断主从是否存在延迟
        3. 如存在延迟等待1分钟
        4. 停止slave
        :return:
        """
        slave_status = self.conn.col_query("show slave status")[0]
        logging.info(json.dumps(slave_status, indent=2))
        Master_Host = slave_status["Master_Host"]
        Master_Log_File = slave_status["Master_Log_File"]
        Read_Master_Log_Pos = slave_status["Read_Master_Log_Pos"]
        Relay_Master_Log_File = slave_status["Relay_Master_Log_File"]
        Exec_Master_Log_Pos = slave_status["Exec_Master_Log_Pos"]

        if Master_Log_File == Relay_Master_Log_File and Read_Master_Log_Pos
== Exec_Master_Log_Pos:
            self.conn.col_query("stop slave;")
            self.conn.col_query("set global sync_binlog=1;")
            self.conn.col_query("set global
innodb_flush_log_at_trx_commit=1;")
            self.conn.col_query("set global read_only=0;")
            master_status = self.conn.col_query("show master status;")[0]
            logging.info("stop slave;show master status;")
            logging.info("记录新主库的binlog位置: ")
            logging.info(json.dumps(master_status, indent=2))
            with open("/alidata/keepalived-2.0.18/logs/master_info", 'w') as
f:
                f.write(json.dumps(master_status, indent=1))
        else:
            time.sleep(60)
            slave_status = self.conn.col_query("show slave status")[0]
            logging.info(json.dumps(slave_status, indent=2))
            self.conn.col_query("stop slave;")
            self.conn.col_query("set global sync_binlog=1;")
            self.conn.col_query("set global
innodb_flush_log_at_trx_commit=1;")
            self.conn.col_query("set global read_only=0;")
            master_status = self.conn.col_query("show master status;")[0]
            logging.info(json.dumps(master_status, indent=2))
            with open("/alidata/keepalived-2.0.18/logs/master_info", 'w') as
f:
                f.write(json.dumps(master_status, indent=1))

        # 记录主库真实的binlog文件和position编号
        try:
            os.popen(
                "scp root@{0}:/alidata/mysql/log/mysql-bin.index
/alidata/keepalived-2.0.18/logs/{0}-mysql-bin.index".format(
                    Master_Host))
            master_binlog_file_real = \
                open("/alidata/keepalived-2.0.18/logs/{0}-mysql-
bin.index".format(Master_Host)).readlines()[-1].strip()
            os.popen(
                "scp root@{0}:{1}  /alidata/keepalived-2.0.18/logs/{0}-
{2}".format(Master_Host, master_binlog_file_real,

      master_binlog_file_real.split('/')[

          -1]))
            master_binlog_file_slave = "/alidata/keepalived-2.0.18/logs/{0}-
{1}".format(Master_Host,

           master_binlog_file_real.split(

               '/')[-1])
            cmd = "/alidata/mysql/bin/mysqlbinlog -vv " +
master_binlog_file_slave + " | tail -n 100|grep end_log_pos|tail -n 2|head -n
1|awk '{print $7}'"
            master_binlog_pos_real = os.popen(cmd).read()
        except Exception as e:
            logging.error(str(e))

        else:
            logging.info("主库 {0} 最后一个binlog日志文件 {1}  位置编号为
{2}".format(Master_Host, master_binlog_file_real,

master_binlog_pos_real))
            logging.info("从库 {0} 重演主库binlog日志文件 {1}  位置编号为
{2}".format(
                self.params["url"],
                slave_status["Relay_Master_Log_File"],
                slave_status["Exec_Master_Log_Pos"]))

    def make_slave(self):
        """
        清空slave配置，重新获取远程日志文件及位置编号，并开启半同步复制；
        :return:
        """
        try:
            os.popen(
                "scp root@{0}:/alidata/keepalived-2.0.18/logs/master_info
/alidata/keepalived-2.0.18/logs/{0}-master_info".format(
                    self.other_node))
            master_info = json.loads(
                open("/alidata/keepalived-2.0.18/logs/{0}-
master_info".format(self.other_node)).read())
        except Exception as e:
            logging.error("无法获取远程日志文件及位置编号")
            logging.error(str(e))
        else:
            self.conn.col_query("stop slave;")
            logging.info("stop slave;")
            sql = "change master to
master_user='slave',master_password='Slave@replication',master_host='{0}',mas
ter_auto_position=0;"
            self.conn.col_query(sql)
            logging.info(sql)
            sql = "change master to
master_user='slave',master_password='Slave@replication',master_host='{0}',mas
ter_log_file='{1}',master_log_pos={2};".format(
                self.other_node, master_info["File"],
master_info["Position"])
            self.conn.col_query(sql)
            self.conn.col_query("start slave;")
            self.conn.col_query("set global read_only=1;")
            logging.info("start slave;")
            logging.info("set global read_only=1;")
            logging.info(sql)
            slave_status = self.conn.col_query("show slave status;")[0]
            logging.info(json.dumps(slave_status, indent=2))

    def stop_mysql(self):
        try:
            master_status = self.conn.col_query("show master status;")[0]
        except:
            logging.error("数据库服务异常")
        else:
            logging.info("数据库正常")
            logging.info(json.dumps(master_status, indent=2))
            logging.info("主库 {0} 最后一个binlog日志文件 {1}  位置编号为
{2}".format(
                  self.params["url"], master_status["File"],
master_status["Position"]))


        try:
            slave_status = self.conn.col_query("show slave status;")[0]
        except:
            logging.error("数据库服务异常")
        else:
            logging.info("数据库正常")
            logging.info(json.dumps(slave_status, indent=2))
            logging.info("从库 {0} 重演主库binlog日志文件 {1}  位置编号为
{2}".format(
                self.params["url"],
                slave_status["Relay_Master_Log_File"],
                slave_status["Exec_Master_Log_Pos"]))

    def start(self):
        if self.keepalived == "MASTER":
            self.make_master()
            logging.info("切换状态为MASTER")
        elif self.keepalived == "BACKUP":
            self.make_slave()
            logging.info("切换状态为BACKUP")
        elif self.keepalived == "STOP":
            self.stop_mysql()
            logging.info("切换状态为STOP")
        else:
            logging.error("keepalived配置有误或脚本执行异常")

        self.conn.close()


if __name__ == "__main__":
    lock = filelock.FileLock("/tmp/kps.txt")
    if lock:
        logging.info("ZST Get Lock.start!!!")
    try:
        with lock.acquire(timeout=5):
            pass
    except filelock.timeout:
        print "timeout"
        logging.warning("get file lock timeout")

    mysql = {
        "url": config.dbhost,
        "port": config.dbport,
        "username": config.dbuser,
        "password": config.dbpassword,
        "dbname": "mysql",
    }
    params = {
        "mysql": mysql,
        "keepalived": sys.argv[3].upper(),
        "other_node": config.other_node,
    }

    db = DBase(**params)
    db.start()
```

## *数据库角色切换*

### 算法

- 如果参数为backup，则调用make_slave()函数：清空slave配置，重新获取远程日志文件及位置编号，并开启半同步复制，set global read_only=1;；
- 如果参数为master，则调用make_master()函数：先判断同步复制是否执行完成，如果未执行完成等待1分钟后，停止同步（stop slave;），并且记录切换后的日志和位置编号，set glbal read_only=0;
- 如果参数为stop，则调用stop_mysql()函数：记录当前主或从的日志信息，为故障修复做准备；
- 如果参数为fault，则调用alert()函数：keepalived本身配置或调用的脚本执行异常，记录异常。

### notify.py

```
#!/usr/bin/python
# coding: utf-8

import time
import sys
import os
import logging
import json

# Third-part
import mysql_helper
import filelock
import config

preSlaveSQL = "set global read_only=1;"
preMasterSQL = "set global read_only=0;"
log_dir = config.log_dir

logging.basicConfig(level=logging.DEBUG,
                    format='%(asctime)s %(filename)s[line:%(lineno)d] %
(levelname)s %(message)s',
                    datefmt='%a, %d %b %Y %H:%M:%S',
                    filename='{0}/notify.log'.format(log_dir),
                    filemode='a',
                    maxBytes=10485760,  # 10MB 设置日志文件的大小
                    backupCount=20,  # 文件最大的个数
                    encoding='utf8')


class DBase:
    def __init__(self, **kwargs):
        self.params = kwargs["mysql"]
        self.keepalived = kwargs["keepalived"]
        self.other_node = kwargs["other_node"]
        try:
            self.conn = mysql_helper.MysqlHelper(**self.params)
        except Exception, e:
            logging.info("数据库连接异常 " + str(e))
            exit(1)

    def alert(self):
        print("{}".format(self.keepalived))

    def make_master(self):
        """
        将从库切换为主库
        1. 获取从库slave状态
        2. 判断主从是否存在延迟
        3. 如存在延迟等待1分钟
        4. 停止slave
        :return:
        """
        slave_status = self.conn.col_query("show slave status")[0]
        logging.info(json.dumps(slave_status, indent=2))
        Master_Host = slave_status["Master_Host"]
        Master_Log_File = slave_status["Master_Log_File"]
        Read_Master_Log_Pos = slave_status["Read_Master_Log_Pos"]
        Relay_Master_Log_File = slave_status["Relay_Master_Log_File"]
        Exec_Master_Log_Pos = slave_status["Exec_Master_Log_Pos"]

        if Master_Log_File == Relay_Master_Log_File and Read_Master_Log_Pos
== Exec_Master_Log_Pos:
            self.conn.col_query("stop slave;")
            self.conn.col_query("set global sync_binlog=1;")
            self.conn.col_query("set global
innodb_flush_log_at_trx_commit=1;")
            self.conn.col_query("set global read_only=0;")
            master_status = self.conn.col_query("show master status;")[0]
            logging.info("stop slave;show master status;")
            logging.info("记录新主库的binlog位置: ")
            logging.info(json.dumps(master_status, indent=2))
            with open("/alidata/keepalived-2.0.18/logs/master_info", 'w') as
f:
                f.write(json.dumps(master_status, indent=1))

        else:
            time.sleep(60)
            slave_status = self.conn.col_query("show slave status")[0]
            logging.info(json.dumps(slave_status, indent=2))
            self.conn.col_query("stop slave;")
            self.conn.col_query("set global sync_binlog=1;")
            self.conn.col_query("set global
innodb_flush_log_at_trx_commit=1;")
            self.conn.col_query("set global read_only=0;")
            master_status = self.conn.col_query("show master status;")[0]
            logging.info(json.dumps(master_status, indent=2))
            with open("/alidata/keepalived-2.0.18/logs/master_info", 'w') as
f:
                f.write(json.dumps(master_status, indent=1))

        # 记录主库真实的binlog文件和position编号
        try:
            os.popen(
                "scp root@{0}:/alidata/mysql/log/mysql-bin.index
/alidata/keepalived-2.0.18/logs/{0}-mysql-bin.index".format(
                    Master_Host))
            master_binlog_file_real = \
                open("/alidata/keepalived-2.0.18/logs/{0}-mysql-
bin.index".format(Master_Host)).readlines()[-1].strip()
            os.popen(
                "scp root@{0}:{1}  /alidata/keepalived-2.0.18/logs/{0}-
{2}".format(Master_Host, master_binlog_file_real,

      master_binlog_file_real.split('/')[

          -1]))
            master_binlog_file_slave = "/alidata/keepalived-2.0.18/logs/{0}-
{1}".format(Master_Host,

           master_binlog_file_real.split(

               '/')[-1])
            cmd = "/alidata/mysql/bin/mysqlbinlog -vv " +
master_binlog_file_slave + " | tail -n 100|grep end_log_pos|tail -n 2|head -n
1|awk '{print $7}'"
            master_binlog_pos_real = os.popen(cmd).read()
        except Exception as e:
            logging.error(str(e))

        else:
            logging.info("主库 {0} 最后一个binlog日志文件 {1}  位置编号为
{2}".format(Master_Host, master_binlog_file_real,

master_binlog_pos_real))
            logging.info("从库 {0} 重演主库binlog日志文件 {1}  位置编号为
{2}".format(
                self.params["url"],
                slave_status["Relay_Master_Log_File"],
                slave_status["Exec_Master_Log_Pos"]))

    def make_slave(self):
        """
        清空slave配置，重新获取远程日志文件及位置编号，并开启半同步复制；
        :return:
        """
        try:
            os.popen(
                "scp root@{0}:/alidata/keepalived-2.0.18/logs/master_info
/alidata/keepalived-2.0.18/logs/{0}-master_info".format(
                    self.other_node))
            master_info = json.loads(
                open("/alidata/keepalived-2.0.18/logs/{0}-
master_info".format(self.other_node)).read())
        except Exception as e:
            logging.error("无法获取远程日志文件及位置编号")
            logging.error(str(e))
        else:
            self.conn.col_query("stop slave;")
            logging.info("stop slave;")
            sql = "change master to
master_user='slave',master_password='Slave@replication',master_host='{0}',mas
ter_auto_position=0;"
            self.conn.col_query(sql)
            logging.info(sql)
            sql = "change master to
master_user='slave',master_password='Slave@replication',master_host='{0}',mas
ter_log_file='{1}',master_log_pos={2};".format(
                self.other_node, master_info["File"],
master_info["Position"])
            self.conn.col_query(sql)
            self.conn.col_query("set global read_only=1;")
            logging.info("set global read_only=1;")
            logging.info(sql)
            slave_status = self.conn.col_query("show slave status;")[0]
            logging.info(json.dumps(slave_status, indent=2))

    def stop_mysql(self):
        try:
            master_status = self.conn.col_query("show master status;")[0]
        except:
            logging.error("数据库服务异常")
        else:
            logging.info("数据库正常")
            logging.info(json.dumps(master_status, indent=2))
            logging.info("主库 {0} 最后一个binlog日志文件 {1}  位置编号为
{2}".format(
                self.params["url"], master_status["File"],
master_status["Position"]))


        try:
            slave_status = self.conn.col_query("show slave status;")[0]
        except:
            logging.error("数据库服务异常")
        else:
            logging.info("数据库正常")
            logging.info(json.dumps(slave_status, indent=2))
            logging.info("从库 {0} 重演主库binlog日志文件 {1}  位置编号为
{2}".format(
                self.params["url"],
                slave_status["Relay_Master_Log_File"],
                slave_status["Exec_Master_Log_Pos"]))

    def start(self):
        if self.keepalived == "MASTER":
            self.make_master()
            logging.info("切换状态为MASTER")
        elif self.keepalived == "BACKUP":
            self.make_slave()
            logging.info("切换状态为BACKUP")
        elif self.keepalived == "STOP":
            self.stop_mysql()
            logging.info("切换状态为STOP")
        else:
            logging.error("keepalived配置有误或脚本执行异常")

        self.conn.close()


if __name__ == "__main__":
    lock = filelock.FileLock("/tmp/kps.txt")
    if lock:
        logging.info("ZST Get Lock.start!!!")
    try:
        with lock.acquire(timeout=5):
            pass
    except filelock.timeout:
        print "timeout"
        logging.warning("get file lock timeout")

    mysql = {
        "url": config.dbhost,
        "port": config.dbport,
        "username": config.dbuser,
        "password": config.dbpassword,
        "dbname": "mysql",
    }

    params = {
        "mysql": mysql,
        "keepalived": sys.argv[3].upper(),
        "other_node": config.other_node,
    }

    db = DBase(**params)
    db.start()
```

## 冷备策略

## 物理备份：全备+增备

1. 备份工具：innobackupex
2. 备份分类：物理备份、在线热备、全备+增备
3. 备份策略：每天1:59开始执行备份脚本；周一全备份，周二到周日增量；每周自动删除上一周过期备份数据
4. 备份文件：/alidata/backup
5. 其他信息：备份索引/alidata/xtrabackup_cron/var/mysql_increment_hot_backup.index

## 磁盘快照

通过阿里云ECS的快照功能做冷备。

# Keepalived配置

## 切换原理

### *四种故障切换原理*

#### MySQL主库故障

> 当前node1为MySQL MASTER; node2为MySQL SLAVE

1. node1,数据库宕机时pkill keepalived, keepalived的状态由master变为stop
2. node2, 数据库服务正常, keepalived的状态由backup 变为master
3. node1, 故障手动恢复后, keepalived的状态进入backup

#### MySQL从库故障

> 当前node1为MySQL MASTER; node2为MySQL SLAVE

1. 从库node2宕机时pkill keepalived, keepalived的状态由backup变为stop
2. 从库node2故障手动恢复后, keepalived的状态进入backup

#### Keepalived主故障

> 当前node1为MySQL MASTER; node2为MySQL SLAVE

- node1, keepalived故障, keepalived的状态由master改为stop
- node2, keepalived服务正常, keepalived的状态由backup改为master
- node1, 故障手动恢复后, keepalived的状态进入backup

#### Keepalived备故障

> 当前node1为MySQL MASTER; node2为MySQL SLAVE

- node2, keepalived故障, keepalived的状态由backup改为stop
- node2, 故障手动恢复后, keepalived的状态进入backup

## *总结状态变化*

| 类型 | 说明 | 变化前 | 变化后 |
|---|---|---|---|
| 1 | 因MySQL Master 服务不可用将Keepalived被关闭 | master | stop |
| 2 | Keepalived服务异常 | master | fault |
| 3 | MySQL Master 服务不可用 或 Keepalived服务不可用 | backup | master |
| 4 | 因MySQL Slave 服务不可用将Keepalived被关闭 | backup | stop |
| 5 | Keepalived服务异常 | backup | fault |

node1 测试

```
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'BACKUP', '100']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'MASTER', '100']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1', 'STOP',
'100']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'BACKUP', '100']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'MASTER', '100']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1', 'FAULT',
'100']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'MASTER', '100']
```

node2 测试

```
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'BACKUP', '90']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'MASTER', '90']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1', 'STOP',
'90']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'BACKUP', '90']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'MASTER', '90']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1', 'FAULT',
'90']
['/alidata/keepalived-2.0.18/scripts/notify.py', 'INSTANCE', 'VI_1',
'BACKUP', '90']
```

切换速度＜1秒

## Keepalived的安装

```
#!/bin/bash

# https://www.keepalived.org/doc/
# version keepalived-2.0.18.tar.gz

# Install Prerequisites on RHEL/CentOS
yum install -y curl gcc openssl-devel libnl3-devel net-snmp-devel

cd /root
mkdir -p /alidata/install
mv keepalived-2.0.18.tar.gz /alidata/install/
cd /alidata/install
tar -xf keepalived-2.0.18.tar.gz
cd keepalived-2.0.18
./configure --prefix=/alidata/keepalived-2.0.18 --with-init=systemd
make
make install
mkdir -p /alidata//keepalived-2.0.18/scripts
mkdir -p /alidata//keepalived-2.0.18/logs
```

## Keepalived的配置

| 配置 | 说明 |
|---|---|
| state BACKUP | 主从两端都配置成了backup，结合使用nopreempt，设置为非抢占模式 |
| virtual_router_id 51 | 分组id，主从节点应配置相同 |
| priority | 优先级，数据库主节点配置高一些 |
| nopreempt | 不主动抢占资源，设置非抢占模式 |
| notify | 状态变更以后执行的脚本 |

## 主库配置

```
global_defs {
   router_id MySQL-HA
}

vrrp_script check_run {
script "/alidata//keepalived-2.0.18/scripts/check_mysql.py"
interval 10
}

vrrp_sync_group VG1 {
group {
VI_1
}
}

vrrp_instance VI_1 {
    state BACKUP
    interface eth1
    virtual_router_id 51
    priority 100
    advert_int 1
    nopreempt
    authentication {
        auth_type PASS
        auth_pass 1111
    }
    track_script {
    check_run
    }

    notify /alidata//keepalived-2.0.18/scripts/notify.py

    virtual_ipaddress {
        192.168.14.88
    }
}
```

## 从库配置

```
global_defs {
   router_id MySQL-HA
}

vrrp_script check_run {
script "/alidata//keepalived-2.0.18/scripts/check_mysql.py"
interval 10
}

vrrp_sync_group VG1 {
group {
VI_1
}
}

vrrp_instance VI_1 {
    state BACKUP
    interface eth1
    virtual_router_id 51
    priority 90
    advert_int 1
    authentication {
        auth_type PASS
        auth_pass 1111
    }
    track_script {
    check_run
    }

    notify /alidata//keepalived-2.0.18/scripts/notify.py

    virtual_ipaddress {
        192.168.14.88
    }
}
```

## 变更配置文件和日志路径

```
sed -i "s@-D@-f /alidata/keepalived-2.0.18/etc/keepalived/keepalived.conf -D
-d -S 0@" /alidata/keepalived-2.0.18/etc/sysconfig/keepalived
cat >> /etc/rsyslog.conf << ENDF
local0.*
/var/log/keepalived.log
ENDF
systemctl restart rsyslog
```

## 服务启动和停止命令

```
systemctl status|start|stop|restart keepalived
```

# 故障切换验证

## MySQL故障

### *MySQL主库故障*

> Node1 主 Node2 从

- Node1 数据库（主）故障后，Node2 自动升级为主库
- Node1 数据库故障修复后，启动 keepalived 服务，自动完成主从重构，成为 Node2 的从库

### *MySQL从库故障*

> Node1 主 Node2 从

- Node2 数据库（从）故障后，keepalived 进入stop状态
- Node2 数据库故障修复后， 启动 keepalived 服务，自动完成主从重构，成为 Node1 的从库

## Keepalived故障

## Master故障

> Node1 主 Node2 从

- Node1 keepalived (Master) 故障后, 进入stop状态，如果数据库正常，则记录当前主库的明细；否则，记录数据库异常信息
- Node1 数据库正常，启动 keepalived 服务，自动完成主从重构，成为 Node2 的从库
- Node1 数据库异常，手动修复故障后，启动 keepalived 服务

## Backup故障

> Node1 主 Node2 从

- Node2 keepalived（Backup）故障后，进入stop状态，如果数据库正常，记录当前从库的明细；否则记录数据库异常信息

- Node2 数据库正常，启动 keepalived 服务
- Node2 数据库异常，手动修复故障后，启动 keepalived 服务

# 日志文件

## 日志路径

| 日志 | 路径 | 功能 | 备注 |
|---|---|---|---|
| MySQL | /alidata/mysql/data/slow.log | 慢查询日志 | |
| | /alidata/mysql/data/error.log | 错误日志 | |
| | /aliata/mysql/log/ | 二进制日志 | 保留近10天 |
| Keepalived | /var/log/keepalived.log | 错误日志 | |
| | /alidata//keepalived-2.0.18/logs/check_mysql.log | 数据库健康检查日志 | 日志文件的大小10MB ； 文件最大的个数20 |
| | /alidata//keepalived-2.0.18/logs/notify.log | 数据库切换日志 | 日志文件的大小10MB；文件最大的个数20 |

# MySQL双机高可用告警规则

> 此处仅重点罗列双机高可用架构中的告警规则；关于MySQL本身的告警指标（1400+）和告警规则（10+）较多此处不一一罗列。

| **告警规则（6项）** | **监控间隔** | **连续N次触发** | **等级** |
|---|---|---|---|
| MySQL 数据库主从I/O线程异常 | 3min | 1次 | 严重 |
| MySQL 数据库主从SQL线程异常 | 3min | 1次 | 严重 |
| MySQL 数据库半同步复制状态异常 | 3min | 1次 | 严重 |
| MySQL 数据库主从延迟（超过5秒） | 3min | 1次 | 严重 |
| MySQL 数据库有未提交的长事务（超过60秒） | 3min | 1次 | 严重 |
| Keepalived状态变化（Master/Backup/Stop/Fault） | 10s | 1次 | 严重 |

# 其他问题

## OS需要关注

- 服务器规格配置要一致，否则容易导致复制延迟；
- 操作系统建议使用RedHat，易于维护管理（运维人员更熟悉Redhat/CentOS）；

## 客户需要关注

- 数据库版本选择5.6存在延迟的风险： MySQL5.6 延迟问题没有彻底解决，如果对延迟比较敏感应升级至MySQL 5.7或8.0最新版本，利用多线程复制的方式可以很大程度降低复制延迟；