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课前准备

- 准备redis安装包

课堂主题

Redis集群原理、Redis和lua整合、Redis消息模式、Redis实现分布式锁、缓存穿透、缓存雪崩、缓存击穿、缓存双写一致性

课堂目标

- 理解RedisCluster的原理和容错机制
- 能够配置RedisCluster并使用
- 理解lua概念，能够使用Redis和lua整合使用
- 理解redis消息原理
- 掌握redis分布式锁
- 理解缓存穿透、缓存雪崩、缓存击穿、缓存双写一致性并掌握解决方案

知识要点

Redis集群

Redis的集群策略

Redis-cluster架构图

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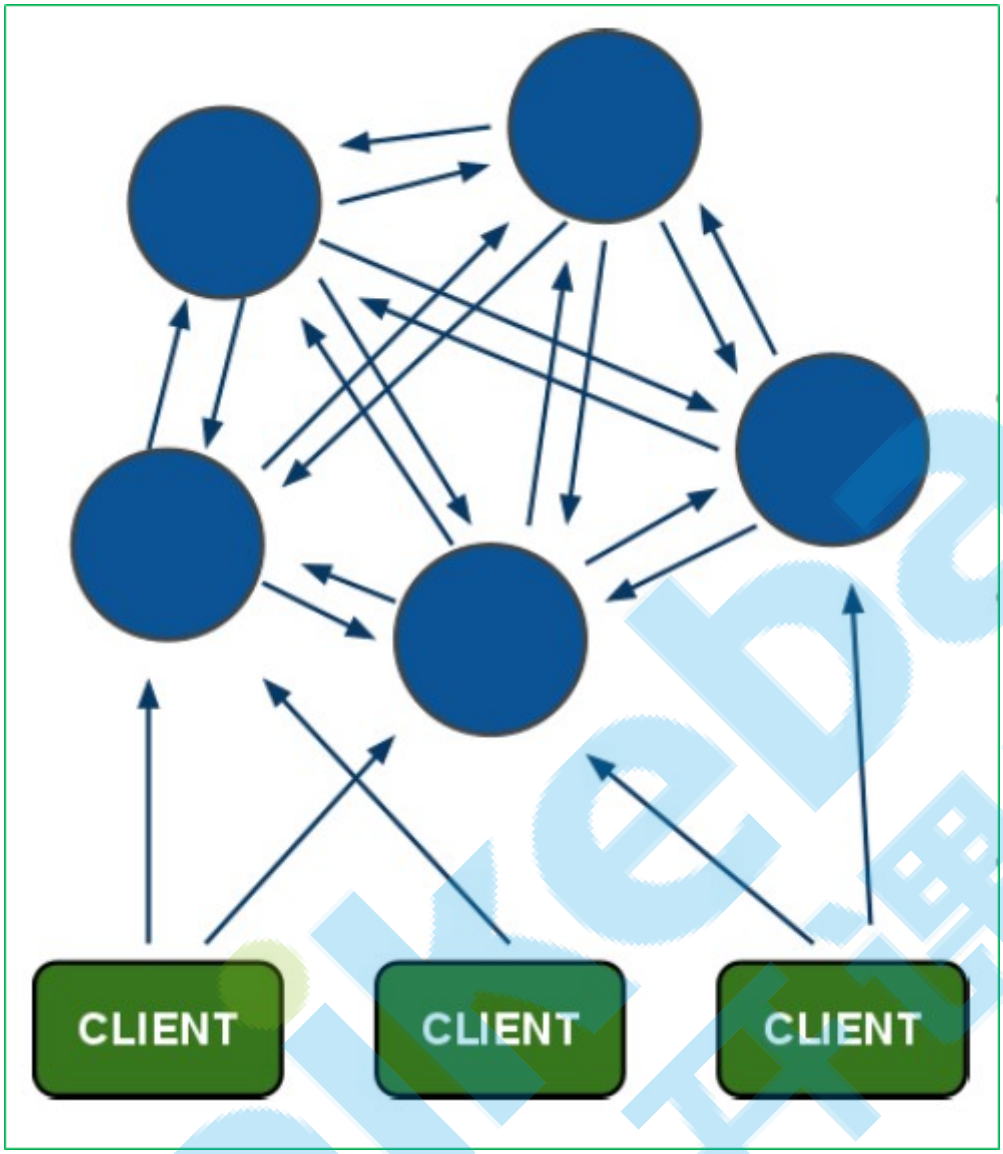

Redis-cluster投票:容错

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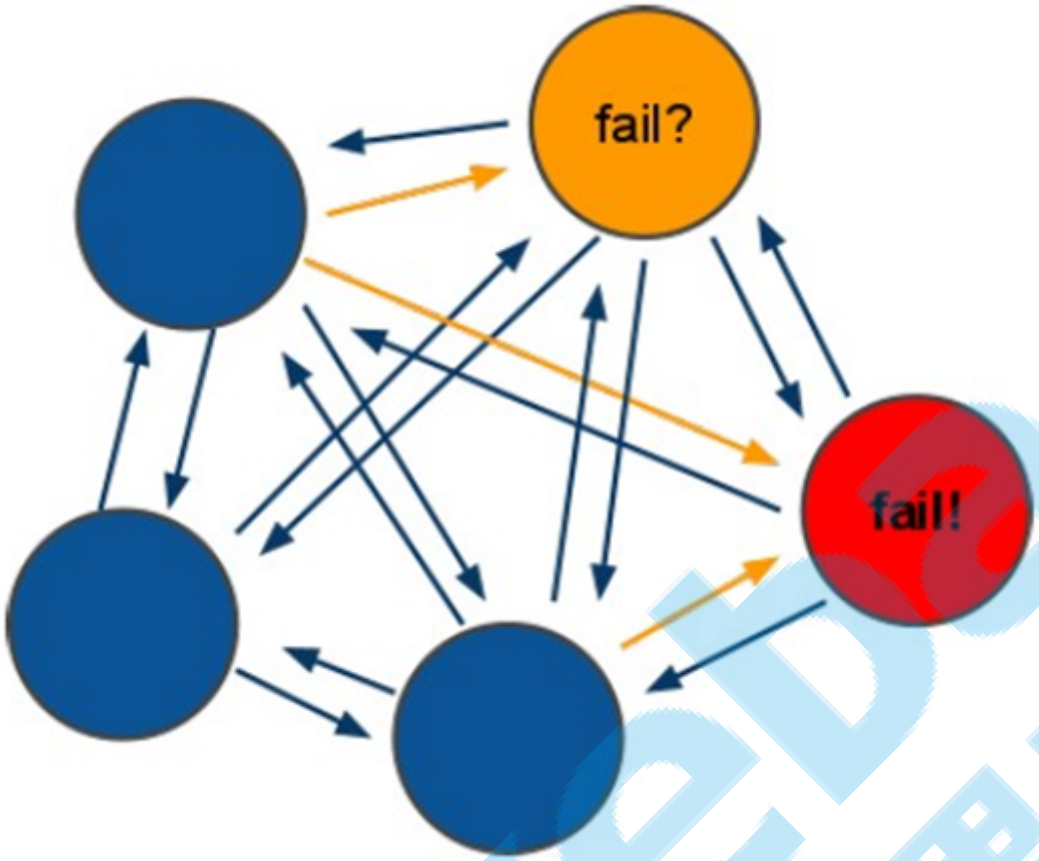

安装RedisCluster

安装RedisCluster

> Redis集群最少需要三台主服务器，三台从服务器。
>
> 端口号分别为：7001~7006

- 第一步：创建7001实例，并编辑redis.conf文件，修改port为7001。

  注意：创建实例，即拷贝单机版安装时，生成的bin目录，为7001目录。

```
# Accept connections on the specified port, default is 6379.
# If port 0 is specified Redis will not listen on a TCP socket.
port 7001
```

- 第二步：修改redis.conf配置文件，打开Cluster-enable yes

```
################################ REDIS CLUSTER  ###############################
#
# ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
# WARNING EXPERIMENTAL: Redis Cluster is considered to be stable code, however
# in order to mark it as "mature" we need to wait for a non trivial percentage
# of users to deploy it in production.
# ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
#
# Normal Redis instances can't be part of a Redis Cluster; only nodes that are
# started as cluster nodes can. In order to start a Redis instance as a
# cluster node enable the cluster support uncommenting the following:
#
cluster-enabled yes

# Every cluster node has a cluster configuration file. This file is not
# intended to be edited by hand. It is created and updated by Redis nodes.
# Every Redis Cluster node requires a different cluster configuration file.
# Make sure that instances running in the same system do not have
# overlapping cluster configuration file names.
#
```

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- 第三步：复制7001，创建7002~7006实例，**注意端口修改。**
- 第四步：启动所有的实例
- 第五步：创建Redis集群

```
./redis-cli --cluster create 192.168.10.135:7001 192.168.10.135:7002
192.168.10.135:7003 192.168.10.135:7004 192.168.10.135:7005
192.168.10.135:7006 --cluster-replicas 1
>>> Creating cluster
Connecting to node 192.168.10.133:7001: OK
Connecting to node 192.168.10.133:7002: OK
Connecting to node 192.168.10.133:7003: OK
Connecting to node 192.168.10.133:7004: OK
Connecting to node 192.168.10.133:7005: OK
Connecting to node 192.168.10.133:7006: OK
>>> Performing hash slots allocation on 6 nodes...
Using 3 masters:
192.168.10.133:7001
192.168.10.133:7002
192.168.10.133:7003
Adding replica 192.168.10.133:7004 to 192.168.10.133:7001
Adding replica 192.168.10.133:7005 to 192.168.10.133:7002
Adding replica 192.168.10.133:7006 to 192.168.10.133:7003
M: d8f6a0e3192c905f0aad411946f3ef9305350420 192.168.10.133:7001
   slots:0-5460 (5461 slots) master
M: 7a12bc730ddc939c84a156f276c446c28acf798c 192.168.10.133:7002
   slots:5461-10922 (5462 slots) master
M: 93f73d2424a796657948c660928b71edd3db881f 192.168.10.133:7003
   slots:10923-16383 (5461 slots) master
S: f79802d3da6b58ef6f9f30c903db7b2f79664e61 192.168.10.133:7004
   replicates d8f6a0e3192c905f0aad411946f3ef9305350420
S: 0bc78702413eb88eb6d7982833a6e040c6af05be 192.168.10.133:7005
   replicates 7a12bc730ddc939c84a156f276c446c28acf798c
S: 4170a68ba6b7757e914056e2857bb84c5e10950e 192.168.10.133:7006
   replicates 93f73d2424a796657948c660928b71edd3db881f
Can I set the above configuration? (type 'yes' to accept): yes
>>> Nodes configuration updated
>>> Assign a different config epoch to each node
>>> Sending CLUSTER MEET messages to join the cluster
Waiting for the cluster to join....
>>> Performing Cluster Check (using node 192.168.10.133:7001)
M: d8f6a0e3192c905f0aad411946f3ef9305350420 192.168.10.133:7001
   slots:0-5460 (5461 slots) master
M: 7a12bc730ddc939c84a156f276c446c28acf798c 192.168.10.133:7002
   slots:5461-10922 (5462 slots) master
M: 93f73d2424a796657948c660928b71edd3db881f 192.168.10.133:7003
   slots:10923-16383 (5461 slots) master
M: f79802d3da6b58ef6f9f30c903db7b2f79664e61 192.168.10.133:7004
   slots: (0 slots) master
   replicates d8f6a0e3192c905f0aad411946f3ef9305350420
M: 0bc78702413eb88eb6d7982833a6e040c6af05be 192.168.10.133:7005
   slots: (0 slots) master
   replicates 7a12bc730ddc939c84a156f276c446c28acf798c
M: 4170a68ba6b7757e914056e2857bb84c5e10950e 192.168.10.133:7006
   slots: (0 slots) master
   replicates 93f73d2424a796657948c660928b71edd3db881f
[OK] All nodes agree about slots configuration.
```

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```
>>> Check for open slots...
>>> Check slots coverage...
[OK] All 16384 slots covered.
[root@localhost-0723 redis]#
```

命令客户端连接集群

命令：

```
./redis-cli -h 127.0.0.1 -p 7001 -c
```

注意：**-c** 表示是以redis集群方式进行连接

```
./redis-cli -p 7006 -c
127.0.0.1:7006> set key1 123
-> Redirected to slot [9189] located at 127.0.0.1:7002
OK
127.0.0.1:7002>
```

查看集群的命令

- 查看集群状态

```
127.0.0.1:7003> cluster info
cluster_state:ok
cluster_slots_assigned:16384
cluster_slots_ok:16384
cluster_slots_pfail:0
cluster_slots_fail:0
cluster_known_nodes:6
cluster_size:3
cluster_current_epoch:6
cluster_my_epoch:3
cluster_stats_messages_sent:926
cluster_stats_messages_received:926
```

- 查看集群中的节点：

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```
127.0.0.1:7003> cluster nodes
7a12bc730ddc939c84a156f276c446c28acf798c 127.0.0.1:7002 master - 0 1443601739754
2 connected 5461-10922
93f73d2424a796657948c660928b71edd3db881f 127.0.0.1:7003 myself,master - 0 0 3
connected 10923-16383
d8f6a0e3192c905f0aad411946f3ef9305350420 127.0.0.1:7001 master - 0 1443601741267
1 connected 0-5460
4170a68ba6b7757e914056e2857bb84c5e10950e 127.0.0.1:7006 slave
93f73d2424a796657948c660928b71edd3db881f 0 1443601739250 6 connected
f79802d3da6b58ef6f9f30c903db7b2f79664e61 127.0.0.1:7004 slave
d8f6a0e3192c905f0aad411946f3ef9305350420 0 1443601742277 4 connected
0bc78702413eb88eb6d7982833a6e040c6af05be 127.0.0.1:7005 slave
7a12bc730ddc939c84a156f276c446c28acf798c 0 1443601740259 5 connected
127.0.0.1:7003>
```

维护节点

集群创建成功后可以继续向集群中添加节点

添加主节点

- 先创建7007节点
- 添加7007结点作为新节点

  执行命令：

```
./redis-cli --cluster add-node 127.0.0.1:7007 127.0.0.1:7001
```

```
[root@server01 7007]# ./redis-trib.rb add-node  192.168.101.3:7007 192.168.101.3:7001
>>> Adding node 192.168.101.3:7007 to cluster 192.168.101.3:7001
Connecting to node 192.168.101.3:7001: OK
Connecting to node 192.168.101.3:7003: OK
Connecting to node 192.168.101.3:7006: OK
Connecting to node 192.168.101.3:7002: OK
Connecting to node 192.168.101.3:7005: OK
Connecting to node 192.168.101.3:7004: OK
>>> Performing Cluster Check (using node 192.168.101.3:7001)
M: cad9f7413ec6842c971dbcc2c48b4ca959eb5db4 192.168.101.3:7001
   slots:0-5460 (5461 slots) master
   1 additional replica(s)
M: 1a8420896c3ff60b70c716e8480de8e50749ee65 192.168.101.3:7003
   slots:10923-16383 (5461 slots) master
   1 additional replica(s)
S: 444e7bedbdfa40714ee55cd3086b8f0d5511fe54 192.168.101.3:7006
   slots: (0 slots) slave
   replicates 1a8420896c3ff60b70c716e8480de8e50749ee65
M: 4e7c2b02f0c4f4cfe306d6ad13e0cfee90bf5841 192.168.101.3:7002
   slots:5461-10922 (5462 slots) master
   1 additional replica(s)
S: d2421a820cc23e17a01b597866fd0f750b698ac5 192.168.101.3:7005
   slots: (0 slots) slave
   replicates 4e7c2b02f0c4f4cfe306d6ad13e0cfee90bf5841
S: 69d94b4963fd94f315fba2b9f12fae1278184fe8 192.168.101.3:7004
   slots: (0 slots) slave
   replicates cad9f7413ec6842c971dbcc2c48b4ca959eb5db4
[OK] All nodes agree about slots configuration.
>>> Check for open slots...
>>> Check slots coverage...
[OK] All 16384 slots covered.
Connecting to node 192.168.101.3:7007: OK
>>> Send CLUSTER MEET to node 192.168.101.3:7007 to make it join the cluster.
[OK] New node added correctly.
```

- 查看集群结点发现7007已添加到集群中

```
192.168.101.3:7005> cluster nodes
69d94b4963fd94f315fba2b9f12fae1278184fe8 192.168.101.3:7004 slave cad9f7413ec6842c971dbcc2c48b4ca959eb5db4 0 1430155626174 4 connected
444e7bedbdfa40714ee55cd3086b8f0d5511fe54 192.168.101.3:7006 slave 1a8420896c3ff60b70c716e8480de8e50749ee65 0 1430155621629 9 connected
4e7c2b02f0c4f4cfe306d6ad13e0cfee90bf5841 192.168.101.3:7002 master - 0 1430155627185 2 connected 5461-10922
d2421a820cc23e17a01b597866fd0f750b698ac5 192.168.101.3:7005 myself,slave 4e7c2b02f0c4f4cfe306d6ad13e0cfee90bf5841 0 0 5 connected
1a8420896c3ff60b70c716e8480de8e50749ee65 192.168.101.3:7003 master - 0 1430155625164 9 connected 10923-16383
15b809eadae88955e36bcdbb8144f61bbbaf38fb 192.168.101.3:7007 master - 0 1430155628700 0 connected
cad9f7413ec6842c971dbcc2c48b4ca959eb5db4 192.168.101.3:7001 master - 0 1430155628197 1 connected 0-5460
```

hash槽重新分配（数据迁移）

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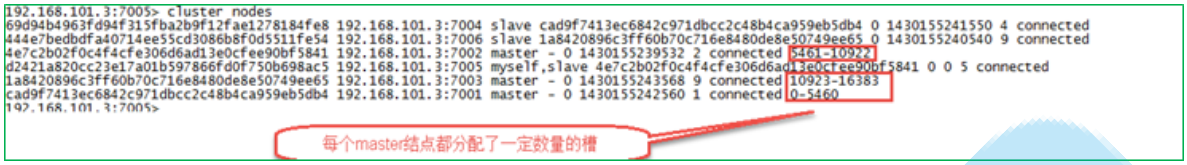
添加完主节点需要对主节点进行hash槽分配，这样该主节才可以存储数据。

- **查看集群中槽占用情况**

```
cluster nodes
```

redis集群有16384个槽，集群中的每个结点分配自已槽，通过查看集群结点可以看到槽占用情况。

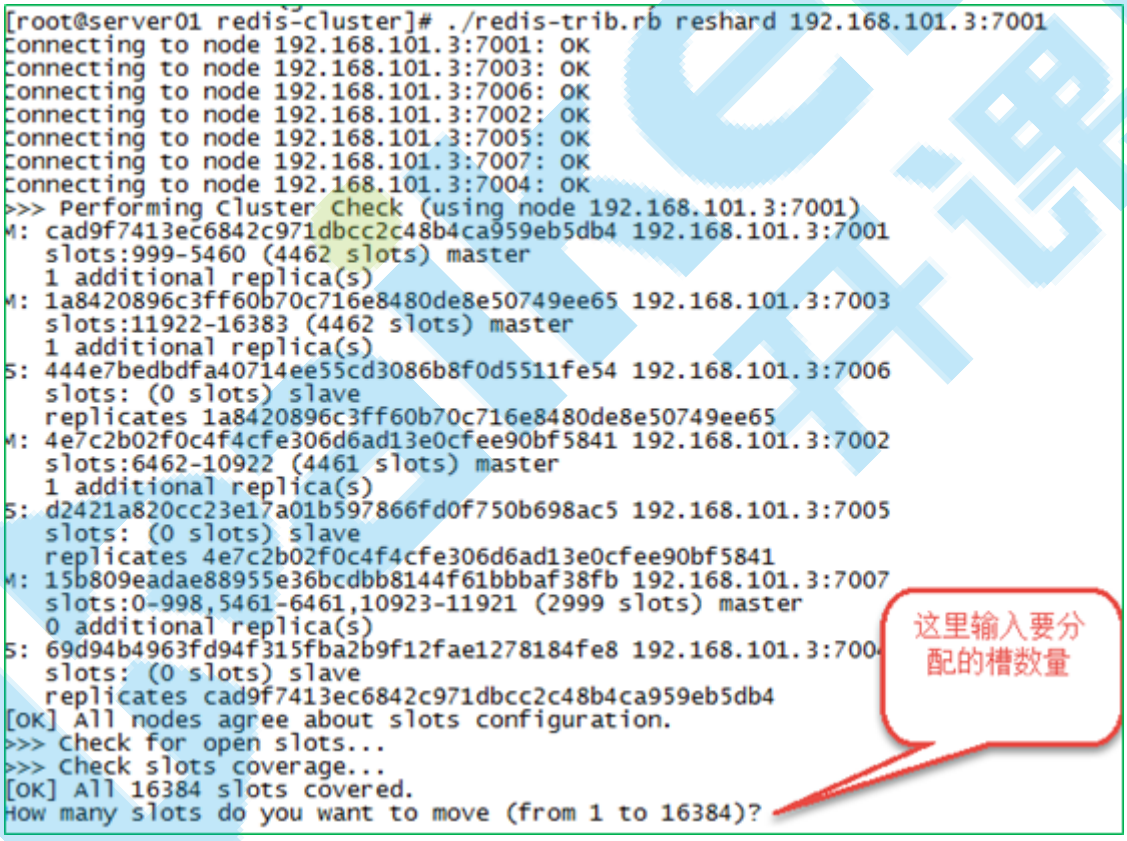


给刚添加的7007结点分配槽

- **第一步：连接上集群（连接集群中任意一个可用结点都行）**

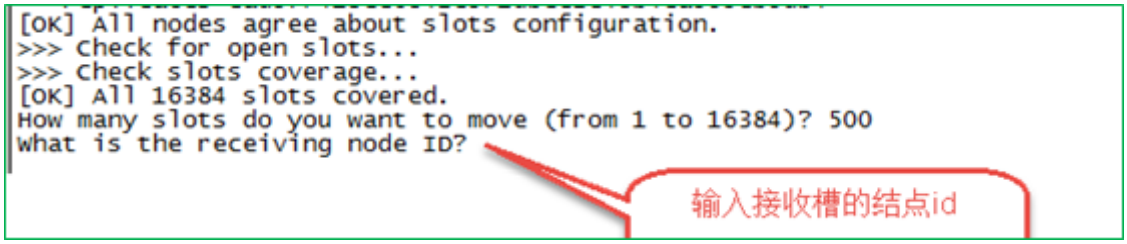
```
./redis-cli --cluster reshard 127.0.0.1:7007
```

- **第二步：输入要分配的槽数量**



输入：**3000**，表示要给目标节点分配3000个槽

- **第三步：输入接收槽的结点id**



输入：**15b809eadae88955e36bcdbb8144f61bbbaf38fb**

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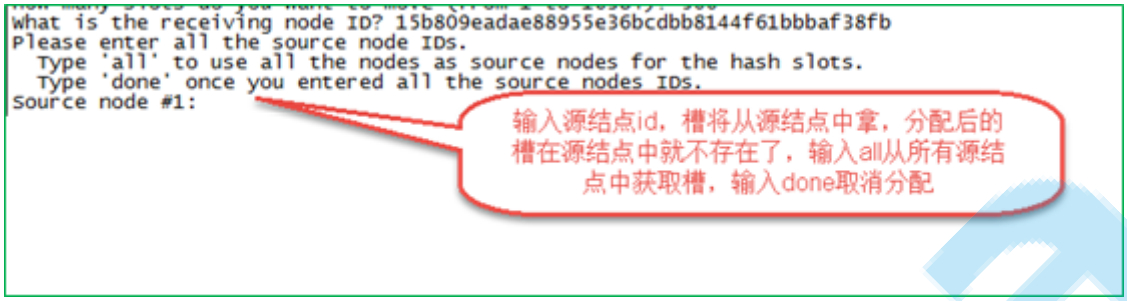
PS：这里准备给7007分配槽，通过cluster nodes查看7007结点id为：

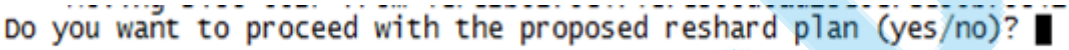
15b809eadae88955e36bcdbb8144f61bbbaf38fb

- **第四步：输入源结点id**



输入：**all**

- **第五步：输入yes开始移动槽到目标结点id**



输入：**yes**

添加从节点

- **添加7008从结点，将7008作为7007的从结点**

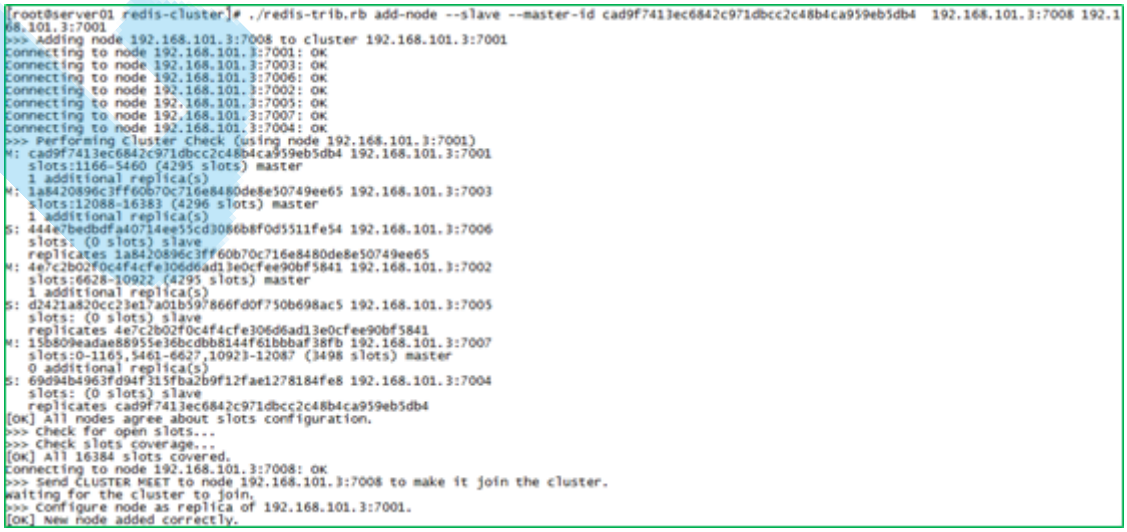
命令：

```
./redis-cli --cluster add-node 新节点的ip和端口    旧节点ip和端口 --cluster-slave --cluster-master-id 主节点id
```

例如：

```
./redis-cli --cluster add-node 127.0.0.1:7008 127.0.0.1:7007 --cluster-slave --cluster-master-id d1ba0092526cdfe66878e8879d446acfdcde25d8
```

d1ba0092526cdfe66878e8879d446acfdcde25d8是7007结点的id，可通过cluster nodes查看。



注意：如果原来该结点在集群中的配置信息已经生成到cluster-config-file指定的配置文件中（如果cluster-config-file没有指定则默认为**nodes.conf**），这时可能会报错：

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```
[ERR] Node XXXXXX is not empty. Either the node already knows other nodes (check with CLUSTER NODES) or contains some key in database 0
```

解决方法是删除生成的配置文件nodes.conf，删除后再执行./redis-trib.rb add-node指令

- **查看集群中的结点，刚添加的7008为7007的从节点：**

```
192.168.101.3:7005> cluster nodes
05dbaf8059630157c245dfe5441dbe9c26b9016d 192.168.101.3:7008 slave cad9f7413ec6842c971dbcc2c48b4ca959eb5db4 0 1430157051979 1 connected
69d94b4963fd94f315fba2b9f12fae1278184fe8 192.168.101.3:7004 slave cad9f7413ec6842c971dbcc2c48b4ca959eb5db4 0 1430157046926 4 connected
444e7bedbdfa40714ee55cd3086b8f0d5511fe54 192.168.101.3:7006 slave 1a8420896c3ff60b70c716e8480de8e50749ee65 0 1430157051878 9 connected
4e7c2b02f0c4f4cfe306d6ad13e0cfee90bf5841 192.168.101.3:7002 master - 0 1430157049956 2 connected 6628-10922
d2421a820cc23e17a01b597866fd0f750b698ac5 192.168.101.3:7005 myself,slave 4e7c2b02f0c4f4cfe306d6ad13e0cfee90bf5841 0 0 5 connected
1a8420896c3ff60b70c716e8480de8e50749ee65 192.168.101.3:7003 master - 0 1430157050968 9 connected 12088-16383
15b809eadae88955e36bcdbb8144f61bbbaf38fb 192.168.101.3:7007 master - 0 1430157052990 10 connected 0-1165 5461-6627 10923-12087
cad9f7413ec6842c971dbcc2c48b4ca959eb5db4 192.168.101.3:7001 master - 0 1430157048946 1 connected 1166-5460
```

删除结点

命令：

```
./redis-cli --cluster del-node 127.0.0.1:7008
41592e62b83a8455f07f7797f1d5c071cffedb50
```

删除已经占有hash槽的结点会失败，报错如下：

```
[ERR] Node 127.0.0.1:7005 is not empty! Reshard data away and try again.
```

需要将该结点占用的hash槽分配出去（参考hash槽重新分配章节）。

Jedis连接集群

需要开启防火墙，或者直接关闭防火墙。

```
service iptables stop
```

代码实现

创建JedisCluster类连接redis集群。

```
@Test
public void testJedisCluster() throws Exception {
    //创建一连接，JedisCluster对象,在系统中是单例存在
    Set<HostAndPort> nodes = new HashSet<>();
    nodes.add(new HostAndPort("192.168.10.133", 7001));
    nodes.add(new HostAndPort("192.168.10.133", 7002));
    nodes.add(new HostAndPort("192.168.10.133", 7003));
    nodes.add(new HostAndPort("192.168.10.133", 7004));
    nodes.add(new HostAndPort("192.168.10.133", 7005));
    nodes.add(new HostAndPort("192.168.10.133", 7006));
    JedisCluster cluster = new JedisCluster(nodes);
    //执行JedisCluster对象中的方法，方法和redis一一对应。
    cluster.set("cluster-test", "my jedis cluster test");
    String result = cluster.get("cluster-test");
    System.out.println(result);
    //程序结束时需要关闭JedisCluster对象
    cluster.close();
}
```

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使用spring

Ø 配置applicationContext.xml

```
<!-- 连接池配置 -->
<bean id="jedisPoolConfig" class="redis.clients.jedis.JedisPoolConfig">
    <!-- 最大连接数 -->
    <property name="maxTotal" value="30" />
    <!-- 最大空闲连接数 -->
    <property name="maxIdle" value="10" />
    <!-- 每次释放连接的最大数目 -->
    <property name="numTestsPerEvictionRun" value="1024" />
    <!-- 释放连接的扫描间隔（毫秒） -->
    <property name="timeBetweenEvictionRunsMillis" value="30000" />
    <!-- 连接最小空闲时间 -->
    <property name="minEvictableIdleTimeMillis" value="1800000" />
    <!-- 连接空闲多久后释放, 当空闲时间>该值 且 空闲连接>最大空闲连接数 时直接释放 -->
    <property name="softMinEvictableIdleTimeMillis" value="10000" />
    <!-- 获取连接时的最大等待毫秒数,小于零:阻塞不确定的时间,默认-1 -->
    <property name="maxWaitMillis" value="1500" />
    <!-- 在获取连接的时候检查有效性, 默认false -->
    <property name="testOnBorrow" value="true" />
    <!-- 在空闲时检查有效性, 默认false -->
    <property name="testWhileIdle" value="true" />
    <!-- 连接耗尽时是否阻塞, false报异常,ture阻塞直到超时, 默认true -->
    <property name="blockWhenExhausted" value="false" />
</bean>
<!-- redis集群 -->
<bean id="jedisCluster" class="redis.clients.jedis.JedisCluster">
    <constructor-arg index="0">
        <set>
            <bean class="redis.clients.jedis.HostAndPort">
                <constructor-arg index="0" value="192.168.101.3"></constructor-
arg>
                <constructor-arg index="1" value="7001"></constructor-arg>
            </bean>
            <bean class="redis.clients.jedis.HostAndPort">
                <constructor-arg index="0" value="192.168.101.3"></constructor-
arg>
                <constructor-arg index="1" value="7002"></constructor-arg>
            </bean>
            <bean class="redis.clients.jedis.HostAndPort">
                <constructor-arg index="0" value="192.168.101.3"></constructor-
arg>
                <constructor-arg index="1" value="7003"></constructor-arg>
            </bean>
            <bean class="redis.clients.jedis.HostAndPort">
                <constructor-arg index="0" value="192.168.101.3"></constructor-
arg>
                <constructor-arg index="1" value="7004"></constructor-arg>
            </bean>
            <bean class="redis.clients.jedis.HostAndPort">
                <constructor-arg index="0" value="192.168.101.3"></constructor-
arg>
                <constructor-arg index="1" value="7005"></constructor-arg>
```

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```
            </bean>
            <bean class="redis.clients.jedis.HostAndPort">
                <constructor-arg index="0" value="192.168.101.3"></constructor-
arg>
                <constructor-arg index="1" value="7006"></constructor-arg>
            </bean>
        </set>
    </constructor-arg>
    <constructor-arg index="1" ref="jedisPoolConfig"></constructor-arg>
</bean>
```

Ø 测试代码

```
private ApplicationContext applicationContext;
    @Before
    public void init() {
        applicationContext = new ClassPathXmlApplicationContext(
                "classpath:applicationContext.xml");
    }

    // redis集群
    @Test
    public void testJedisCluster() {
        JedisCluster jedisCluster = (JedisCluster) applicationContext
                .getBean("jedisCluster");

        jedisCluster.set("name", "zhangsan");
        String value = jedisCluster.get("name");
        System.out.println(value);
    }
```

Redis和lua整合

什么是lua

Redis中使用lua的好处

lua的安装（了解）

lua常见语法（了解）

Redis整合lua脚本

EVAL命令

lua脚本中调用Redis命令

EVALSHA

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SCRIPT命令

redis-cli --eval

Redis消息模式

Redis实现分布式锁

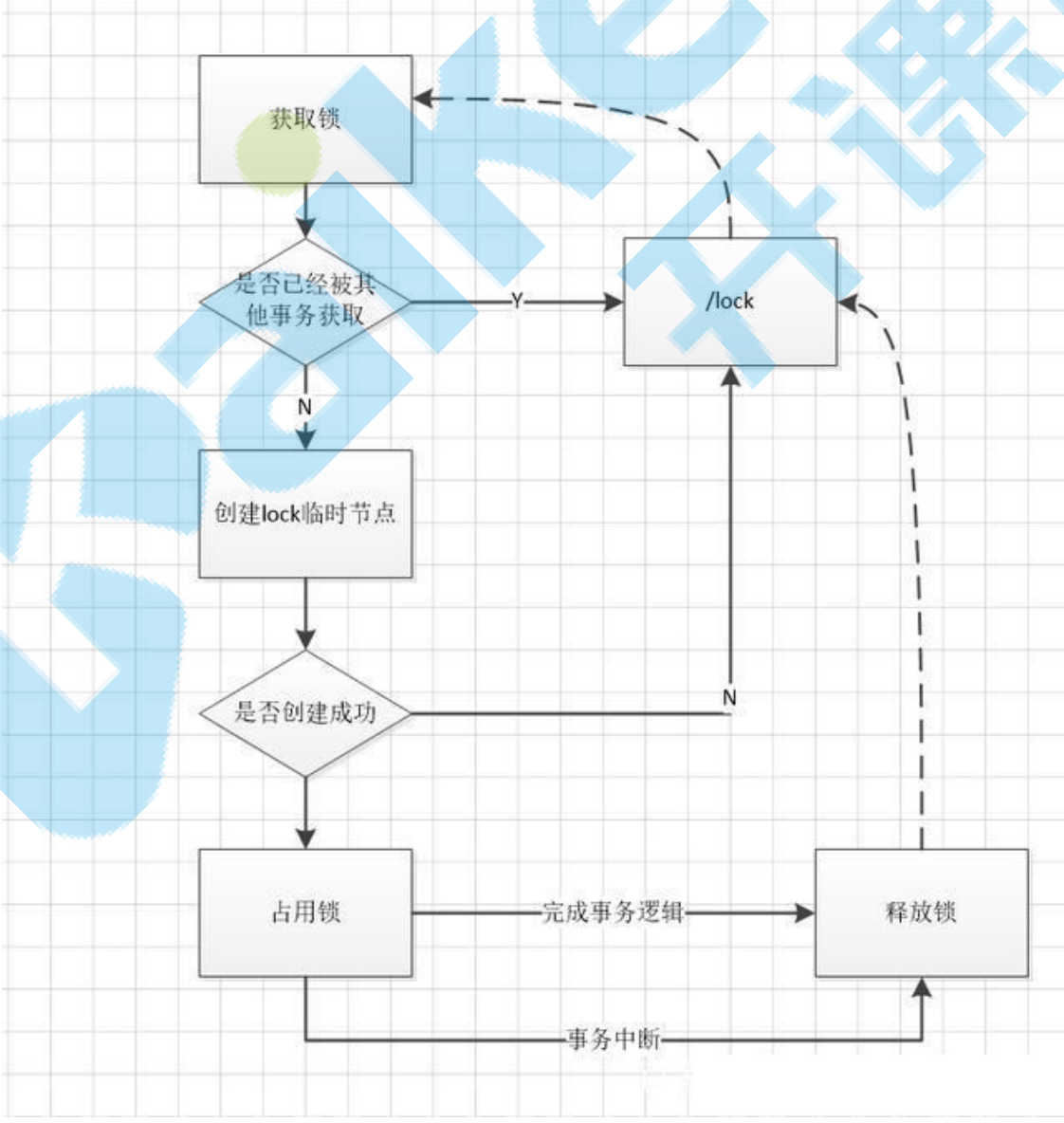
锁的处理

单应用中使用锁：（单进程多线程）

分布式应用中使用锁：（多进程多线程）

分布式锁的实现方式

- 基于数据库的乐观锁实现分布式锁
- 基于`zookeeper`临时节点的分布式锁



- 基于`Redis`的分布式锁

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实现分布式锁

获取锁

方式1（**使用set命令实现**）--推荐

方式2（**使用setnx命令实现**） -- 并发会产生问题

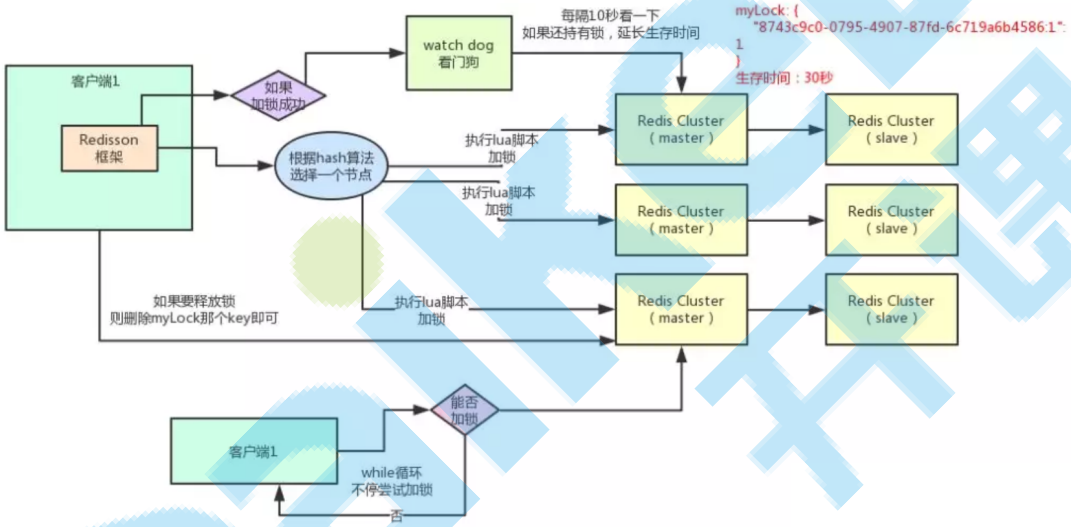
释放锁

方式1（del命令实现）

方式2（**redis+lua脚本实现**）--推荐

生产环境中的分布式锁

落地生产环境用分布式锁，一般采用开源框架，比如Redisson。下面来讲一下Redisson对Redis分布式锁的实现原理。



常见缓存问题

缓存穿透

一般的缓存系统，都是按照key去缓存查询，如果不存在对应的value，就应该去后端系统查找（比如DB）。如果key对应的value是一定不存在的，并且对该key并发请求量很大，就会对后端系统造成很大的压力。

也就是说，对不存在的key进行高并发访问，导致数据库压力瞬间增大，这就叫做【缓存穿透】。

缓存雪崩

当缓存服务器重启或者大量缓存集中在某一个时间段失效，这样在失效的时候，也会给后端系统(比如DB)带来很大压力。

缓存击穿

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对于一些设置了过期时间的key，如果这些key可能会在某些时间点被超高并发地访问，是一种非常“热点”的数据。这个时候，需要考虑一个问题：缓存被“击穿”的问题，这个和缓存雪崩的区别在于这里针对某一key缓存，前者则是很多key。

缓存在某个时间点过期的时候，恰好在这个时间点对这个Key有大量的并发请求过来，这些请求发现缓存过期一般都会从后端DB加载数据并回设到缓存，这个时候大并发的请求可能会瞬间把后端DB压垮。

缓存双写一致性

先更新数据库再更新缓存(不建议使用)

先更新数据库再删除缓存

先删除缓存再更新数据库

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