容器集群管理云平台

Cluster as a service

由美国Google+AWS原生容器集群cluster management团队打造

Kubernetes Master High Availability 高级实践

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About Me

- Current：杭州才云科技 云开源高级工程师
- 曾华为工作5年:
    1. linux内核相关的研发 – 2年
    2. 众核OS、LibOS的相关研发 – 2年
    3. 容器相关研发 – 1年

Goals

1. 从Kubernetes架构设计看高可用
2. 社区高可用版本演进
3. HA Master整体架构
4. 核心技术点和难点
5. 实践中的遇到的那些坑
6. 社区关于HA Master的未来发展

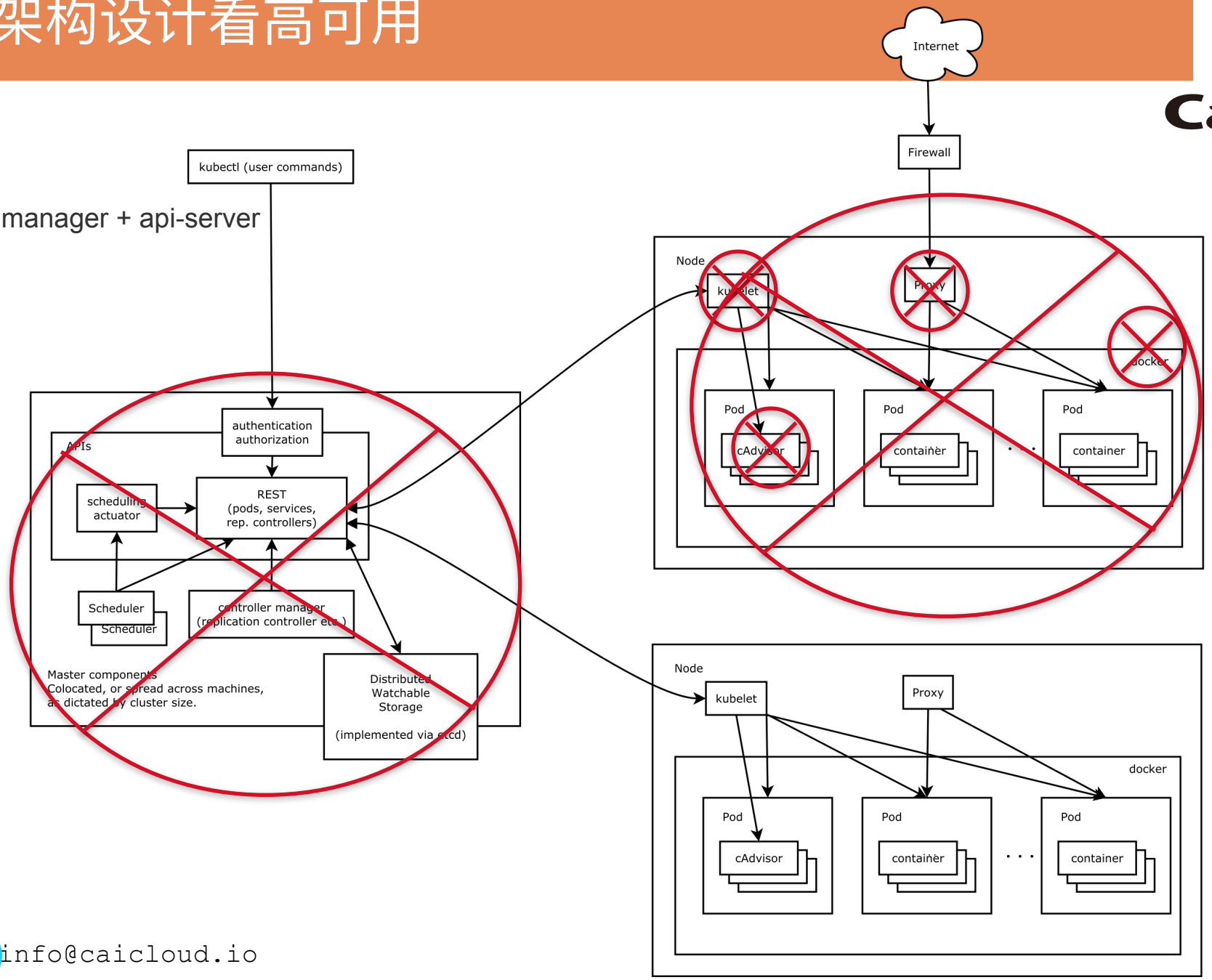
从Kubernetes架构设计看高可用

Node：kubelet + kube-proxy

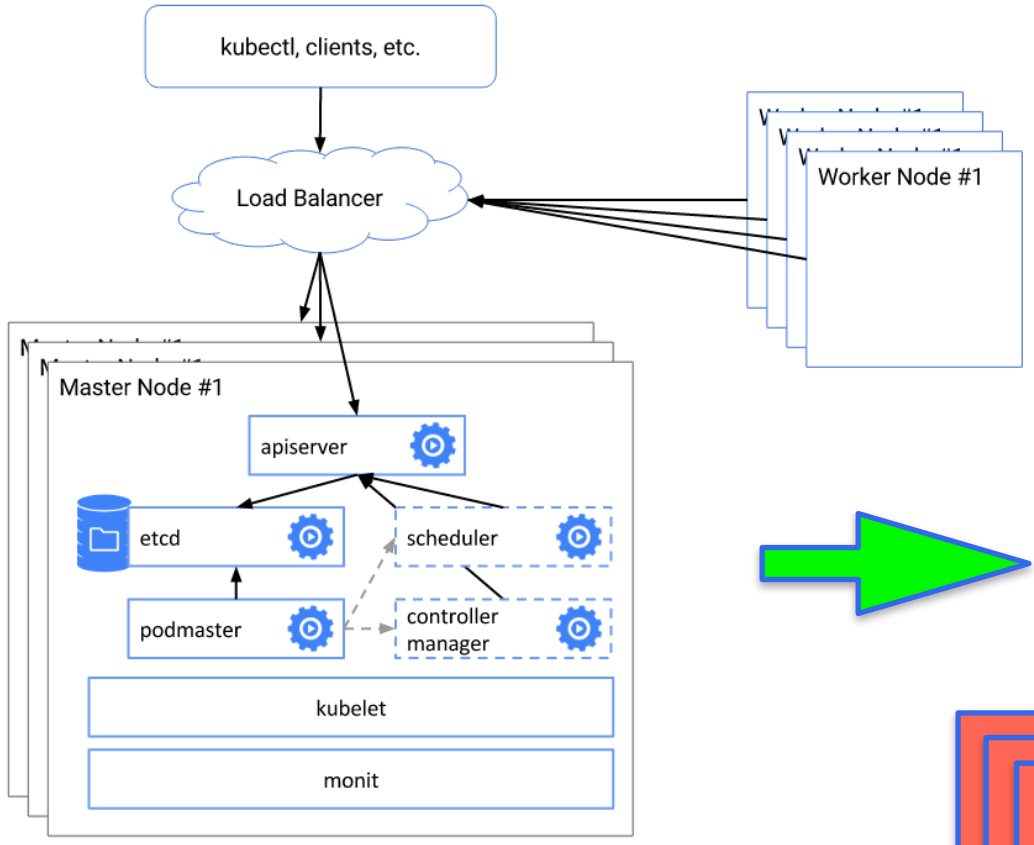
Master：scheduler + controller manager + api-server

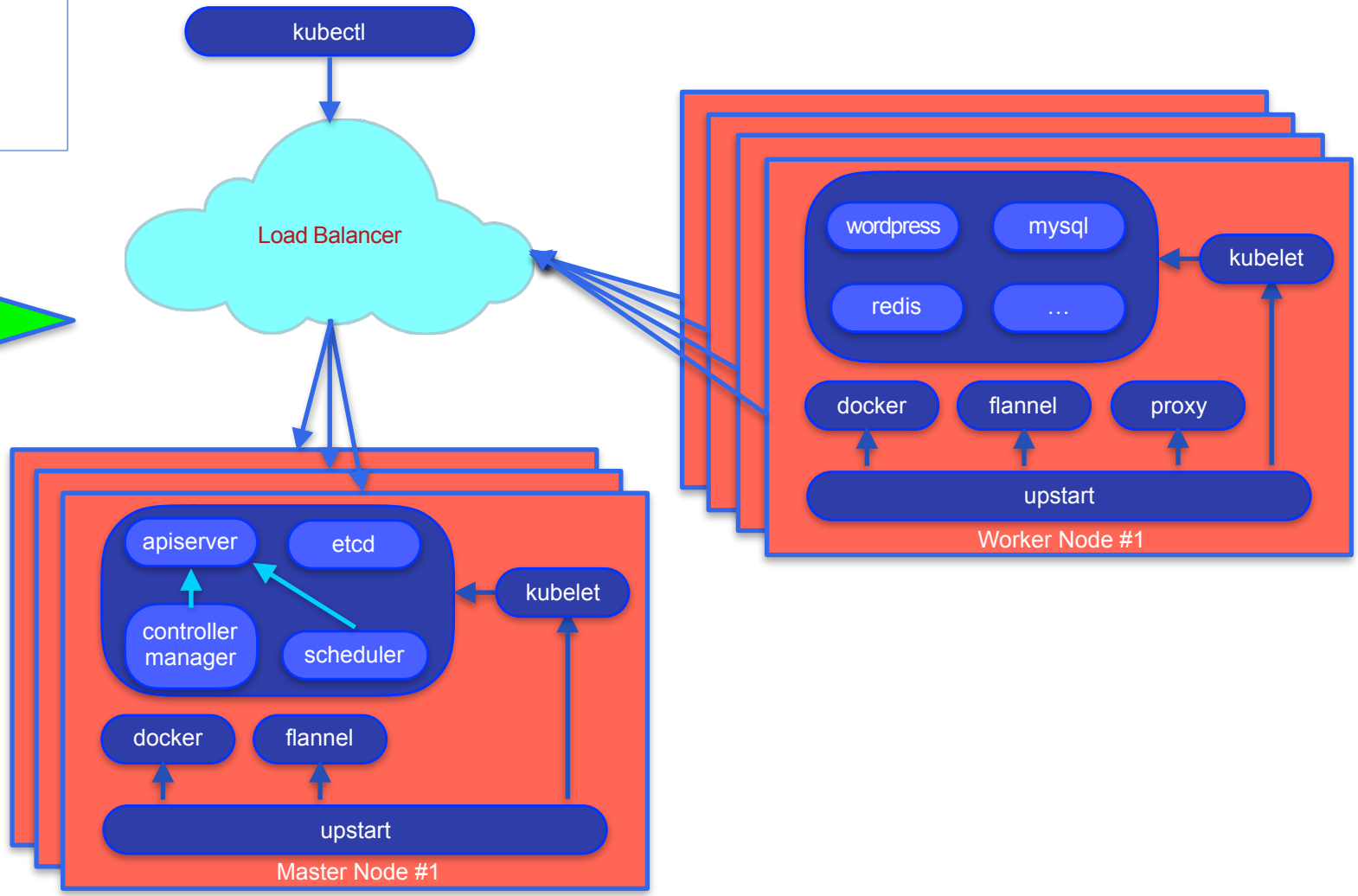
Etcd: 持久化存储

1. Pod不可用?
   RC, Scheduler
2. Node节点不可用?
   多Node节点
3. Kubelet, Proxy, Flannel, Docker不可用?
   进程监控程序
   容器化
4. Master不可用?
   多Master节点
   Master组件多副本
   Master组件容器化
   Etcd集群



社区高可用版本演进





优点

1. podmaster作为公共库
2. 减少静态pod和etc访问
3. self-hosted

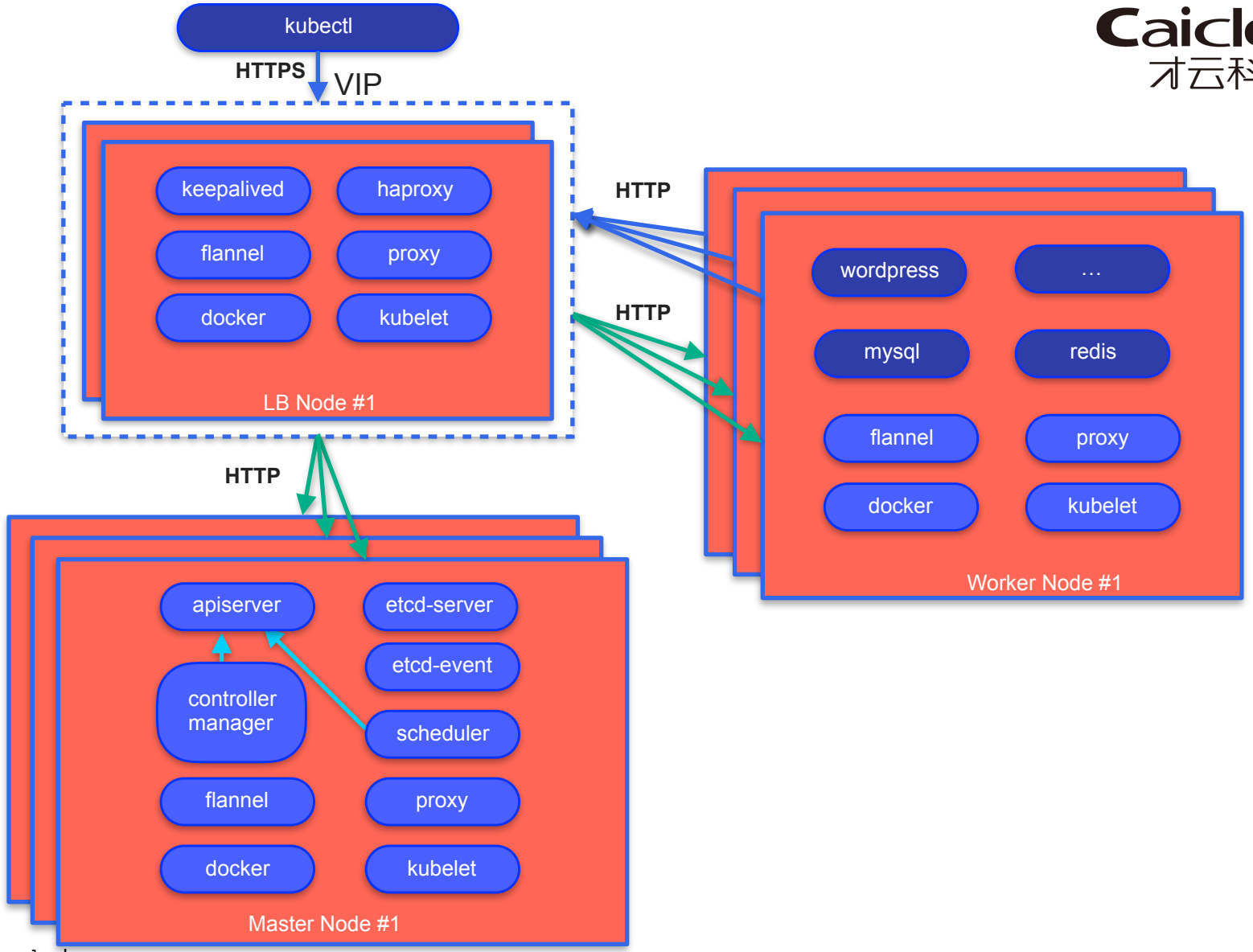
HA Master整体架构（一）

HOST	IP ADDRESS	Components
lb-1	192.168.205.252	kubelet, haproxy, keepalived, flannel
lb-2	192.168.205.253	kubelet, haproxy, keepalived, flannel
master-1	192.168.205.11	kubelet, apiserver, controller manager, scheduler, kubeproxy, etcd, flannel
master-2	192.168.205.12	kubelet, apiserver, controller manager, scheduler, kubeproxy, etcd, flannel
master-3	192.168.205.13	kubelet, apiserver, controller manager, scheduler, kubeproxy, etcd, flannel
node-1	192.168.205.21	kubelet, kubeproxy, flannel
node-2	192.168.205.22	kubelet, kubeproxy, flannel
node-3	192.168.205.23	kubelet, kubeproxy, flannel

VIP：192.168.205.254

HA Master整体架构（二）

1. HA Master 组件进程形式部署
   - 可靠性保证：monit, upstart, systemd
   - 组件间依赖：调整进程启动顺序
2. 全容器形式部署
   - 可靠性保证：监控程序保证kubelet服务，kubelet保证static pod高可用
   - 组件间依赖：调整pod启动顺序



核心技术点和难点 （一：启动顺序）

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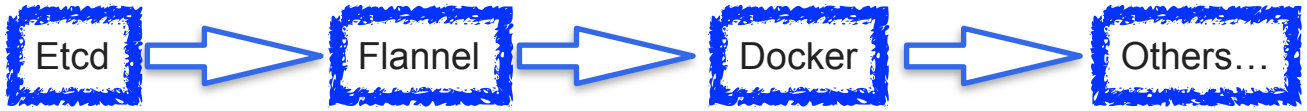
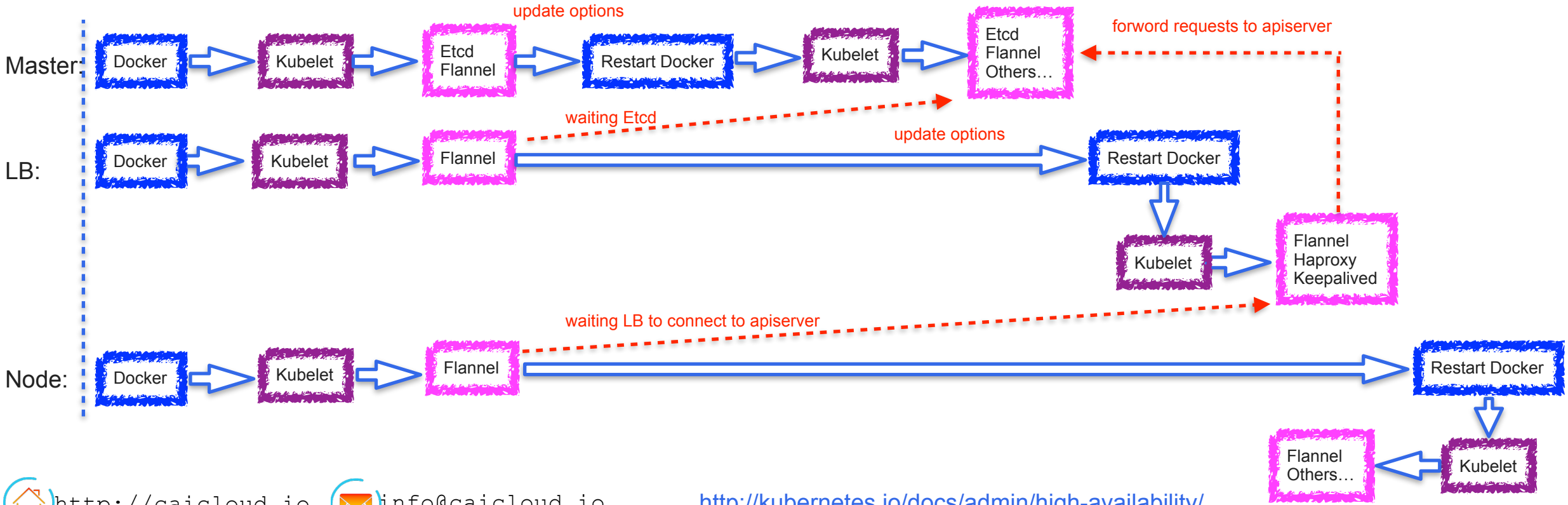
1. 进程形式



1. 全容器形式



http://kubernetes.io/docs/admin/high-availability/

核心技术点和难点（二：运行在特权模式的组件）

1. 开启Kubernetes集群的特权模式权限

```
--allow-privileged=true
```

A. Kubelet

- 允许docker容器向kubelet请求以特权模式运行

B. Apiserver

- 允许docker容器能够访问apiserver

2. 运行在特权模式下的docker容器

```
securityContext:
    privileged: true
```

A. Kubeproxy static pod

- 通过Iptables设置防火墙规则

B. Flannel static pod

- 访问vxlan、openvswitch等路由数据报文

A. Keepalived static pod

- 访问IP_VS内核模块来建立VIP

核心技术点和难点（三：组件pod必须运行在主机网络）

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- 以static pod形式存在的Kubernetes集群组件必须运行在主机网络下：

  hostNetwork: true

  理由：

  A. 心跳和信息交流通过它们配置文件中的静态IP地址进行

  flannel提供动态网络

  B. kubeproxy、flannel、haproxy需要通过主机网络修改路由规则

  C. haproxy需要将外网请求重定向到内网后端服务器上

核心技术点和难点（四：External Loadbalancer部署）

- 通过haproxy和keepalived pod实现Master的负载均衡，对外提供统一的VIP
- haproxy和keepalived可以放在同一个pod
  - 普通进程形式：killall -0 haproxy
  - 容器模式：通过haproxy的健康检查页面监控状态
- haproxy SSL配置
  - haproxy本身只提供代理：仅支持4层代理
  - haproxy实现SSL Termination proxy

实践中的遇到的那些坑（官网Haproxy镜像的坑）

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- “haproxy image”的“docker-entrypoint.sh”：

```
#!/bin/sh
set -e

# first arg is `-f` or `--some-option`
if [ "${1#-}" != "$1" ]; then
    set -- haproxy "$@"
fi

if [ "$1" = 'haproxy' ]; then
    # if the user wants "haproxy", let's use "haproxy-systemd-wrapper"
    # instead so we can have proper reloadability implemented by upstream
    shift # "haproxy"
    set -- "$(which haproxy-systemd-wrapper)" -p /run/haproxy.pid "$@"
fi

exec "$@"
```

```
-Ds passe en daemon systemd
 This patch adds a new option "-Ds" which is exactly like "-D", but instead of
 forking n times to get n jobs running and then exiting, prefers to wait for all the
 children it just created. With this done, haproxy becomes more systemd-compliant,
 without changing anything for other systems.
```

```
containers:
  - name: lb-haproxy
    image: index.caicloud.io/caicloud/haproxy:v1.6.5
    command:
    - haproxy                    /usr/local/sbin/haproxy
    - -f
    - /etc/haproxy/haproxy.cfg
    - -p
    - /run/haproxy.pid
  - name: lb-keepalived
    image: index.caicloud.io/caicloud/keepalived:v1.2.19
    command:
    - keepalived
    - --log-console
    - --dont-fork
    - -f
    - /etc/keepalived/keepalived.conf
```

社区关于HA Master的未来发展（一）

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- —api-servers配置
  - kubelet配置apiserver，通过“—api-servers”指定多个：—api-servers=http://m1b:8080,http://m1c:8080,http://m2a:8080,http://m2b:8080,http://m2c:8080，但是只有第一个起作用
- —master配置
  - controller manager和scheduler：只能通过“—master”配置一个apiserver，无法支持多个apiserver

- 参考链接：

A. https://github.com/kubernetes/kubernetes/issues/26852

B. https://github.com/kubernetes/kubernetes/pull/25428

社区关于HA Master的未来发展（二）

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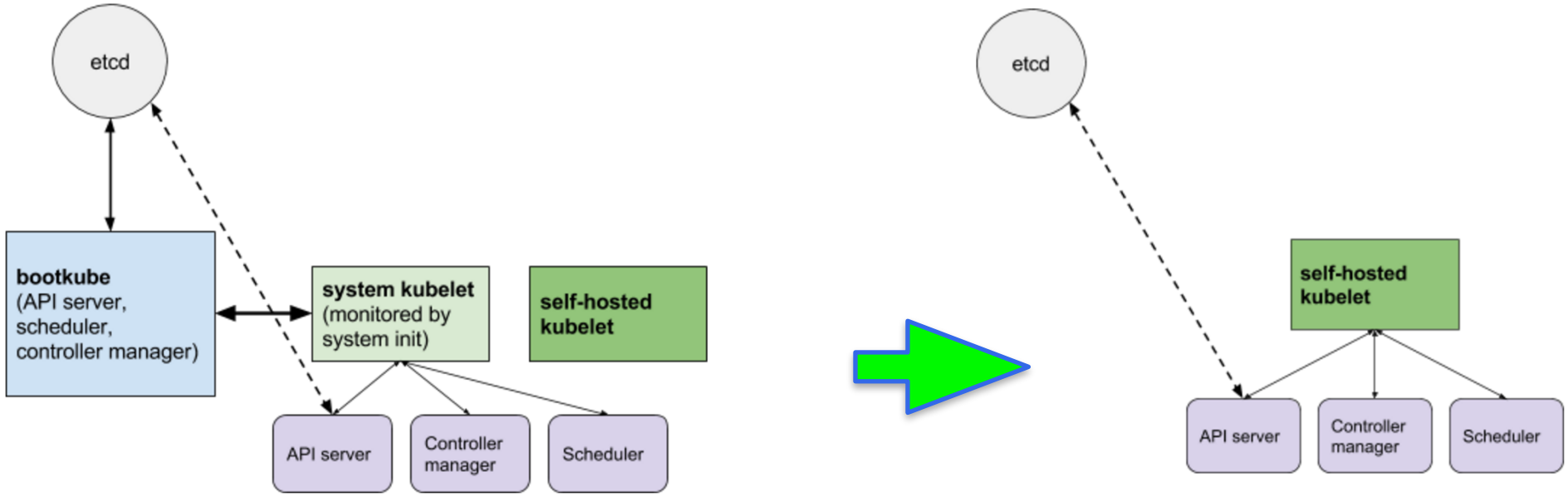
- self-hosted install/update design with bootkube
  - self-hosted：runs all required and optional components of a Kubernetes cluster on top of Kubernetes itself.



- 参考链接：

A. https://docs.google.com/document/d/1VNp4CMjPPHevh2_JQGMl-hpz9JSLq3s7HlI87CTjl-8/edit

B. https://groups.google.com/forum/#!topic/kubernetes-sig-cluster-ops/li_brwXYeCI

C. https://github.com/philips/kubernetes/blob/ebcde947994e85488f1511dfcae0295e2a6bd67e/docs/proposals/self-hosted-kubelet.md#proposal

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DBAplus线上分享实录 | Kubernetes Master High Availability 高级实践

原创 2016-06-29 才云 唐继元 Caicloud

才云科技云开源高级工程师唐继元受邀DBAplus社群，在线分享《Kubernetes Master High Availability 高级实践》，介绍如何构建Kubernetes Master High Availability环境。

http://mp.weixin.qq.com/s?__biz=MzIzMzExNDQ3MA==&mid=2650091772&idx=1&sn=727c986f602e4de6ad6a2cf66a45aa89#rd

Kubernetes高级实践：Master高可用方案设计和踩过的那些坑

唐继元 2016年06月30日

HA Master的整体架构、技术难点和实践遇到的坑，以及社区对HA Master的企望。

http://dbaplus.cn/news-21-499-1.html

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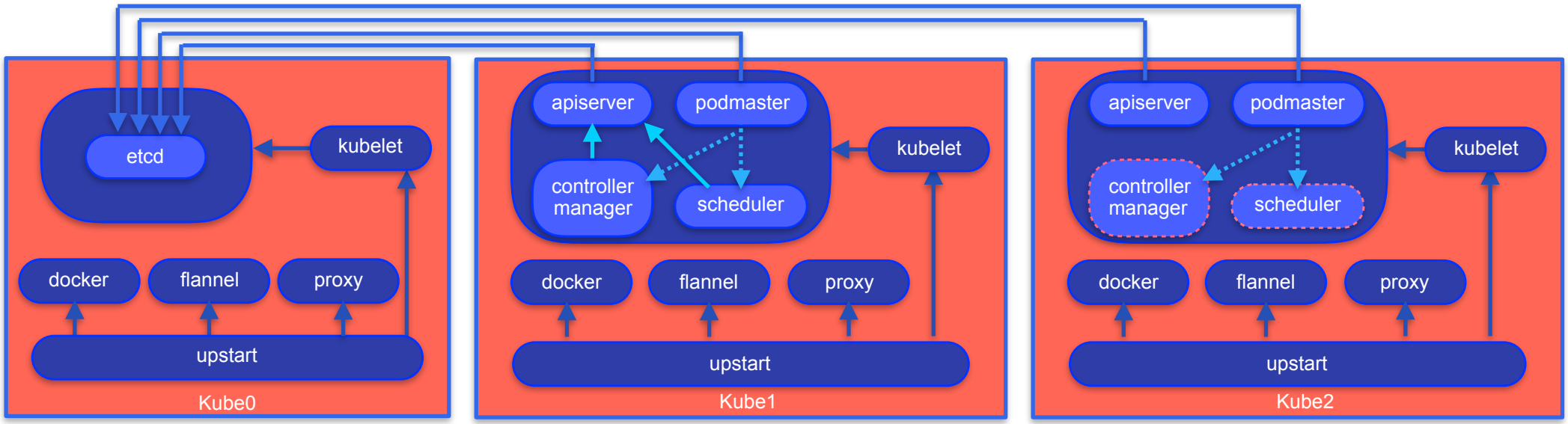
Thank you!

http://caicloud.io info@caicloud.io

Kubernetes High Availability V1




```
func (c *config) leaseAndUpdateLoop(etcdClient *etcd.Client) {
  for {
    master, err := c.acquireOrRenewLease(etcdClient)
    c.update(master);
    time.Sleep(c.sleep)
  }
}

func (c *config) update(master bool) error {
  switch {
  case master && !exists:
    return copyFile(c.src, c.dest)
  case master && exists && sum(c.src) != sum(c.dest):
    return copyFile(c.src, c.dest)
  case !master && exists:
    return os.Remove(c.dest)
  }
}

func main() {
  etcdClient, err := etcd.New(cfg)
  leaseAndUpdateLoop(&etcdClient)
}
```

分析

1. apiserver多副本? stateless
2. scheduler多副本? only one is active
   controller manager多副本? only one is active

优点

1. Master三大组件高可用
2. 容器化

缺点

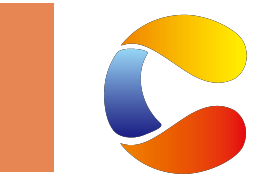
1. Etcd 单点
2. Podcaster 开销

```
"containers":[
    {
    "name": "scheduler-elector",
    "image": "gcr.io/google_containers/podmaster:1.1",
    "command": [
                "/podmaster",
                "--etcd-servers=http://127.0.0.1:4001",
                "--key=scheduler",
                "--source-file=/kubernetes/kube-scheduler.manifest",
                "--dest-file=/manifests/kube-scheduler.manifest"
              ],
    ...
    },
    {
    "name": "controller-manager-elector",
    "image": "gcr.io/google_containers/podmaster:1.1",
    "command": [
                "/podmaster",
                "--etcd-servers=http://127.0.0.1:4001",
                "--key=controller",
                "--source-file=/kubernetes/kube-controller-manager.manifest",
                "--dest-file=/manifests/kube-controller-manager.manifest"
              ],
    ...
    }
],
```

https://github.com/kubernetes/contrib/tree/master/pod-master

https://github.com/kubernetes/kubernetes/tree/release-1.1/examples/high-availability

Kube-controller-managerment self-hosted 源码分析



/* cmd/kube-controller-manager/app/controllermanager.go */

```
// Run runs the CMServer.  This should never exit.
func Run(s *options.CMServer) error {
    ...
    run := func(stop <-chan struct{}) {
        err := StartControllers(s, kubeClient, kubeconfig, stop)
        glog.Fatalf("error running controllers: %v", err)
        panic("unreachable")
    }
    // --leader-elect选项未配置则直接启动controllers
    if !s.LeaderElection.LeaderElect {
        run(nil)
        panic("unreachable")
    }
    // 否则进入选举流程
    // 参与选举
    leaderelection.RunOrDie(leaderelection.LeaderElectionConfig{
        EndpointsMeta: api.ObjectMeta{
            Namespace: "kube-system",
            Name:      "kube-controller-manager",
        },
        Client:        kubeClient,
        Identity:      id,
        EventRecorder: recorder,
        LeaseDuration: s.LeaderElection.LeaseDuration.Duration,
        RenewDeadline: s.LeaderElection.RenewDeadline.Duration,
        RetryPeriod:   s.LeaderElection.RetryPeriod.Duration,
        Callbacks: leaderelection.LeaderCallbacks{
            OnStartedLeading: run,  // 选举成功，启动controllers
            OnStoppedLeading: func() {  // 选举失败
                glog.Fatalf("leaderelection lost")
            },
        },
    })
    panic("unreachable")
}
```

/* pkg/client/leaderelection/leaderelection.go */

```
// RunOrDie starts a client with the provided config
// or panics if the config
// fails to validate.
func RunOrDie(lec LeaderElectionConfig) {
    le, err := NewLeaderElector(lec)
    if err != nil {
        panic(err)
    }
    le.Run() // 选举过程
}

// Run starts the leader election loop
func (le *LeaderElector) Run() {
    defer func() {
        runtime.HandleCrash()
        le.config.Callbacks.OnStoppedLeading()
    }()

    // 周期性 acquire leader lease，直到 get it successfully
    le.acquire()
    // 获取到 a leader lease 后启动 controllers
    stop := make(chan struct{})
    go le.config.Callbacks.OnStartedLeading(stop)
    // 周期性的 renew leader lease
    // 除非 failed to renew leader lease
    le.renew()
    close(stop)
}
```

Caicloud Kubernetes High Availability版本一

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LB特点

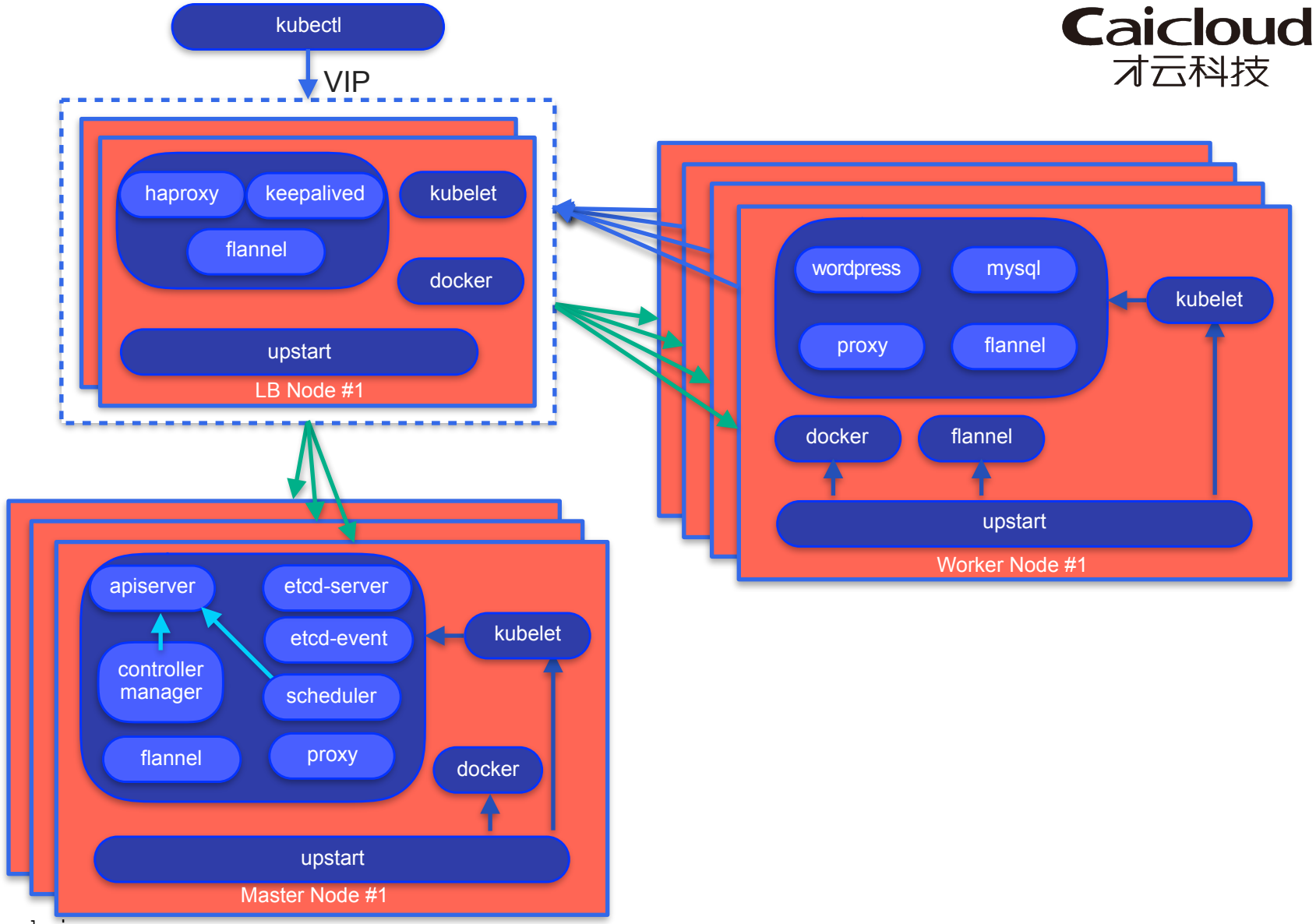
1. 支持HA MASTER
2. K8S集群组件容器化，可移植性高
3. 统一访问入口
4. 支持NodePort的负载均衡
5. 容器化

KeepAlived

1. 保障Haproxy的高可用
2. 提供VIP

Haproxy

1. 提供基于TCP和HTTP应用的代理
2. IP, Session亲和性
3. 基于pod livenessProbe的健康检查



Load Balancing

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Internal

- Kube-proxy

External

- NodePort
- LoadBalancer
- External IPs
- Ingress