Part 4 - Kubernetes Real-Time Troubleshooting

Introduction 🌐

Welcome to the world of Kubernetes troubleshooting, where every challenge is an opportunity to sharpen your skills and emerge victorious. Join us as we embark on a journey through common real-time scenarios, unraveling mysteries, and uncovering solutions along the way.

Scenario 16: Pod Resource Starvation

```
Status:       Running
IP:           192.168.12.38
IPs:
  IP:           192.168.12.38
Controlled By:  ReplicaSet/atomicred-5cbfbdd9df
Containers:
  atomicred:
    Container ID:  containerd://035b87381e2a06ff03372ae44b7502fcd85cab37b91080612e7a009ffb2646f6
    Image:         issif/atomic-red:latest
    Image ID:      docker.io/issif/atomic-red@sha256:ad7a8166114f1c41dfd92f5b11fadb85605de02b86d73a5c9e3c13c5e2f1e493
    Port:          <none>
    Host Port:     <none>
    Command:
      sleep
      3560d
    State:          Running
      Started:      Fri, 19 Jan 2024 17:17:58 +0000
    Ready:          True
    Restart Count:  0
    Limits:
      cpu:     500m
      memory:  128Mi
    Requests:
      cpu:        250m
      memory:     64Mi
    Environment:  <none>
```

FOLLOW – Prasad Suman Mohan (for more updates)

Symptoms: Pods experience performance degradation or fail due to resource starvation, such as CPU or memory exhaustion.

Diagnosis: Monitor pod resource usage (`kubectl top pod`) and review resource requests and limits (`kubectl describe pod <pod_name>`) for any mismatches or overcommitments.

Solution:

1. Adjust resource requests and limits for pods based on observed usage patterns and performance requirements.
2. Implement Horizontal Pod Autoscaling (HPA) to dynamically adjust pod replicas based on resource utilization metrics.
3. Use Kubernetes resource quotas and limits to enforce resource allocation boundaries and prevent resource contention.
4. Optimize container resource usage by identifying and mitigating memory leaks, CPU-intensive processes, or inefficient application code.

Scenario 17: Container Image Pull Failures – n/w issues

```
root@kubernet-1:~# kubectl get pods -n kubeflow
NAME                                                READY     STATUS             RESTARTS   AGE
ambassador-7f7646f648-2q4vv                         3/3       Running            0          1d
ambassador-7f7646f648-9g656                         3/3       Running            0          1d
ambassador-7f7646f648-9j29n                         3/3       Running            0          1d
argo-ui-74c857b6b5-5hfp9                            1/1       Running            0          1d
centraldashboard-fd4f5c56c-w6mhm                    0/1       ImagePullBackOff   0          1d
modeldb-backend-64ff8bc7cd-449hr                    0/1       ImagePullBackOff   0          1d
modeldb-db-6c9bc58dc-bxwzg                          1/1       Running            0          1d
modeldb-frontend-cfdc9d6df-6t2bl                    0/1       ImagePullBackOff   0          1d
spartakus-volunteer-c56b8576c-9mw6l                 0/1       ImagePullBackOff   0          1d
studyjob-controller-6f57f669f5-zd4k4                0/1       CrashLoopBackOff   471        1d
tf-hub-0                                            0/1       ImagePullBackOff   0          1d
tf-job-dashboard-7cc898fbcc-kck5z                   0/1       ErrImagePull       0          1d
tf-job-operator-v1alpha2-69ccc996bc-646q4           0/1       ErrImagePull       0          1d
vizier-core-65574878f9-qwqfd                        0/1       ImagePullBackOff   0          1d
vizier-db-5bbf77b76f-q6mxf                          0/1       Pending            0          1d
vizier-suggestion-bayesianoptimization-5bcf5598bc-f8d84   0/1       ImagePullBackOff   0          1d
vizier-suggestion-grid-7f9df8d567-vjgvt             0/1       ImagePullBackOff   0          1d
vizier-suggestion-hyperband-769564d755-vw9gh        0/1       ImagePullBackOff   0          1d
vizier-suggestion-random-76fdfdb5b7-g6mnd           0/1       ImagePullBackOff   0          1d
workflow-controller-657666fd66-djhwg                1/1       Running            0          1d
```

Symptoms: Pods fail to start or remain in a pending state due to failures in pulling container images from the registry, resulting in image pull errors due to lack of network connectivity.

Diagnosis: Check pod events (`kubectl describe pod <pod_name>`) and container logs (`kubectl logs <pod_name> -c <container_name>`) for any image pull errors or connectivity issues.

Solution:

1. Verify network connectivity from the Kubernetes cluster to the container registry, ensuring firewall rules and network policies allow outbound traffic.
2. Check authentication credentials (e.g., Docker credentials, service account tokens) used to authenticate with the container registry and ensure they are valid and up-to-date.

3. Monitor container image pull latency and registry availability metrics to identify potential bottlenecks or performance issues.
4. Use local image caching or a private image registry within the Kubernetes cluster to reduce reliance on external registries and improve image pull performance and reliability.

Scenario 18: Node Disk Pressure and Eviction

Symptoms: Nodes experience disk pressure conditions, leading to pod evictions and disruptions in workload availability.

Diagnosis: Monitor node disk usage (`kubectl describe node <node_name>`) and inspect system logs (`journalctl -u kubelet`) for disk-related errors or warnings.

```
vents:
Type     Reason                   Age                From               Message
----     ------                   ----               ----               -------
Warning  FreeDiskSpaceFailed      33m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4337165926 bytes, but freed 0 bytes
Normal   NodeHasNoDiskPressure    31m (x4 over 4d)   kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeHasNoDiskPressure
Warning  ImageGCFailed            28m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4340938342 bytes, but freed 0 bytes
Warning  FreeDiskSpaceFailed      28m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4340938342 bytes, but freed 0 bytes
Warning  ImageGCFailed            23m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4342310502 bytes, but freed 0 bytes
Warning  FreeDiskSpaceFailed      23m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4342310502 bytes, but freed 0 bytes
Warning  ImageGCFailed            18m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4351325798 bytes, but freed 0 bytes
Warning  FreeDiskSpaceFailed      18m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4351325798 bytes, but freed 0 bytes
Warning  FreeDiskSpaceFailed      13m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4353996390 bytes, but freed 0 bytes
Warning  ImageGCFailed            13m                kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4353996390 bytes, but freed 0 bytes
Warning  FreeDiskSpaceFailed      8m                 kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4356044390 bytes, but freed 0 bytes
Warning  ImageGCFailed            8m                 kubelet, vgqengapps01  failed to garbage collect required amount of images. Wanted to free 4356044390 bytes, but freed 0 bytes
Normal   NodeHasDiskPressure       1m (x3 over 4d)    kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeHasDiskPressure
Warning  CheckLimitsForResolvConf  1m (x1159 over 4d) kubelet, vgqengapps01  Resolv.conf file '/etc/resolv.conf' contains search line consisting of more than 3 domains!
Warning  EvictionThresholdMet      1m (x12 over 4d)   kubelet, vgqengapps01  Attempting to reclaim ephemeral-storage
Normal   NodeHasSufficientMemory   1m                 kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeHasSufficientMemory
Normal   NodeHasSufficientDisk     1m                 kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeHasSufficientDisk
Normal   Starting                  1m                 kubelet, vgqengapps01  Starting kubelet.
Normal   NodeHasNoDiskPressure     1m (x2 over 1m)    kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeHasNoDiskPressure
Normal   NodeHasSufficientPID      1m                 kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeHasSufficientPID
Normal   NodeNotReady              1m                 kubelet, vgqengapps01  Node vgqengapps01 status is now: NodeNotReady
Normal   NodeAllocatableEnforced   56s                kubelet, vgqengapps01  Updated Node Allocatable limit across pods
Warning  EvictionThresholdMet      56s                kubelet, vgqengapps01  Attempting to reclaim ephemeral-storage
Warning  CheckLimitsForResolvConf  54s (x16 over 54s) kubelet, vgqengapps01  Resolv.conf file '/etc/resolv.conf' contains search line consisting of more than 3 domains!
```

Solution:

1. Identify and remove unnecessary files or logs consuming disk space on the affected nodes.
2. Configure log rotation and retention policies for container logs to prevent excessive disk usage and avoid node eviction.
3. Use node maintenance scripts or automation tools to periodically clean up temporary files and reclaim disk space.
4. Consider resizing persistent volumes or adding additional storage capacity to nodes experiencing persistent disk pressure issues.

Scenario 19: Network Policy Enforcement Failures

```
[root@kube kubeYamlTest]# kubectl get all -n ingress-nginx
NAME                                       READY   STATUS      RESTARTS   AGE
pod/ingress-nginx-admission-create-jr6q4   0/1     Completed   0          87s
pod/ingress-nginx-admission-patch-wjnjj    0/1     Completed   1          87s
pod/ingress-nginx-controller-8f7b9d799-w7dpt   1/1     Running     0          97s

NAME                                         TYPE           CLUSTER-IP     EXTERNAL-IP   PORT(S)                      AGE
service/ingress-nginx-controller             LoadBalancer   10.98.18.122   <pending>     80:30529/TCP,443:31217/TCP   97s
service/ingress-nginx-controller-admission   ClusterIP      10.96.156.86   <none>        443/TCP                      97s

NAME                                       READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/ingress-nginx-controller   1/1     1            1           97s

NAME                                                  DESIRED   CURRENT   READY   AGE
replicaset.apps/ingress-nginx-controller-8f7b9d799    1         1         1       97s

NAME                                       COMPLETIONS   DURATION   AGE
job.batch/ingress-nginx-admission-create   1/1           2s         97s
job.batch/ingress-nginx-admission-patch    1/1           3s         97s
[root@kube kubeYamlTest]#
```

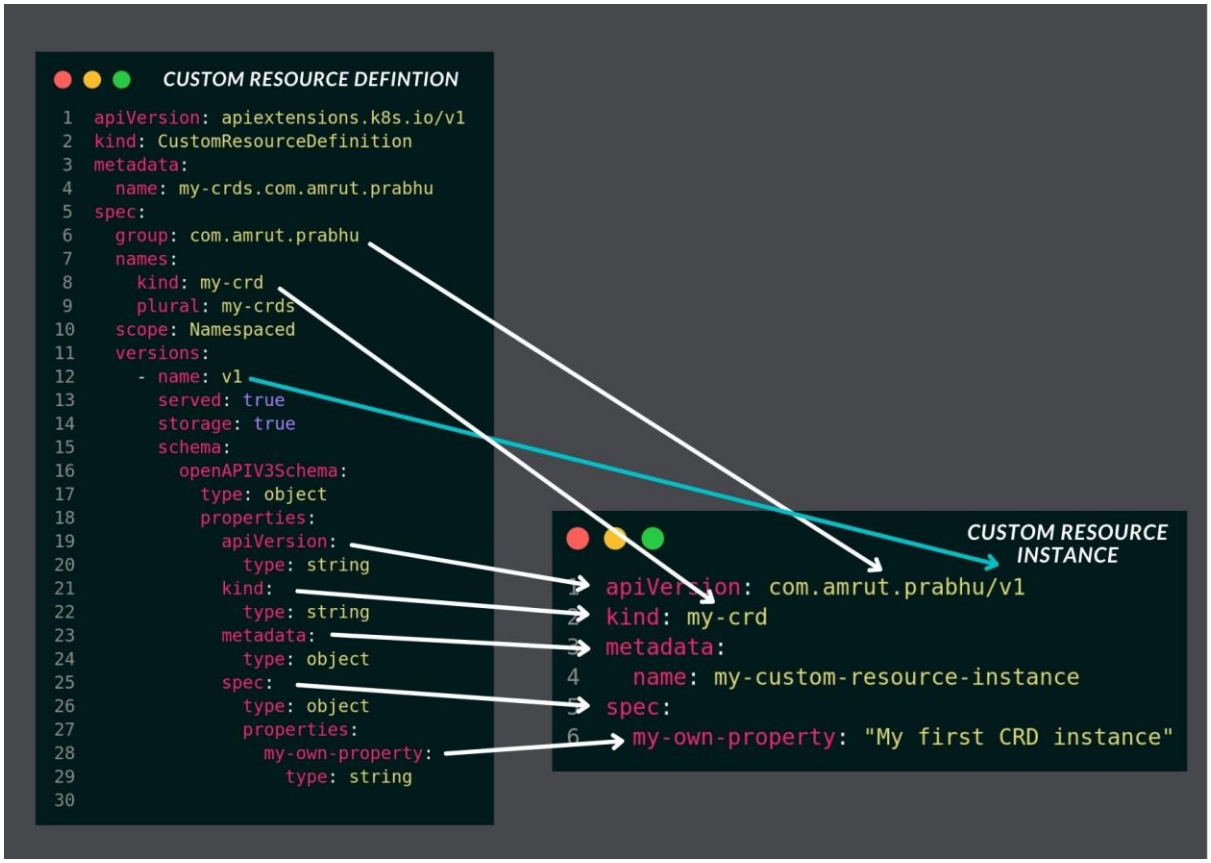
Symptoms: Network policies fail to enforce ingress or egress rules between pods, leading to unauthorized network access or security breaches.

Diagnosis: Review network policy configurations (`kubectl get networkpolicy`) and network plugin logs for any errors or policy enforcement failures.

Solution:

1. Verify that the network plugin (e.g., Calico, Flannel, Cilium) is properly configured and supports network policy enforcement in the Kubernetes cluster.
2. Use network policy visualization tools or network packet capture utilities to inspect network traffic and validate policy enforcement.
3. Implement network policy testing and validation procedures in staging or development environments to ensure policies behave as expected.
4. Update network policies to reflect changes in application requirements or security policies and apply them consistently across all namespaces and clusters.

Scenario 20: Custom Resource Definition (CRD) Version Compatibility



Symptoms: Operators or controllers fail to reconcile custom resources (CRs) due to version incompatibility or schema validation errors.

Diagnosis: Review operator logs (`kubectl logs <operator_pod>`) and CRD definitions (`kubectl get crd`) for any errors or mismatches between CR versions and API schemas.

Solution:

1. Ensure that operators and controllers are compatible with the CRD versions used in the Kubernetes cluster, and update them as needed.
2. Validate CR specifications against the corresponding CRD schemas to ensure compliance with API requirements and avoid validation errors.
3. Implement CRD versioning and API evolution strategies to smoothly transition between different versions and avoid breaking changes in CR definitions.
4. Monitor operator health and reconciliation status to detect and address any issues with CR processing or lifecycle management.

In the up-coming parts, we will discussion on more troubleshooting steps for the different Kubernetes based scenarios. So, stay tuned for the and follow @Prasad Suman Mohan for more such posts.

FOLLOW – Prasad Suman Mohan (for more updates)