OMEC in a Kubernetes Orchestrated Environment

Saikrishna Edupuganti
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Enabling OMEC Network Functions

Current status

Operator
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- Disaggregated Control & Data Plane
- I/O intensive, multi-interface data plane
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Hugepages

```
apiVersion: v1
type: Pod
metadata:
  name: hugepages-example
spec:
  containers:
    - image: fedora
      command:
      - sleep
      - if
      name: example
      volumeMounts:
      - mountPath: /hugepages
        name: hugepage
        resources:
        limits:
          hugepages-2Mi: 100Mi
        memory: 200Mi
        requests:
        memory: 100Mi
      volumes:
      - name: hugepage
        emptyDir:
        medium: HugePages
```
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CPU Isolation/Affinity

apiVersion: v1
kind: Pod
metadata:
  name: grtd-qos-example
spec:
  containers:
  - image: fedora
    command:
      - sleep
      - inf
    name: example
  resources:
    limits:
      memory: 200Mi
      cpu: 2
    requests:
      memory: 200Mi
      cpu: 2

# Allowing for CPU pinning and isolation in case of guaranteed QoS class
cpuManagerPolicy: static

---

Pin/Isolate A

```
apiVersion: kubelet.config.k8s.io/v1beta1
kind: KubeletConfiguration

# Allowing for CPU pinning and isolation in case of guaranteed QoS class
cpuManagerPolicy: static
```
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Multiple Network Interfaces

Multus: Intel, RedHat driven effort

Allows Pod to have multiple interfaces

Calls other CNIs but reports back to k8s/CRI result of primary CNI
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Multiple Network Interfaces

Bypasses k8s, so BYO service discovery, load-balancing, network policy

Alternatives

- [nokia/danm](https://github.com/nokia/danm)
- [networkservicemesh](https://github.com/cisco/networkservicemesh) (cisco)
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High-speed Network IO

Currently SR-IOV the only choice: Linux/DPDK

Device plugin helps with scheduling

Need Multus or enlightened CNI, to connect device plugin allocated with netdev to move into netns

Used only as secondary interface to the pod, so same limitations - bypasses k8s, BYO ...
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High-speed Network IO

Device plugin helps with scheduling

Need Multus or enlightened CNI, to move device plugin allocated netdev into netns
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High-speed Network IO

Implemented **vfioeth** CNI for DPDK mode

Create representor veth pair inside netns

Set MAC, IP & routes on one end

DPDK app uses the other end to send/receive control plane packets to/from the kernel

```json
---
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: sriov-net
  annotations:
    k8s.v1.cni.cncf.io/resourceName: intel.com/sriov_netdevice
spec:
  config: {
    "type": "sriov",
    "name": "sriov-net",
    "ipam": {
      "type": "host-local",
      "subnet": "198.19.0.0/24",
      "rangeStart": "198.19.0.100",
      "rangeEnd": "198.19.0.200",
      "gateway": "198.19.0.1"
    }
  }
---
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: sriov-net-dpdk
  annotations:
    k8s.v1.cni.cncf.io/resourceName: intel.com/sriov_vfio
spec:
  config: {
    "type": "vfioeth",
    "name": "sriov-net",
    "ipam": {
      "type": "host-local",
      "subnet": "198.19.0.0/24",
      "rangeStart": "198.19.0.100",
      "rangeEnd": "198.19.0.200",
      "gateway": "198.19.0.1"
    }
  }
```
Enabling OMEC Network Functions

High-speed Network IO

Implemented **vfioVeth** CNI for DPDK mode

Create representor veth pair inside netns

Set MAC, IP & routes on one end

DPDK app uses the other end to send/receive control plane packets to/from the kernel
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Manual/bare-metal vs Automated/k8s

<table>
<thead>
<tr>
<th>Test</th>
<th>Usr Sp Drv</th>
<th>Pinning</th>
<th>Huge</th>
<th>Pkts/sec* (w/noise)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>1,550K (1,100K)</td>
</tr>
<tr>
<td>Kubernetes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>1,450K (1,150K)</td>
</tr>
<tr>
<td>Kubernetes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>750K (650K)</td>
</tr>
<tr>
<td>Kubernetes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>1,450K 400K</td>
</tr>
<tr>
<td>Kubernetes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>1,200K (1,100K)</td>
</tr>
</tbody>
</table>

NUMA impact untested. Expected to land in k8s 1.16
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Current status

Operator
Dockerfiles

- SPGW-C, SPGW-U, HSS, HSS-DB, OpenMME

k8s YAMLs

- SPGW-C, SPGW-U in tree: [omec-project/ngic-rtc/deploy/k8s](omec-project/ngic-rtc/deploy/k8s)
- HSS and HSS-DB are in PR: [omec-project/c3po/pull/21](omec-project/c3po/pull/21)
- OpenMME not present

COMAC-in-a-box
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Current status

Operator
Custom Resource Definition + Controller

```yaml
apiVersion: ngic.intel.com/v1alpha1
kind: NGIC
metadata:
  name: ngic-att
spec:
  replicas: 2
  name: us-west-1
  mm: 13.1.1.110
  apn: apn1
teid:
  s11Steps: 12
  s1uSteps: 12
pool:
  ip: 16.0.0.0
  steps: 12
ipam:
  s1uNet:
    ip: 2.2.2.0
    mask: 255.255.255.0
    gateway: 2.2.2.92 #RTR_S1U_IP
  sgiNet:
    ip: 3.3.3.0
    mask: 255.255.255.0
    gateway: 3.3.3.105 #RTR_SGI_IP
dpdk: True
```
Custom Resource Definition + Controller

Company A
Config:
- A
- B

NGIC Operator

Company B
Config:
- C
- D
Custom Resource Definition + Controller

- Currently internal
- Instantiate EPC as k8s custom resource, controller will bring up individual components
- Scale SPGW-C and SPGW-U 1:1 based on active session Prometheus metrics
- Implemented S11 TEID load-balancer to pick backend SPGW-C instance
Custom Resource Definition + Controller

<table>
<thead>
<tr>
<th>TEID</th>
<th>Backend</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>magic()</td>
</tr>
<tr>
<td>0x1000–0x1fff</td>
<td>CP1</td>
</tr>
<tr>
<td>0x2000–0x2fff</td>
<td>CP2</td>
</tr>
<tr>
<td>0xn000–0xnfff</td>
<td>CPn</td>
</tr>
</tbody>
</table>