Introducing Nephio and its approach towards network function orchestration

https://nephio.org/

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About Nephio

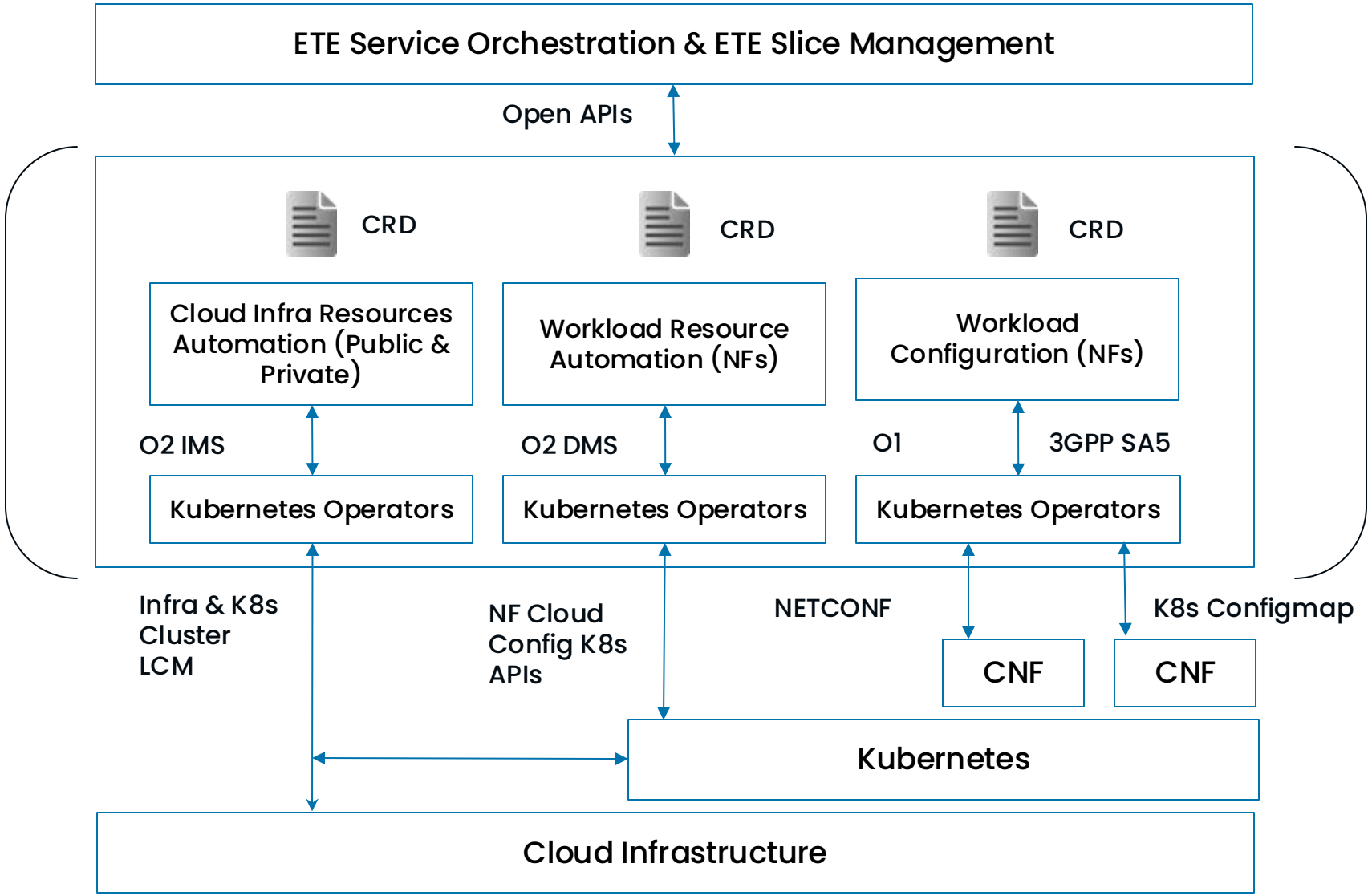
- Cloud Native Network Automation Platform
- Nephio's goal is to deliver carrier-grade, simple, open, **Kubernetes-based cloud native intent automation** and common automation templates that materially simplify the deployment and management of multi-vendor cloud infrastructure and network functions across large scale edge deployments.
- Solving the challenges around fire-and-forget orchestration methods which struggles to take full advantage of the dynamic capabilities of these new infrastructure platforms.
- Started in 2022, a Linux Foundation Networking Project
- Community comprises of cloud providers, telco operators, network function vendors and hardware vendors.

Fundamental Building Blocks

- Kubernetes (K8s) as an Orchestration Framework
- Extending kubernetes functionality using K8s Operator pattern
- Intent based orchestration
- Configuration as Data
- GitOps

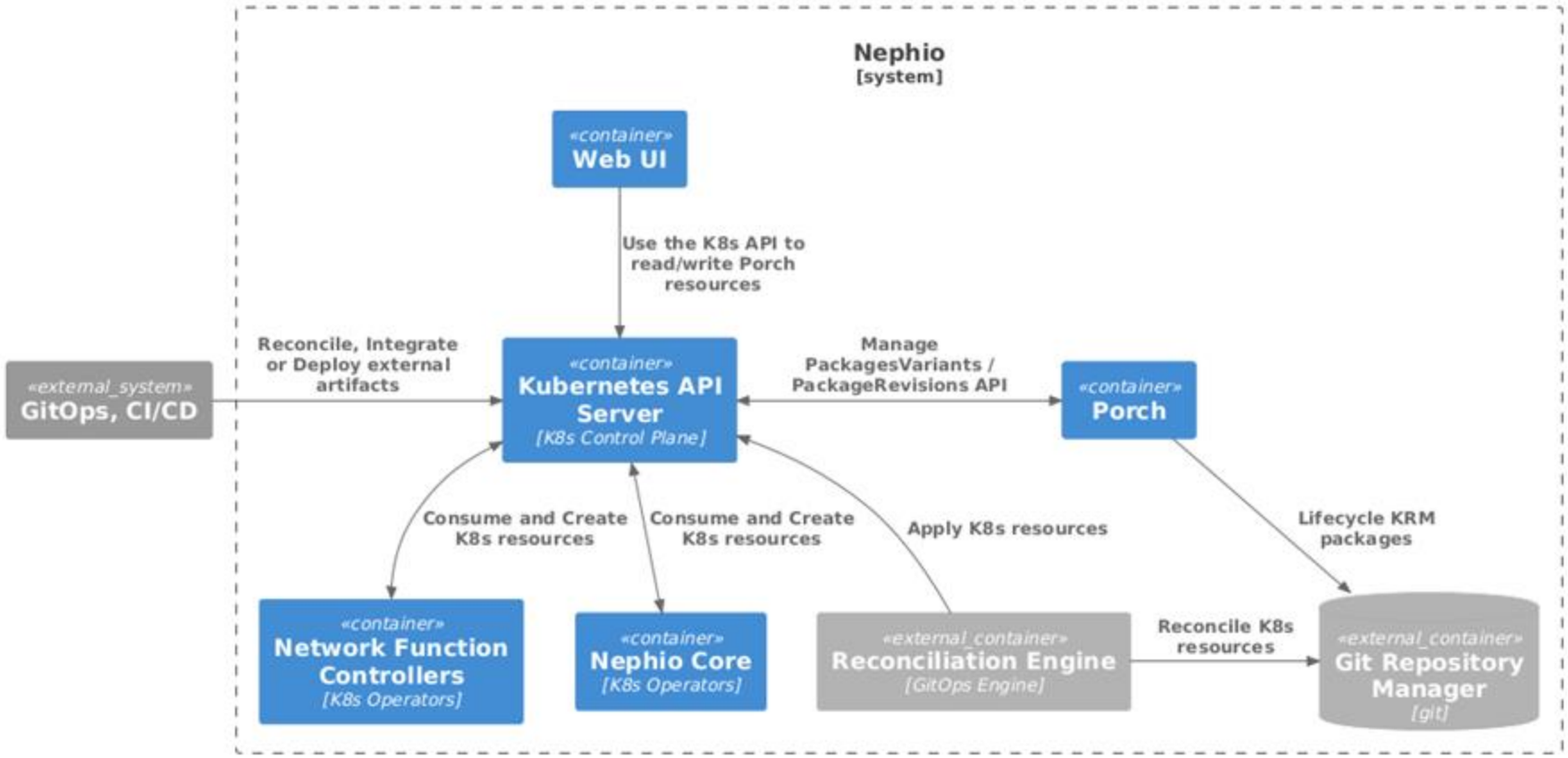
Placement in the Big Picture

Nephio: K8s based Automation



Architecture

- PORCH: Package Orchestration Server (a.k.a. Porch) is a k8s extension apiserver which manages the lifecycle of KRM configuration packages.
- Declarative Function Execution as pipeline

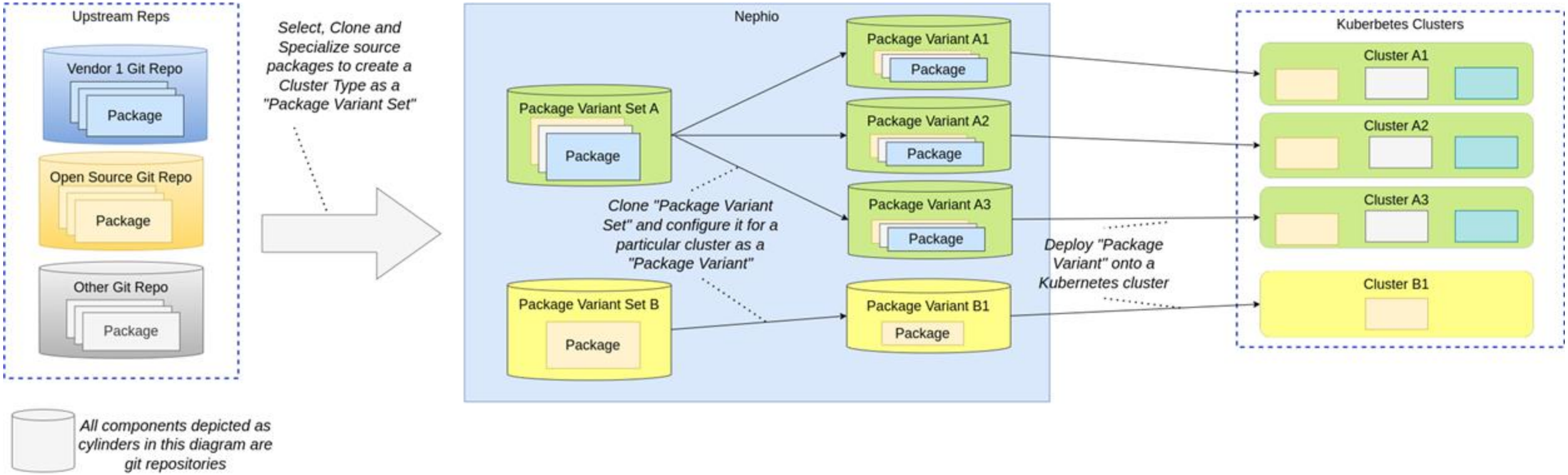


Package Orchestration

```yaml
apiVersion: config.porch.kpt.dev/v1alpha2
kind: PackageVariantSet
metadata:
  name: core-oai-amf
spec:
  upstream:
    repo: oai-core-packages
    package: oai-amf
    revision: main
  targets:
  - objectSelector:
      apiVersion: infra.nephio.org/v1alpha1
      kind: WorkloadCluster
      matchLabels:
        nephio.org/site-type: core
    template:
      downstream:
        package: oai-amf
      annotations:
        approval.nephio.org/policy: initial
      injectors:
      - nameExpr: target.name
```

```yaml
apiVersion: config.porch.kpt.dev/v1alpha1
kind: PackageVariant
metadata:
  name: regional-oai-cucp
spec:
  upstream:
    repo: catalog-workloads-oai
    package: pkg-example-cucp-bp
    revision: main
  downstream:
    repo: regional
    package: oai-ran-cucp
  annotations:
    approval.nephio.org/policy: initial
  injectors:
  - name: regional
```

Nephio Specializers




```
pipeline:
  mutators:
    - image: docker.io/nephio/nfdeploy-fn:v3.0.0
    - image: docker.io/nephio/interface-fn:v3.0.0
    - image: docker.io/nephio/nad-fn:v3.0.0
    - image: docker.io/nephio/nfdeploy-fn:v3.0.0
```

Intent based Orchestration (Core Example)

```
apiVersion: workload.nephio.org/v1alpha1
kind: NFDeployment
metadata:
  name: amf-example
  namespace: amf-example
spec:
  provider: amf.openairinterface.org
  parametersRefs:
  - name: oai-amf-config
    apiVersion: workload.nephio.org/v1alpha1
    kind: NFConfig
```

```
apiVersion: req.nephio.org/v1alpha1
kind: Interface
metadata:
  name: n2
  annotations:
    nephio.org/network-name: n2
    config.kubernetes.io/local-config: "true"
    specializer.nephio.org/owner:
workload.nephio.org/v1alpha1.NFDeployment.amf-example
    specializer.nephio.org/namespace: example
spec:
  networkInstance:
    name: vpc-ran
  cniType: macvlan
  attachmentType: vlan
```

```
apiVersion: workload.nephio.org/v1alpha1
kind: NFConfig
metadata:
  name: oai-amf-config
  namespace: oai-core
spec:
  configRefs:
    - apiVersion: cellular.nephio.org/v1alpha1
      kind: PLMN
      metadata:
        name: oai-plmn
      spec:
        plmnInfo:
          - plmnID:
              mcc: "001"
              mnc: "01"
            tac: 1
            nssai:
              - sst: 1
                sd: ffffff
                dnnInfo:
                  - name: internet
                    sessionType: ipv4
                    dns: 8.8.8.8
    - apiVersion: cellular.nephio.org/v1alpha1
      kind: ServedGUAMI
      metadata:
        name: oai-served-guami
      spec:
        - amfID:
            amfPointer: '01'
            amfRegionID: '01'
            amfSetID: '001'
          plmnID:
            mcc: "001"
            mnc: "01"
```

Intent based Orchestration (RAN Example)

```
apiVersion: workload.nephio.org/v1alpha1
kind: NFDeployment
metadata:
  name: cucp-example
  namespace: example
spec:
  provider: cucp.openairinterface.org
  parametersRefs:
  - apiVersion: workload.nephio.org/v1alpha1
    kind: NFConfig
    name: cucp-nf-config
```

```
apiVersion: req.nephio.org/v1alpha1
kind: Interface
metadata:
  name: e1
  annotations:
    nephio.org/network-name: e1
    config.kubernetes.io/local-config: "true"
    specializer.nephio.org/owner:
workload.nephio.org/v1alpha1.NFDeployment.cucp-example
    specializer.nephio.org/namespace: example
spec:
  networkInstance:
    name: vpc-cu-e1
  cniType: macvlan
  attachmentType: vlan
```

```
apiVersion: workload.nephio.org/v1alpha1
kind: NFConfig
metadata:
  name: cucp-nf-config
  namespace: example
spec:
  configRefs:
  - apiVersion: workload.nephio.org/v1alpha1
    kind: RANConfig
    metadata:
      name: ranconfig
      namespace: default
    spec:
      cellIdentity: 12345678L
      physicalCellID: 0
      tac: 1
      downlinkFrequencyBand: 78
      downlinkSubCarrierSpacing: 1
      downlinkCarrierBandwidth: 51
      uplinkFrequencyBand: 78
      uplinkSubCarrierSpacing: 1
      uplinkCarrierBandwidth: 51
  - apiVersion: workload.nephio.org/v1alpha1
    kind: PLMN
    metadata:
      name: plmn
      namespace: default
    spec:
      PLMNInfo:
      - plmnID:
          mcc: "001"
          mnc: "01"
        tac: 1
        nssai:
        - sd: ffffff
          sst: 1
```

GitOps (Pkg management on Remote Clusters)

- ConfigSync:
  - Operate in distributed setup
  - Doesn't assume the existence of a management cluster
  - Requires root sync object for gitops reconciliation
  - https://github.com/GoogleContainerTools/kpt-config-sync

- Apart from ConfigSync
  - ConfigSync (by default choice till R3): https://github.com/GoogleContainerTools/kpt-config-sync
  - FluxCD
  - ArgoCD

Nephio releases and Its Evolution

- Release 1:
  - Kubernetes cluster management using Cluster API. Only Kubernetes in Docker (KIND) supported.
  - Fully automated user intent based deployment of the UPF, SMF, and AMF services of free5GC Core Network.
  - Deployment of other free5GC network functions.
  - Autoscaling up of the UPF, SMF, and AMF services
- Release 2:
  - Multi-cloud support: Sandbox, Google Cloud Platform and Openshift
  - Generic K8s custom resource to deploy all the NFs
  - Fully automated deployment of OAI O-DU, O-CU-CP and UP and core network functions
  - Helm to operator SDK to ease K8s operator creation
- Release 3:
  - Platform stability (Porch), security best practices, WebGUI enhancement
- Release 4:
  - O-RAN O2IMS cluster creation using Nephio O2ims operator
  - On-going

To join the nephio community: https://lf-nephio.atlassian.net/wiki/spaces/HOME/overview?mode=global

Thank you if you have any questions then you can send me an email
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