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Creating Infinite
Possibilities.

Delivering Network Agility and Automated Operations with GitOps

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Forward

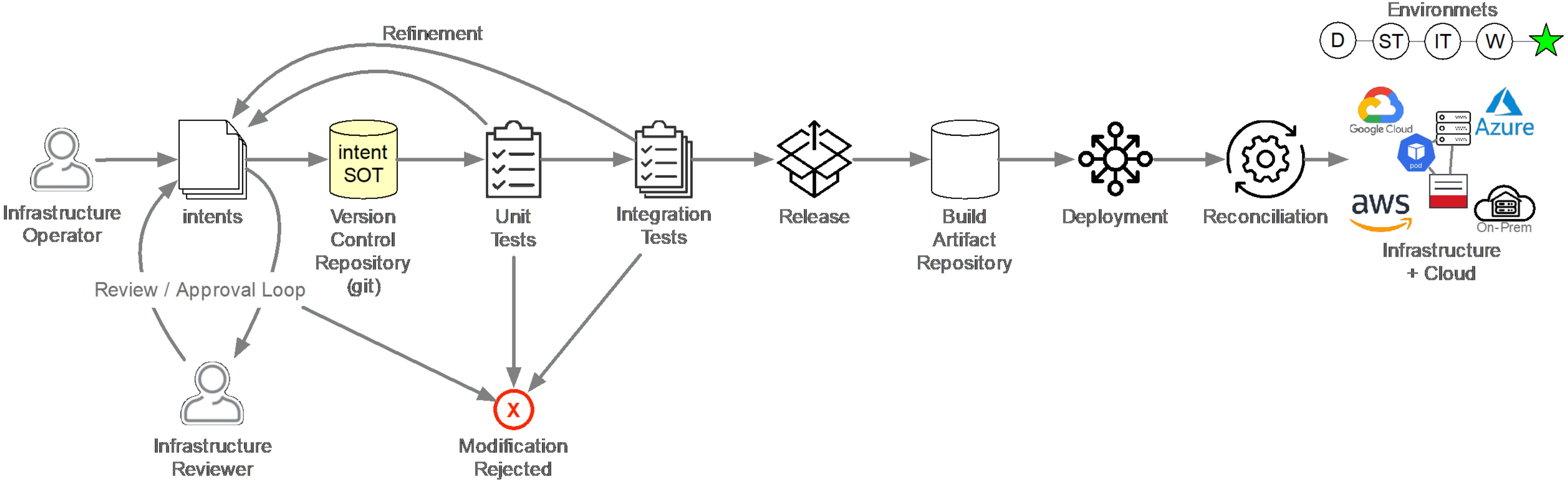
Goals

- A network operations process to increase velocity and decrease human induced errors
- Integrate network operations with other infrastructure operations (compute, storage)

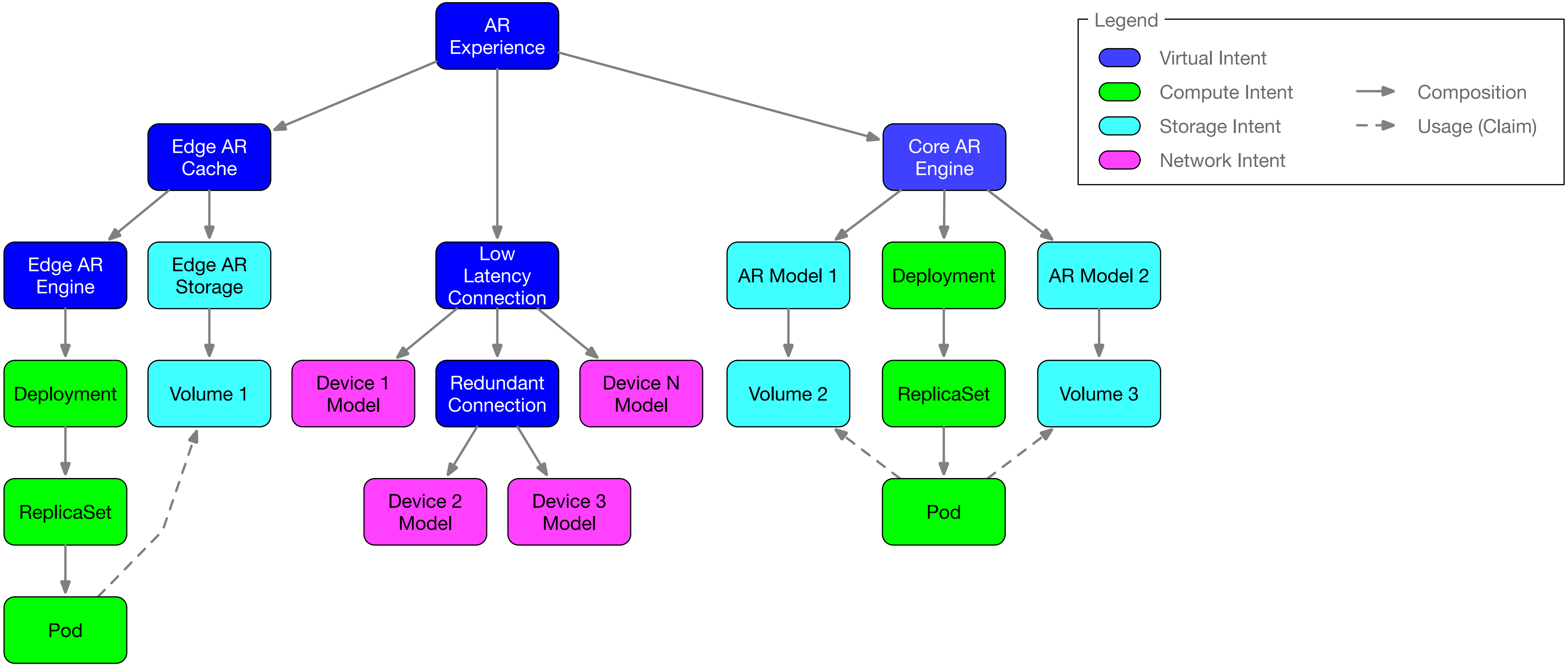
Tools

- DevOps – leverage a DevOps pipeline process for pre-change “checks and verifications”
- GitOps – leverage a versioned, persistent store to drive DevOps pipeline to have complete traceability and differencing (rollback)
- IntOps – (intent operations) change the conversation to focus on the desired outcomes

GitOps


Refinement
Environmets
D
ST
IT
W
Infrastructure Operator
intents
intent SOT
Version Control Repository (git)
Unit Tests
Integration Tests
Release
Build Artifact Repository
Deployment
Reconciliation
Google Cloud
Azure
pod
aws
On-Prem
Infrastructure + Cloud
Review / Approval Loop
Infrastructure Reviewer
X
Modification Rejected

Intent Decomposition - Example



AR Experience

Edge AR Cache

Low Latency Connection

Core AR Engine

Edge AR Engine

Edge AR Storage

AR Model 1

Deployment

AR Model 2

Deployment

Volume 1

Device 1 Model

Redundant Connection

Device N Model

Volume 2

ReplicaSet

Volume 3

ReplicaSet

Device 2 Model

Device 3 Model

Pod

Pod

Legend

🟦 Virtual Intent

🟩 Compute Intent

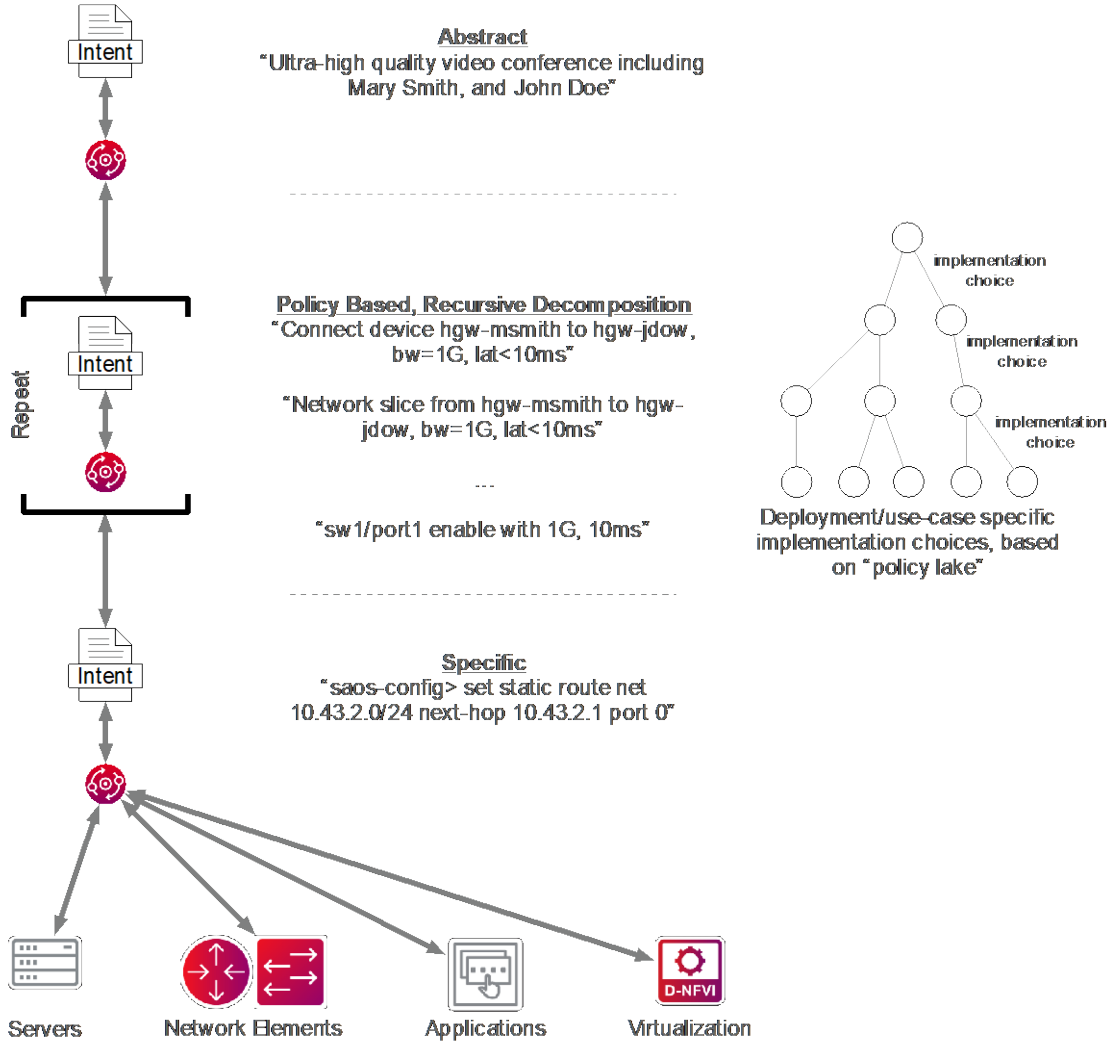
🟦 Storage Intent

🟪 Network Intent

→ Composition

⇢ Usage (Claim)

Intents



Abstract
"Ultra-high quality video conference including Mary Smith, and John Doe"

Policy Based, Recursive Decomposition
"Connect device hgw-msmith to hgw-jdow, bw=1G, lat<10ms"

"Network slice from hgw-msmith to hgw-jdow, bw=1G, lat<10ms"

...

"sw1/port1 enable with 1G, 10ms"

Specific
"saos-config> set static route net 10.43.2.0/24 next-hop 10.43.2.1 port 0"

Deployment/use-case specific implementation choices, based on "policy lake"

Intent-based NetOps

Abstract to Specific Decomposition

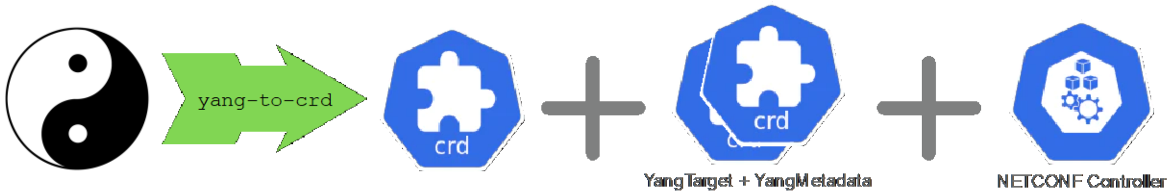
- Abstract intents represent high level desires for the network, i.e., connectivity and constraints
- Abstract intents are decomposed into more and more specific intents that provide the initial abstract intent
- The most specific intent is the actual device (target) configuration

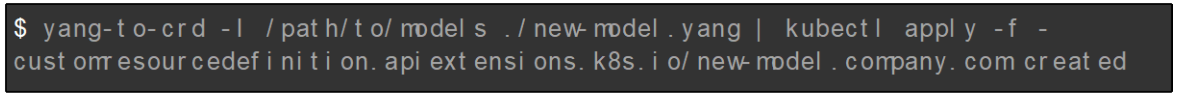
Why Kubernetes

- What is Kubernetes
  - Defined, model driven, reconciliation application framework
  - Detailed RBAC security model
  - Defined ways to do things (opinionated)
  - Manages compute resources well
- Why Kubernetes
  - It managed the “context” so we could focus on the “core” problem we were looking to address
  - Provided OOTB integration with ecosystem of tools, including those used for GitOps
  - Defined and supported extension models
  - Allows us to experiment with the management of resources across the domains of compute and networks using a common mechanism

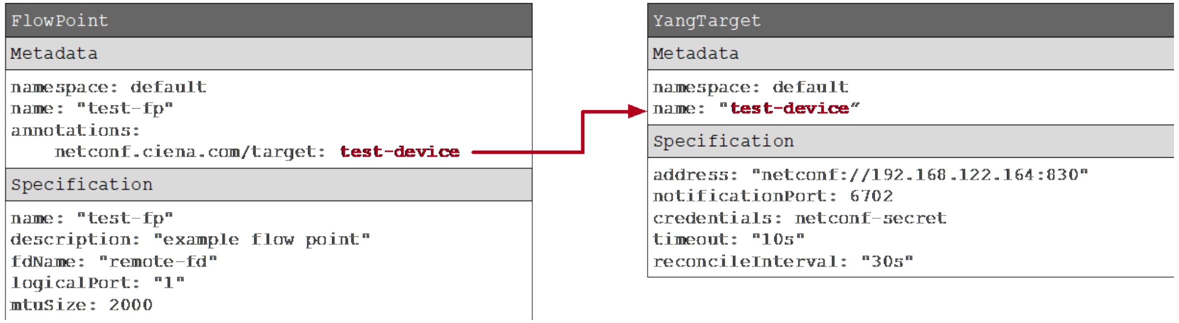
YANG and Kubernetes

- Decided to use existing device models as they are defined in YANG
  - Custom models rarely work
  - Too many standards
- Controller to support all YANG models
  - Didn’t want a controller per model
  - Built to support dynamic addition of models without code change or redeployment
- Multiple models per target
  - Needed new relationship in Kubernetes
- Simple for users
  - Wanted it easy for users to add their own models





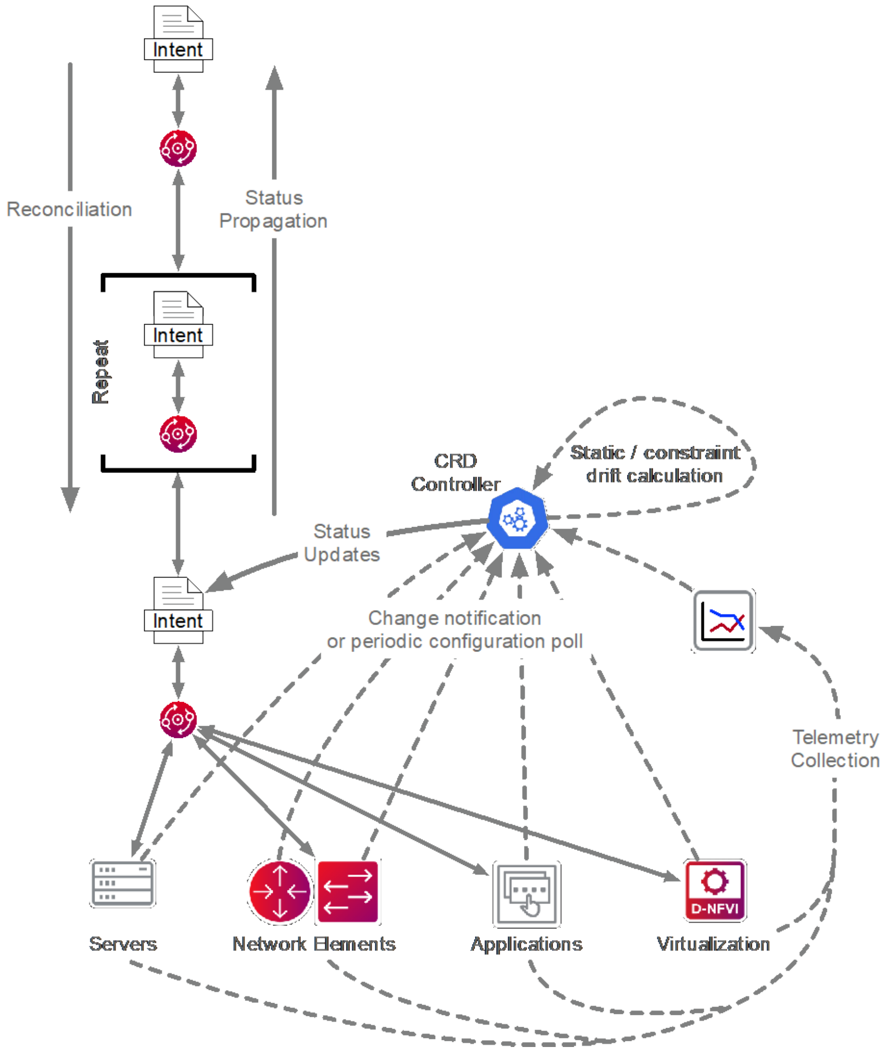
```
$ yang-to-crd -I /path/to/models ./new-model.yang | kubectl apply -f -
customresourcedefinition.apiextensions.k8s.io/new-model.company.com created
```



```
FlowPoint
Metadata
namespace: default
name: "test-fp"
annotations:
    netconf.ciena.com/target: test-device
Specification
name: "test-fp"
description: "example flow point"
fdName: "remote-fd"
logicalPort: "1"
mtuSize: 2000
```

```
YangTarget
Metadata
namespace: default
name: "test-device“
Specification
address: "netconf://192.168.122.164:830"
notificationPort: 6702
credentials: netconf-secret
timeout: "10s"
reconcileInterval: "30s"
```

Reconciliation - Drift



Types of drift

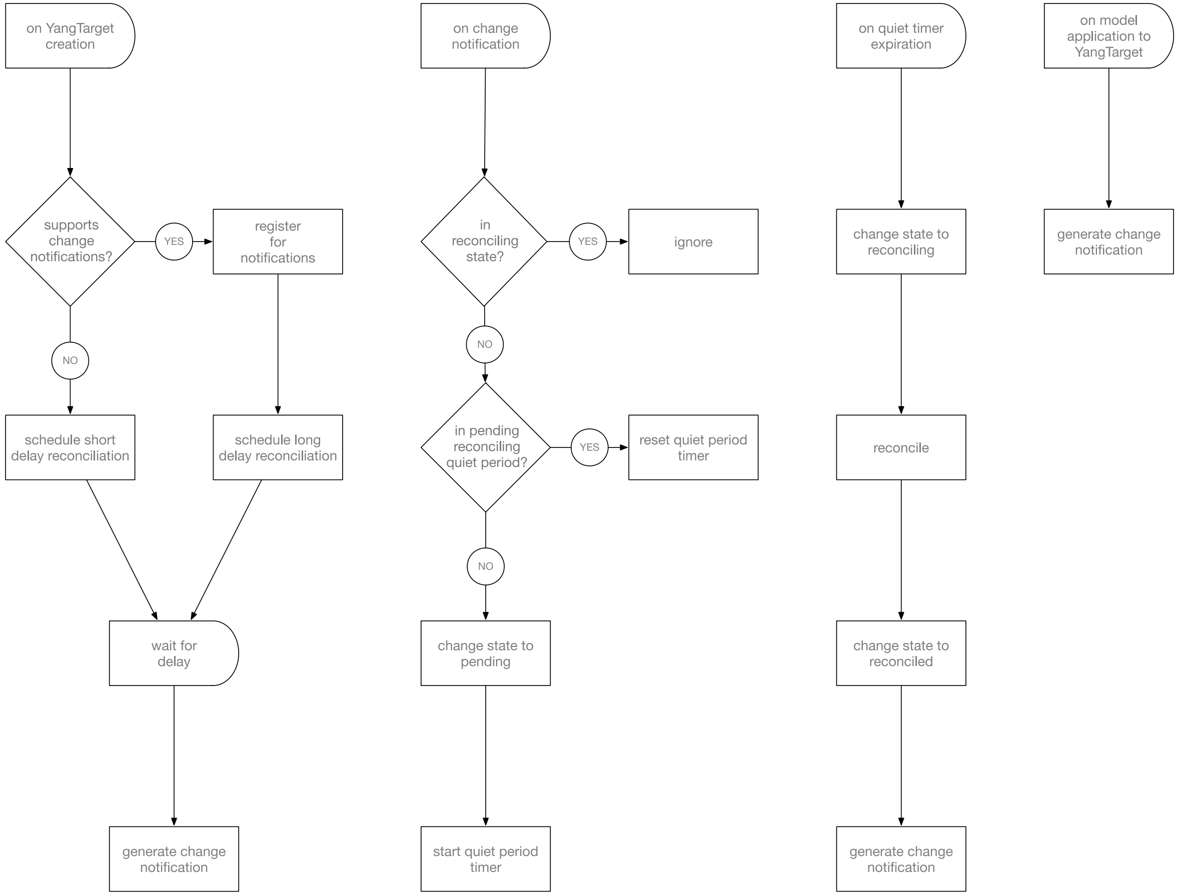
- **Static drift** is the when the desired configuration state differs from the actual configuration state
  - Calculated by comparing actual to desired (or set0
  - i.e., interface admin state, etc.

- **Constraint drift** is when the desired characteristics differs from the observed characteristics
  - Calculated by comparing observed telemetry to desired constraints
  - i.e., latency, jitter, bandwidth, etc.

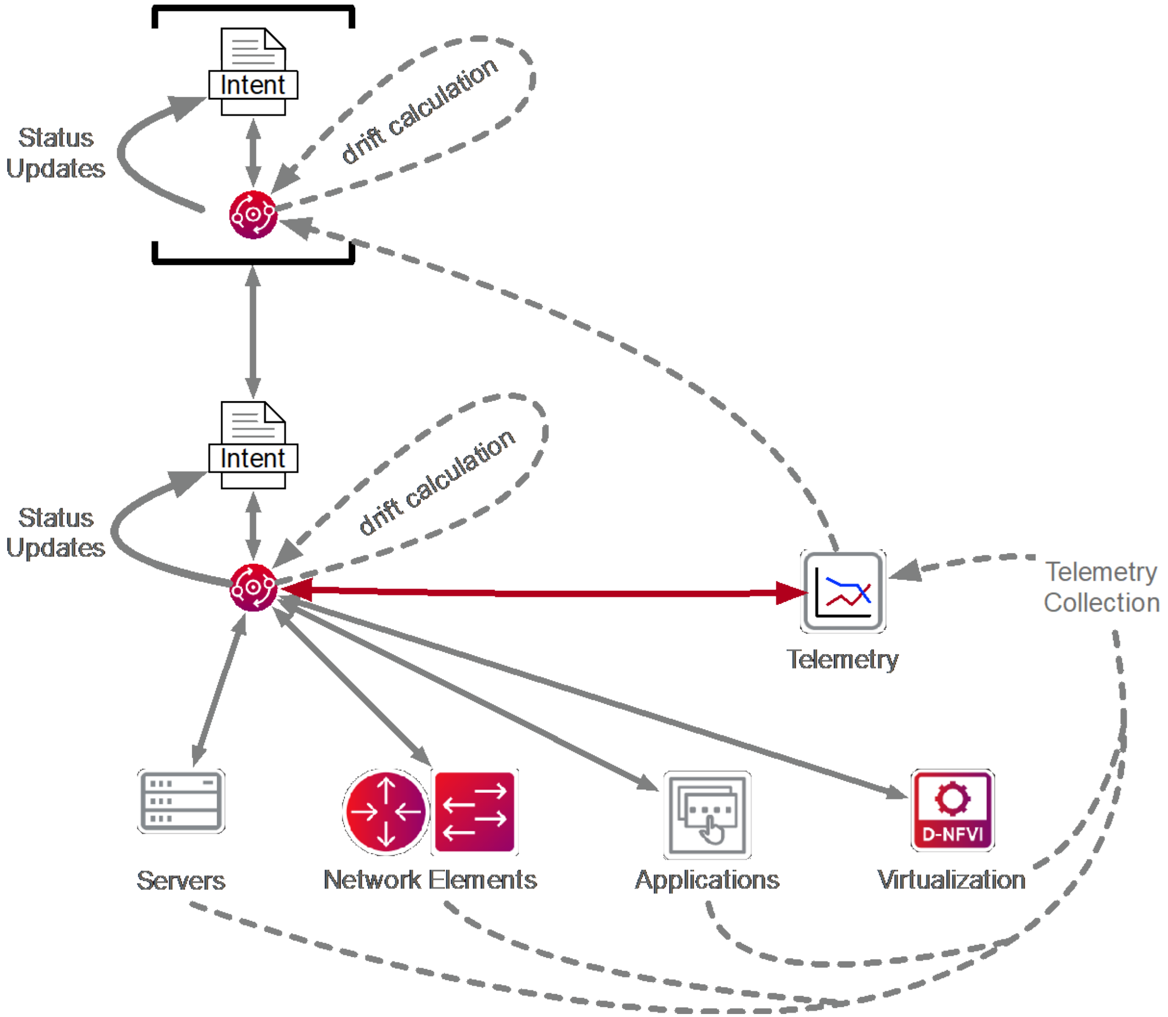
Reconciliation – Static Drift

Change Notifications

- If target supports change notification leverage it as a drift indicator, else period polling of configuration
- When new model state is associated with target, create synthetic change notification
- Reconciliation is an expensive operation, only undertake it after a quiet period
- Reconciliation may cause additional change notifications
- When reconciliation is “complete”, schedule an additional reconciliation (drift calculation) to determine it target is “reconciled”


on YangTarget creation
supports change notifications?
YES
register for notifications
NO
schedule short delay reconciliation
schedule long delay reconciliation
wait for delay
generate change notification
on change notification
in reconciling state?
YES
ignore
NO
in pending reconciling quiet period?
YES
reset quiet period timer
NO
change state to pending
start quiet period timer
on quiet timer expiration
change state to reconciling
reconcile
change state to reconciled
generate change notification
on model application to YangTarget
generate change notification

Reconciliation – Constraint Drift



- Telemetry collection outside the scope of the current work effort
- **But, telemetry collection and eventing can [should] be part of an intent realization**
- Intents would need to be defined that describe constraints such as latency, jitter, drops, etc, e.g., constraints that are dynamic in the network
- Controllers for these intents would have to leverage the telemetry to determine if the intent was in violation
- Constraint drift works specific to abstract to reestablish compliance
- Most specific intent has only static drift as it represents target configuration

Status and Direction

Current Status

- Specific intent capability implemented
  - YANG to CRD
  - NETCONF/YANG Controller
  - Static drift detection / reconciliation
- Integration with GitOps
  - Works OOTB

Future Directions

- Define and implement higher level intents
  - ”Fabric”
  - Higher level intent may require additional information, such as topology
- Dynamic Drift
  - How should it be defined github.com/ciena/turnbuckle
  - Telemetry collection and evaluation
- Multiple geographies
  - Cross administrative domains
- Non-NETCONF/YANG devices
- Other initiatives: Nephio?

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Thank You!

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