CI/CD for Yocto Project® Maintainers with Kubernetes and Tekton Pipelines

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Introduction

- **Trevor:**
  - Userspace/Infrastructure Developer at Wind River
- **Tim:**
  - Yocto Project Architect at Intel
- **Both meta-python maintainers**
- **Very excited about k8s and Tekton**

Agenda

- State of Yocto CI/CD
- K8S and Tekton
- Pipelines!
- Shared State!
- Cool Tools!
- Future Work

Disclaimer

- **Yocto experts, not k8s experts (suggestions welcome!)**
- **Focusing on single-node developer setup (for now)**

State of Yocto CI/CD

The Yocto Autobuilder and Other Pursuits

The Yocto Autobuilder

- Based on the Buildbot framework
- Bare metal (could be containerized)
- Official Yocto Autobuilder has restricted access (and that’s OK)
- Incredibly useful – but maybe overkill for average developer workflow

Other Current Solutions

- Homegrown Autobuilder instances
- Jenkins (security issues!)
- TravisCI
- GitLabCI
- Others?

Kubernetes and Tekton

Containers All The Way Down

What is Kubernetes?

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- Container orchestrator maintained by CNCF, built for resiliency and scalability
- Application-agnostic – use it to build and deploy what you want
- Supports various container runtimes
- https://kubernetes.io/

docker

cri-o

containerd

kubernetes

Why Kubernetes?

- It’s everywhere, highly-scalable, with lots of existing use cases, extensions, services
- Provides building blocks for the user to adapt, rather than a specific, tailored solution
- Yocto is doing more containerized builds – why not use k8s for that?

What is Tekton?

- **CI/CD framework for Kubernetes**
- **Adds:**
  - Tasks
  - Pipelines
  - TaskRuns and PipelineRuns
  - EventListeners
  - TriggerTemplates, TriggerBindings
- **https://tekton.dev/**

Why Tekton?

- Tekton is very customizable, relatively easy to understand
- More modern, designed around contemporary technologies
- Has a rich dashboard, CLI

Our Setup

- Single-node cluster
- HP Z640, E5-2630v4 x2, 64GB RAM
- Fedora 32 Server Edition
- kubeadm, not Minikube

End Goal – Pipelines on a Dashboard

Tekton

Tekton resources
- Pipelines
- PipelineRuns
- PipelineResources
- Tasks
- ClusterTasks
- TaskRuns
- Conditions
- EventListeners
- TriggerBindings
- ClusterTriggerBindings
- TriggerTemplates

Namespace
- tekton-pipelines

Kubernetes resources
- Secrets
- ServiceAccounts

Import resources

About

meta-python-build-pipeline-run-s5d2g 3 hours ago

Rerun

Completed Tasks Completed: 2 (Failed: 0, Cancelled 0), Skipped: 1

- meta-python-setup-workspace
- meta-python-build
  - run-build Completed

meta-python-build Succeeded

Status


```
completionTime: '2020-10-20T14:34:06Z'
conditions:
  - lastTransitionTime: '2020-10-20T14:34:06Z'
    message: All Steps have completed executing
    reason: Succeeded
    status: 'True'
    type: Succeeded
podName: meta-python-build-pipeline-run-s5d2g-meta-python-build-jf-k28jc
startTime: '2020-10-20T14:34:01Z'
steps:
  - container: step-run-build
    imageID: >-
      docker-pullable://threexc/yocto-builder@sha256:5ba6f309308913fc077d4fb758d7d3dc6912487de6f7b733fdec229e234ee8d8
    name: run-build
    terminated:
      containerID: >-
        docker://2d71541a9f9d583a9fb1a6c4ed1401a849519734da80717521cf8ad9ad20a232
      exitCode: 0
      finishedAt: '2020-10-20T14:34:06Z'
      message: '[{"key":"built","value":"No\n","resourceRef":{},"type":"TaskRunResult"}]'
      reason: Completed
      startedAt: '2020-10-20T14:34:06Z'
taskResults:
  - name: built
    value: |
      No
taskSpec:
  results:
    - description: Yes/No status of whether a build was done
      name: built
  steps:
    - image: registry.hub.docker.com/threexc/yocto-builder
      name: run-build
      resources: {}
      script: >
        #!/bin/bash -xe

        cd poky && source oe-init-build-env build

        export LANG=en_US.UTF-8

        # get the latest python recipes and bitbake them

        COMMIT_LOG=$(cd ../../meta-openembedded/ && git log --pretty=oneline
        --grep="python" origin/master..origin/master-next)
```

How Do We Get There?

- https://github.com/threexc/yocto-tekton
- Setup instructions, example pipelines (we'll get to those shortly)
- Already in use in the wild – created to help maintain the meta-python layer

A Pipeline for Poky

Concept

- Identify delta between master and master-next branches
- Get a list of corresponding recipes, build with bitbake
- Report results and any unmappable patches
- https://github.com/threexc/yocto-tekton/tree/main/poky

Pipeline Implementation Examples

```yaml
---
apiVersion: tekton.dev/v1beta1
kind: Task
metadata:
  name: poky-setup-workspace
  namespace: tekton-pipelines
spec:
  steps:
    - name: create-workspace
      image: registry.hub.docker.com/threexc/yocto-builder
      workingDir: /workspace
      script: |
        #!/bin/bash -xe
        if [ ! -d poky ]; then
            git clone git://git.yoctoproject.org/poky
        fi
      volumeMounts:
      - name: build
        mountPath: /workspace

    - name: update-workspace
      image: registry.hub.docker.com/threexc/yocto-builder
      workingDir: /workspace
      script: |
        #!/bin/bash -xe
        (cd poky && git checkout master-next && git pull --rebase)
      volumeMounts:
      - name: build
        mountPath: /workspace
```

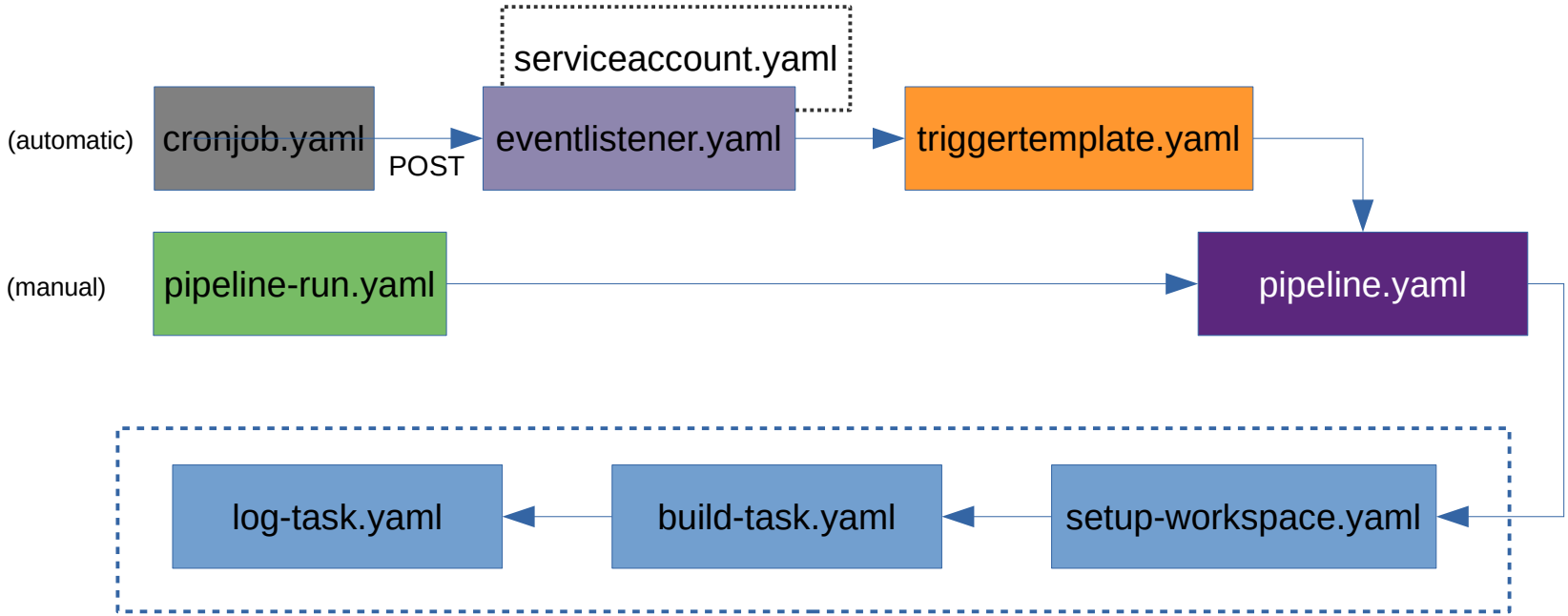
```yaml
apiVersion: tekton.dev/v1beta1
kind: Pipeline
metadata:
  name: poky-build-pipeline
  namespace: tekton-pipelines
spec:
  tasks:
  - name: poky-setup-workspace
    taskRef:
      name: poky-setup-workspace
  - name: poky-build
    runAfter:
     - poky-setup-workspace
    taskRef:
      name: poky-build
```

A Pipeline for meta-python

Concept

- Same idea as the poky pipeline (identify recipes, build, report), for meta-python
- Makes maintaining meta-python way easier!
- Will eventually include containerized image tests (e.g. meta-python-ptest-image)
- https://github.com/threexc/yocto-tekton/tree/main/meta-python

Workflow Example (meta-python)



Pipeline Implementation Examples

```yaml
apiVersion: tekton.dev/v1beta1
kind: Pipeline
metadata:
  name: meta-python-build-pipeline
  namespace: tekton-pipelines
spec:
  tasks:
  - name: meta-python-setup-workspace
    taskRef:
      name: meta-python-setup-workspace
  - name: meta-python-build
    runAfter:
     - meta-python-setup-workspace
    taskRef:
      name: meta-python-build
  - name: meta-python-log
    when:
      - input: "$(tasks.meta-python-build.results.built)"
        operator: in
        values: ["Yes"]
    taskRef:
      name: meta-python-log
```

```yaml
apiVersion: tekton.dev/v1alpha1
kind: PipelineRun
metadata:
  creationTimestamp: null
  generateName: meta-python-build-pipeline-run-
  namespace: tekton-pipelines
spec:
  pipelineRef:
    name: meta-python-build-pipeline
  timeout: 1h0m0s
  podTemplate:
    volumes:
    - name: build
      hostPath:
        path: /tekton/data
    - name: log
      hostPath:
        path: /tekton/data/logs
status: {}
```

Implementation Examples - Continued

```yaml
apiVersion: triggers.tekton.dev/v1alpha1
kind: TriggerTemplate
metadata:
  name: meta-python-build-template
  namespace: tekton-pipelines
spec:
  resourcetemplates:
  - apiVersion: tekton.dev/v1beta1
    kind: PipelineRun
    metadata:
      generateName: meta-python-build-pipeline-run-
    spec:
      pipelineRef:
        name: meta-python-build-pipeline
      timeout: "3h"
      podTemplate:
        volumes:
        - name: build
          hostPath:
            path: /tekton/data
        - name: log
          hostPath:
            path: /tekton/data/logs
```

```yaml
apiVersion: batch/v1beta1
kind: CronJob
metadata:
  name: meta-python-cronjob
  namespace: tekton-pipelines
spec:
  schedule: "0 */12 * * *"
  jobTemplate:
    spec:
      template:
        spec:
          containers:
          - name: meta-python-nettools
            image: threexc/nettools
            args:
            - /bin/bash
            - -c
            - curl -X POST http://el-meta-python-listener.tekton-pipelines.svc.cluster.local:8080
          restartPolicy: OnFailure
```

Automatic Shared State

Pay no attention to the man behind the curtain...

Shared State for Pipelines

- **Everything you've seen actually relies on another pipeline for building sstate!**
- **Similar fundamentals – pipeline runs once per day, runs a poky build that is then used as the SSTATE_MIRROR to reduce build time**
- **https://github.com/threexc/yocto-tekton/tree/main/sstate/automated**

Useful Tools

Improving the Workflow

Useful Tools

- **K9s: https://github.com/derailed/k9s**
- **Helm: https://github.com/helm/helm**
- **Tekton Catalog: https://github.com/tektoncd/catalog**

meta-python + k9s Demo

Demo Video Link

Future Work

Future Work

- Better pipelines/less hard-coding (haven't used TriggerBindings, Secrets, ConfigMaps, etc. at all)
- Proper ingress (i.e. do more than NodePort)
- Take it to the cloud – AWS/GCP/etc.
- Run built image using libvirt/kubevirt?
- Patches from patchwork using pwclient

Thanks for your time!

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Questions?

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