Continuous integration / continuous deployment (CI/CD)

IBM Cloud

Objectives

After completing this lecture, you will be able to:

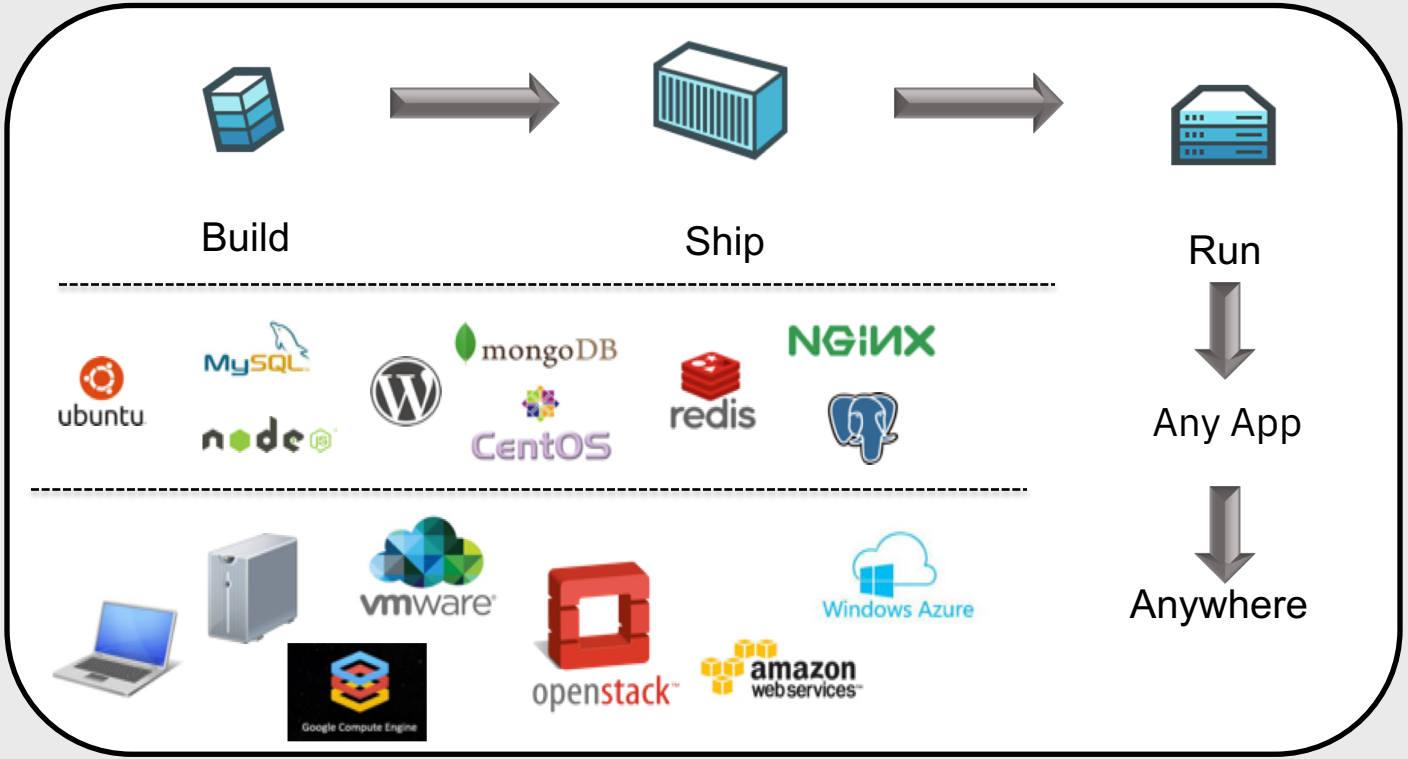
- Describe Continuous Integration and Continuous Deployment (CI/CD)
- Describe the Continuous Integration and Continuous Deployment capabilities in IBM Cloud Private (ICP)
- Describe the build automation technologies in IBM Cloud Private
- Describe the best practices for automating enterprise ICP deployments

Agenda

- CI/CD pipeline in IBM Cloud Private
- Build tools (**build**/**ship**/run)
- Deployment Environments (build/ship/**run**)

Docker mission

Docker is an **open platform** for building distributed applications for developers and system administrators.



Definitions

CI is Continuous Integration (Build/Ship)

- Builds, unit tests, integration tests, performance tests, …

CD is Continuous Deployment (Run)

- Deploying and maintaining pre production and production environment

CI is Dev, CD is Ops …..CI and CD is DevOps (Build/Ship/Run)

Jenkins

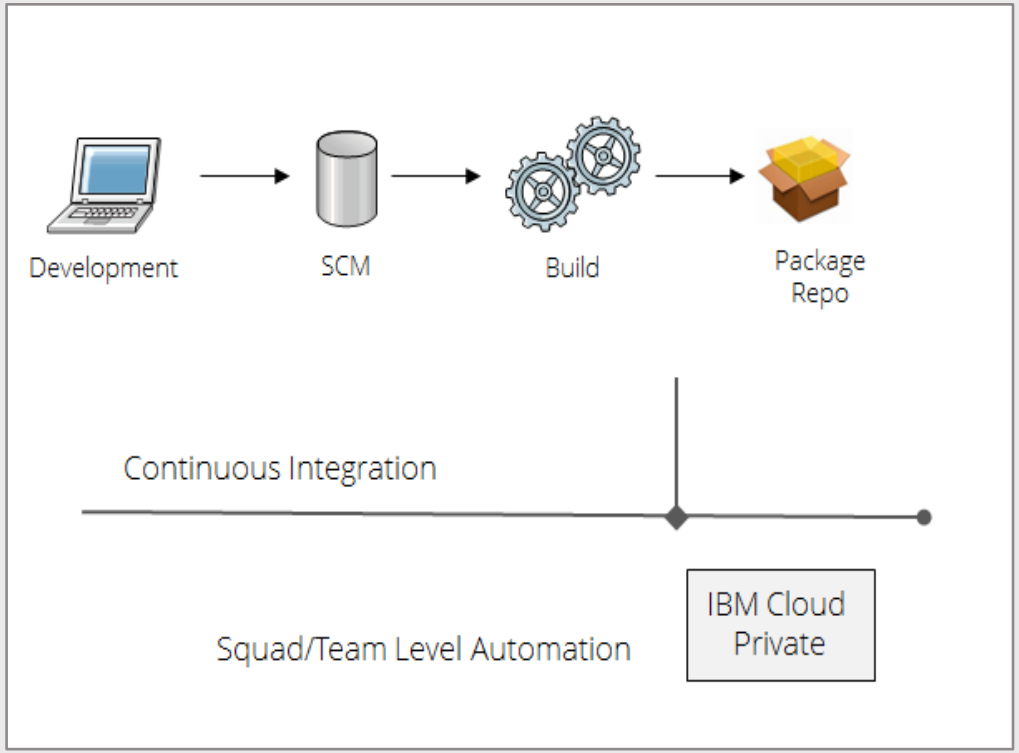
Popular open-source framework for Continuous Integration

Monitors execution of repeated jobs; examples: cron jobs or builds

Generally used for:

- Building/testing software projects continuously
- Monitoring executions of externally-run jobs, such as cron jobs

ICP Continuous Integration (**Build/Ship**/Run)



Frequently performing all of these steps in sequence:

Development

- Rapidly implementing changes in small, tested batches

Source Code Management

- Merging changes from multiple developers

Build

- Creating new deployment artifacts

Package

- Installing builds into runtimes
- Releasing runtimes as immutable images

Automating build

Jenkinsfile: Script file that is used to describe a Jenkins Pipeline.

podTemplate: Describes the docker containers used by this Jenkinsfile

Extract stage: Extracts the source code from *git* and gets the last *commit id*

docker stage: Builds the *flashboard* docker image, tags it with the *commit id* and pushes it to IBM Cloud Private

```
def volumes = [ hostPathVolume(hostPath: '/var/run/docker.sock', mountPath: '/var/run/docker.sock') ]
volumes += secretVolume(secretName: 'microclimate-icp-secret', mountPath: '/msb_reg_sec')
podTemplate(label: 'icp-build',
    containers: [
        containerTemplate(name: 'maven', image: 'maven:3.5.2-jdk-8', ttyEnabled: true, command: 'cat'),
        containerTemplate(name: 'docker', image: 'ibmcom/docker:17.10', ttyEnabled: true, command: 'cat'),
    ],
    volumes: volumes
)
{
    node ('icp-build') {
        def gitCommit
        stage ('Extract') {
          checkout scm
          gitCommit = sh(script: 'git rev-parse --short HEAD', returnStdout: true).trim()
          echo "checked out git commit ${gitCommit}"
        }
        stage ('maven build') {
          container('maven') {
            sh '''
            mvn clean test install
            '''
          }
        }
        stage ('docker') {
          container('docker') {
            def imageTag = "mycluster.icp:8500/nm-pilot/flashboard:${gitCommit}"
            echo "imageTag ${imageTag}"
            sh """
            docker build -t flashboard .
            docker tag flashboard $imageTag
            ln -s /msb_reg_sec/.dockercfg /home/jenkins/.dockercfg
            mkdir /home/jenkins/.docker
            ln -s /msb_reg_sec/.dockerconfigjson /home/jenkins/.docker/config.json
            docker push $imageTag
            """
          }
        }
    }
}
```

maven stage: Executes a *maven* clean, test and install build process

Dockerfile for Liberty

FROM: Base image for the new image. IBM has published an official set of foundational Docker images containing IBM products, such as WebSphere Liberty

Dockerfile: A text file containing Docker image building instructions

COPY: Instruction to copy a configured Liberty server with your application deployed as a whole

Dockerfile

```
1 FROM websphere-liberty:webProfile7
2 COPY /target/liberty/wlp/usr/servers/defaultServer /config/
3 COPY /target/liberty/wlp/usr/shared/resources /config/resources/
4 COPY /src/main/liberty/config/jvm.options /config/jvm.options
5 COPY /lib/vertica-jdbc-7.2.3-0.jar /config/resources/vertica-jdbc-7.2.3-0.jar
6 RUN installUtility install --acceptLicense defaultServer
```

COPY: Instructions to copy shared resources and jvm.options files to the correct folders in the image

RUN: Execute shell commands to install all required Liberty features

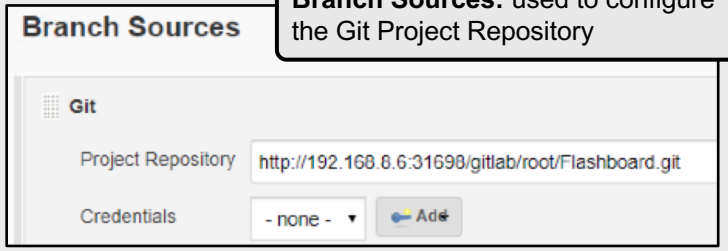
COPY: Instead of copying a configured Liberty server, you may also copy a configured *server.xml* file and application deployable to the image

Alternate

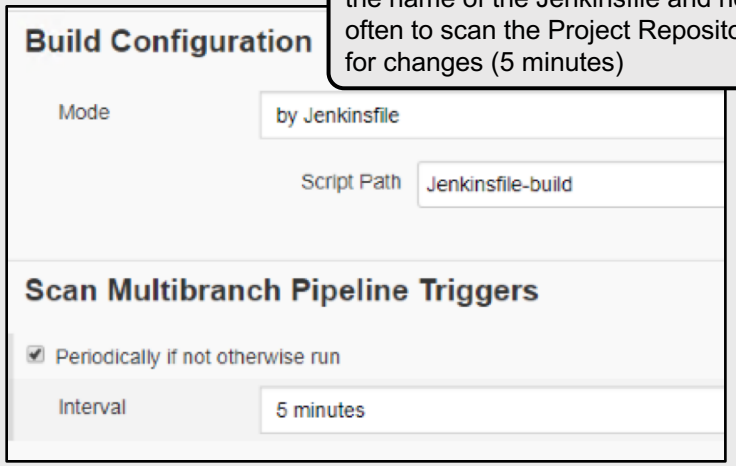
```
2 COPY server.xml /config
3 COPY FB_WAS.war /config/dropins
```

Jenkis Pipeline for automated build

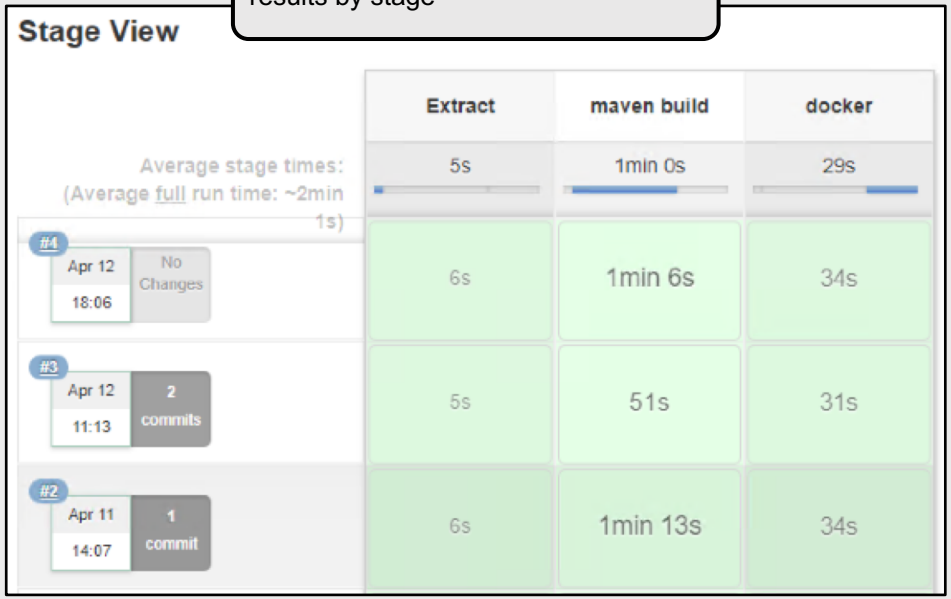
Branch Sources: used to configure the Git Project Repository



Build Configuration: used to specify the name of the Jenkinsfile and how often to scan the Project Repository for changes (5 minutes)



Build Results: displays the most recent pipeline executions and the results by stage



ICP Continuous Deployment (Build/Ship/**Run**)

Rapidly progressing the latest packaged build through the test lifecycle stages and into production

Deploy to Test

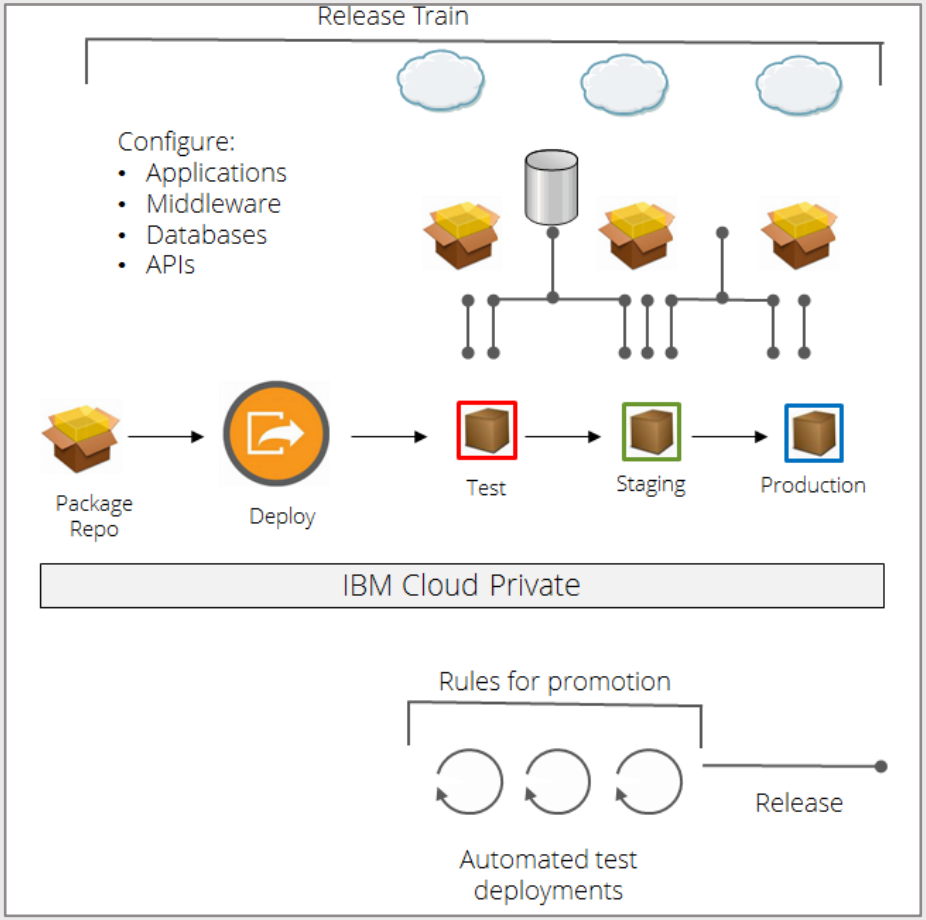
- Perform functional testing

Deploy to Stage

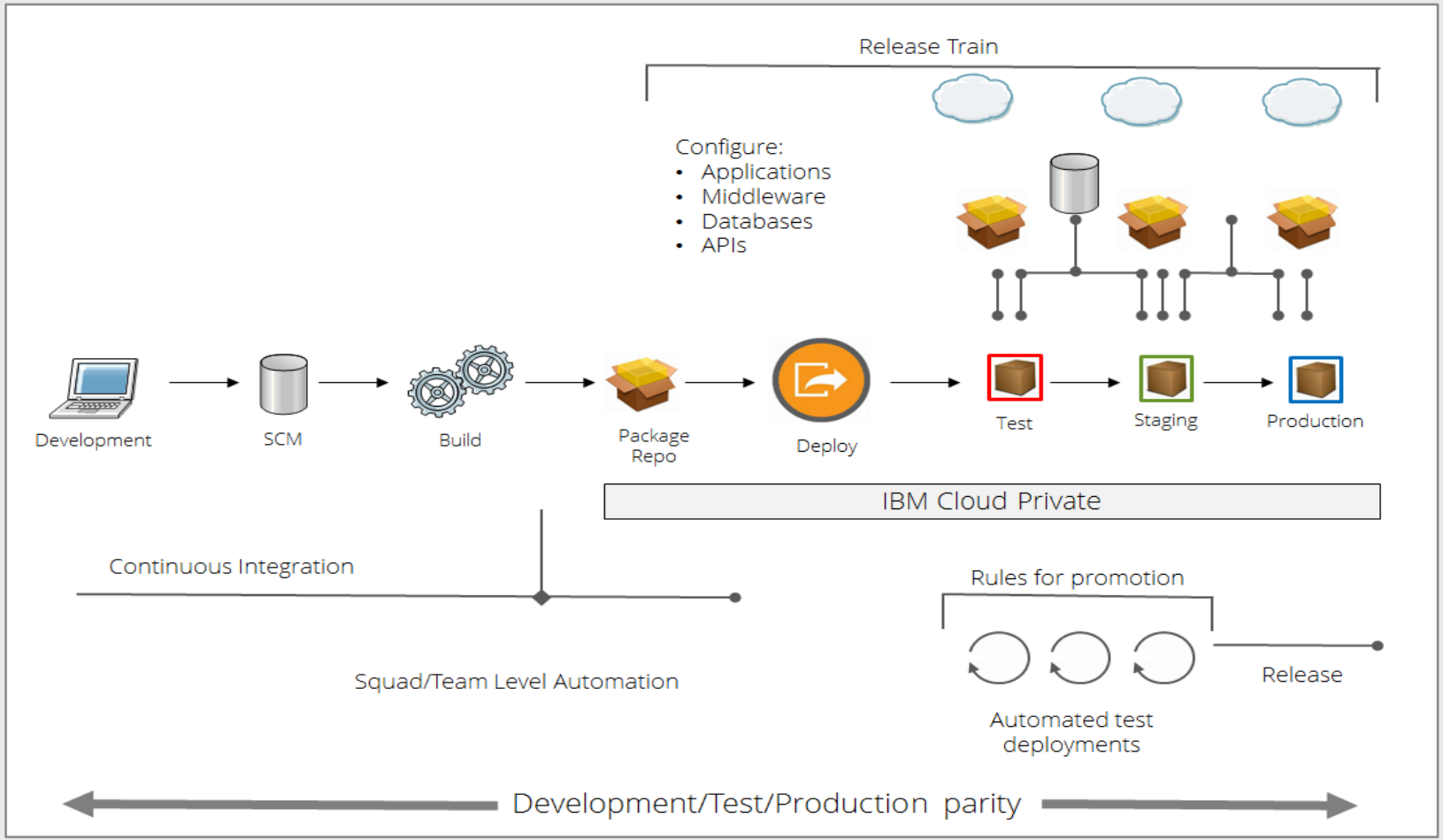
- Rehearse production deployment
- Perform integration testing

Deploy to Prod

- Make the build available to users



ICP CI/CD (Continuous Delivery) pipeline



Automating deployment using Jenkins

podTemplate: Deployment requires a docker container with the kubernetes CLI installed

Extract stage: Extracts the source code from *git* and gets the last *commit id*

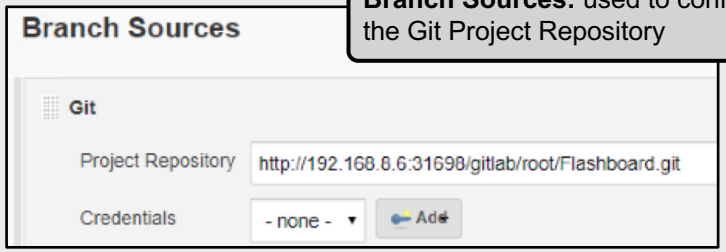
deploy stage: uses the Kubernetes CLI to check whether the *deployment* already exists.

If the *deployment* exists then it is updated with a new docker image which triggers the Pods to be destroyed and recreated with the new image.

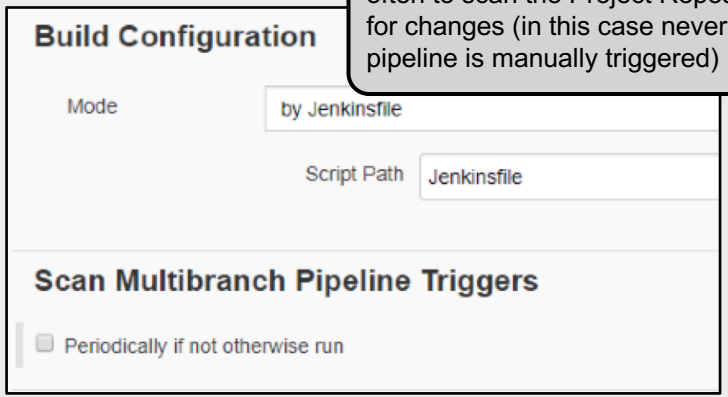
If the *deployment* doesn't exist then the *deployment script file* is updated with the docker image name and tag and then the *deployment* and *service* are created

```
def volumes = [ hostPathVolume(hostPath: '/var/run/docker.sock', mountPath: '/var/run/docker.sock') ]
volumes += secretVolume(secretName: 'microclimate-icp-secret', mountPath: '/msb_reg_sec')
podTemplate(label: 'icp-build',
    containers: [
        containerTemplate(name: 'kubectl', image: 'ibmcom/k8s-kubectl:v1.8.3', ttyEnabled: true, command:
        'cat')
    ],
    volumes: volumes
)
{
    node ('icp-build') {
        stage ('Extract') {
            checkout scm
            gitCommit = sh(script: 'git rev-parse --short HEAD', returnStdout: true).trim()
            echo "checked out git commit ${gitCommit}"
        }
        stage ('deploy') {
          container('kubectl') {
            def imageTag = null
            imageTag = gitCommit
            sh """
            #!/bin/bash
            echo "checking if flashboard-deployment already exists"
            if kubectl describe deployment flashboard-deployment --namespace nm-pilot; then
                echo "Application already exists, update..."
                kubectl set image deployment/flashboard-deployment flashboard=mycluster.icp:8500/nm-
                pilot/flashboard:${imageTag} --namespace nm-pilot
            else
                sed -i "s/<DOCKER_IMAGE>/flashboard:${imageTag}/g" manifests/kube.deploy.yml
                echo "Create deployment"
                kubectl apply -f manifests/kube.deploy.yml --namespace nm-pilot
            fi
            echo "Describe deployment"
            kubectl describe deployment flashboard-deployment --namespace nm-pilot
            echo "finished"
            """
          }
        }
    }
}
```

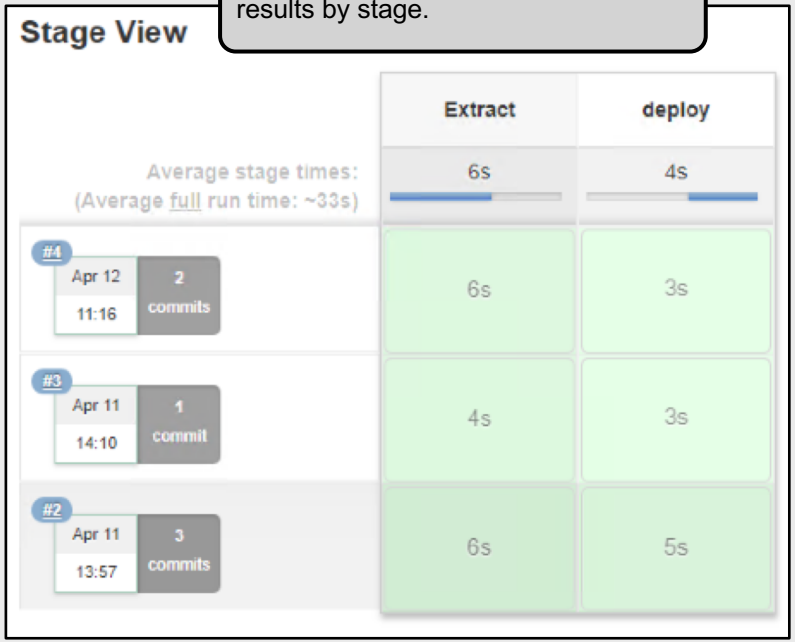
Jenkins Pipeline for automated deploy



Branch Sources: used to configure the Git Project Repository



Build Configuration: used to specify the name of the Jenkinsfile and how often to scan the Project Repository for changes (in this case never as this pipeline is manually triggered)



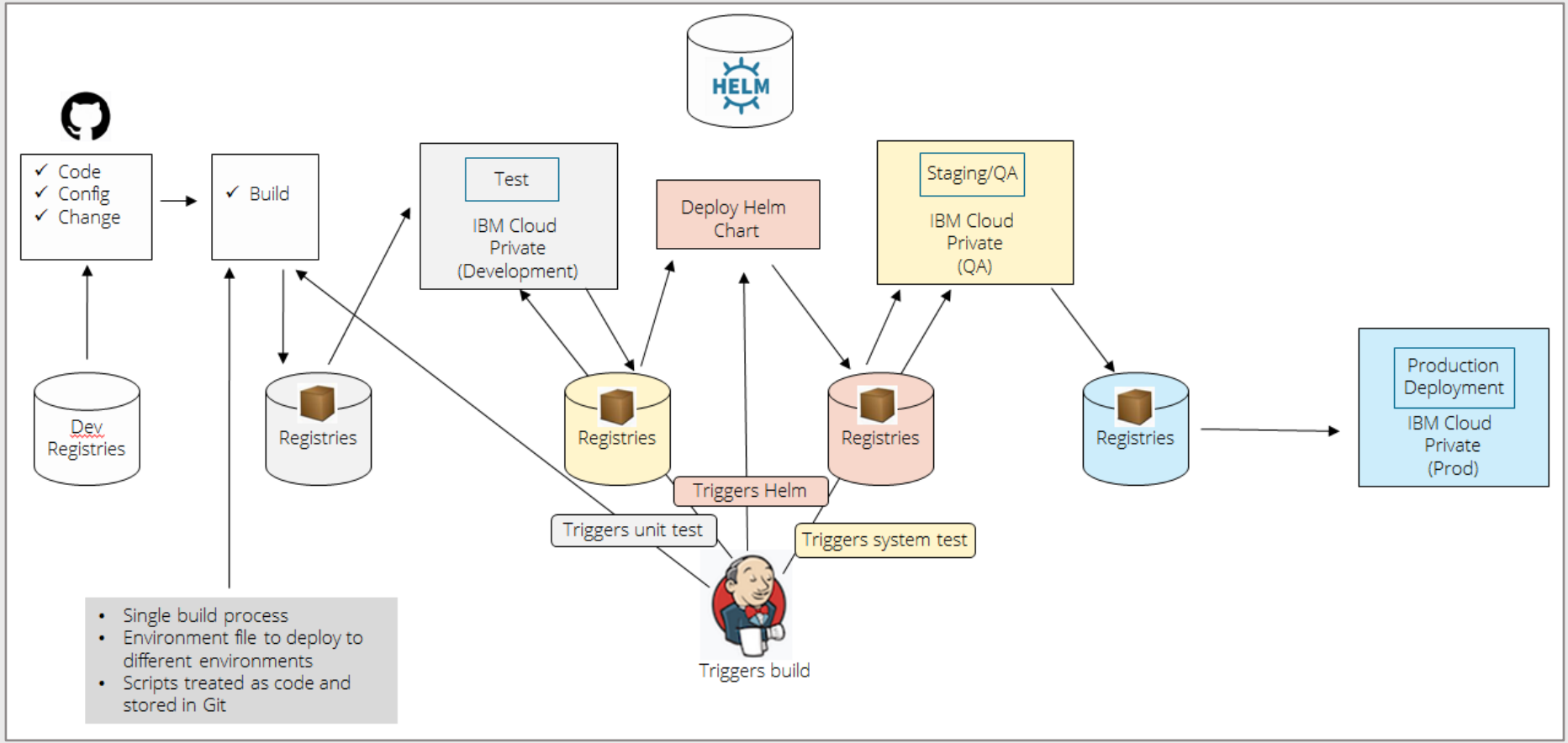
Build Results: displays the most recent pipeline executions and the results by stage.

Automation

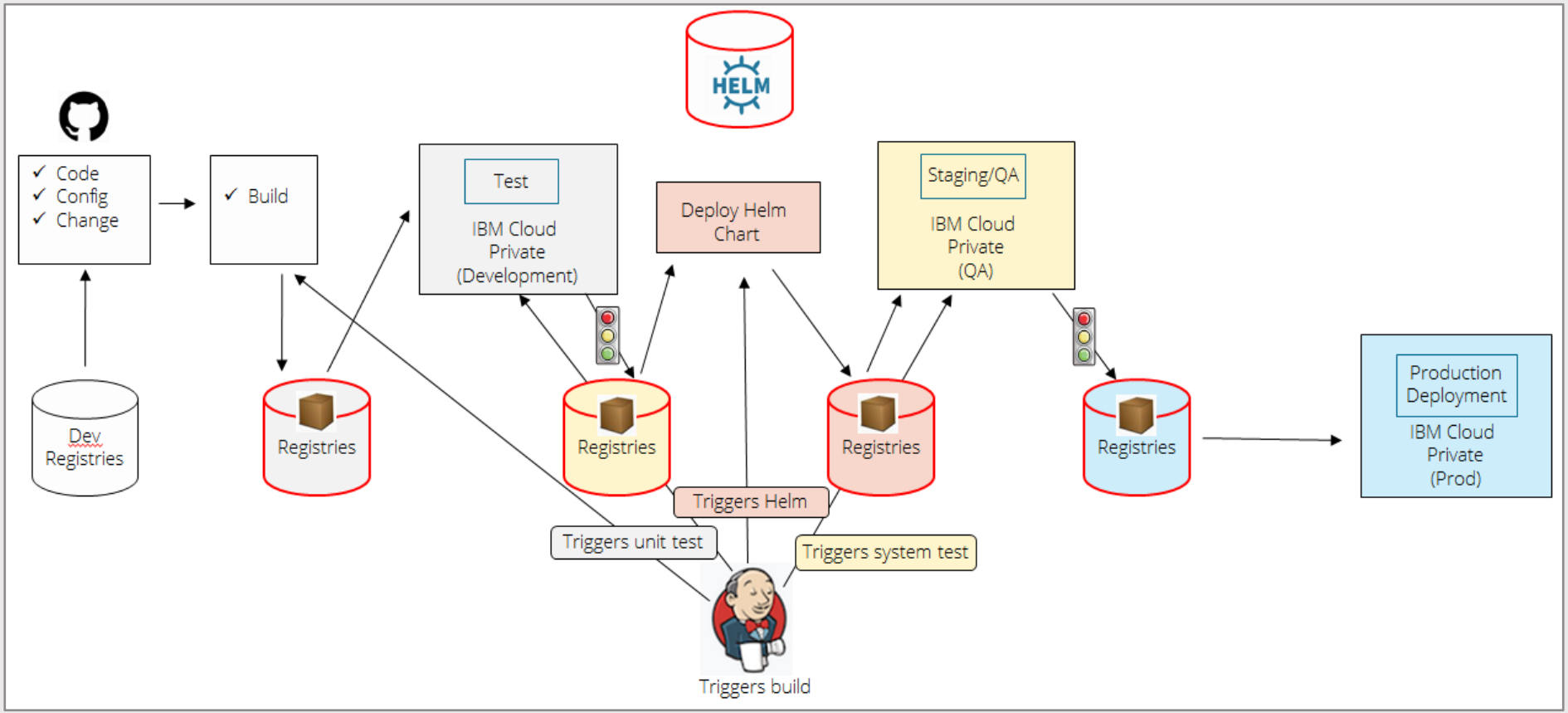
Helm

- A package manager for Kubernetes
- Enables multiple Kubernetes resources to be created with a single command
- Deploying an application often involves creating and configuring multiple resources

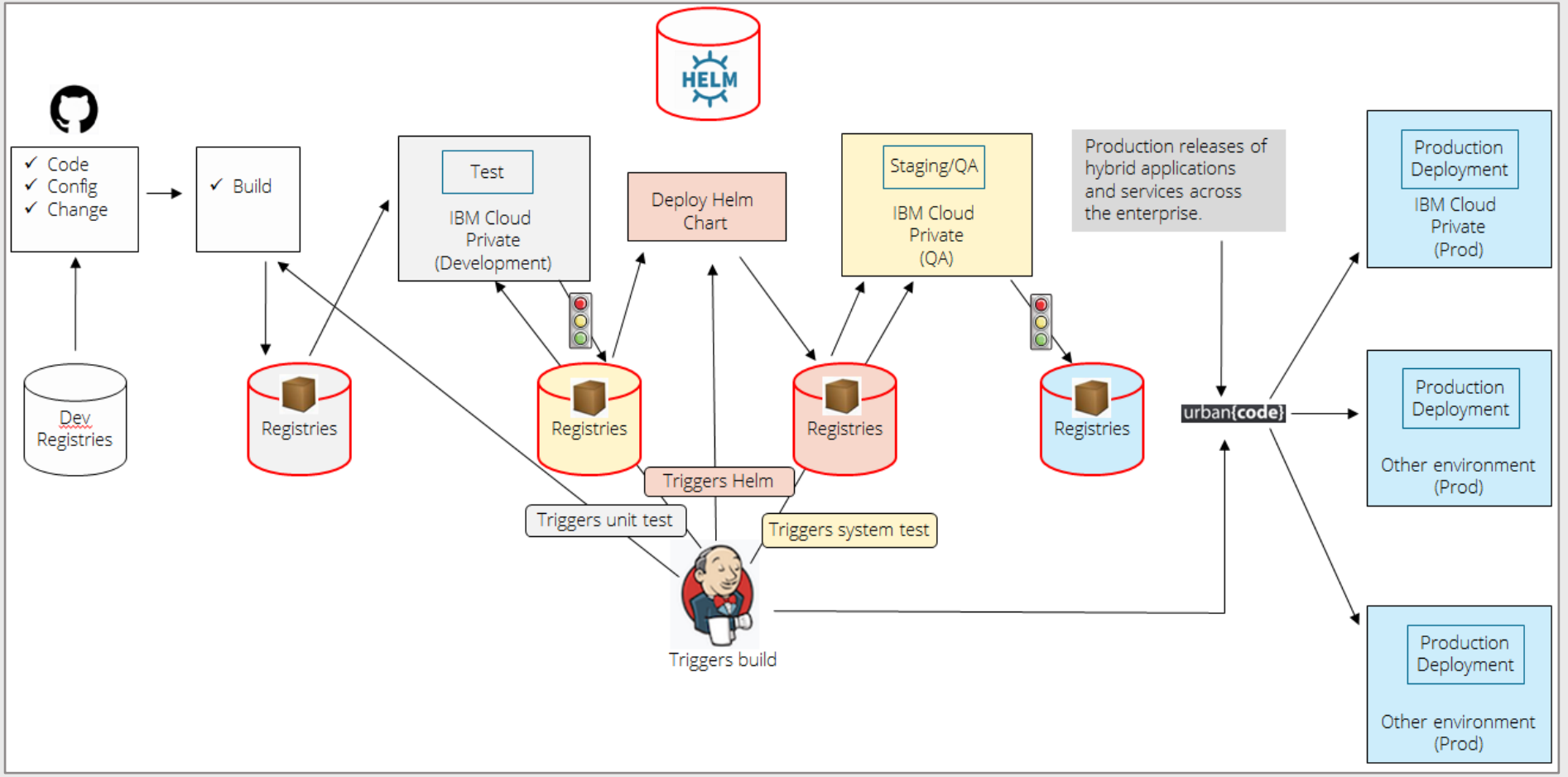
Helm deployment



Quality gates and trusted, secure image repository



Deployment to Hybrid



Customer Example

DevOps Roles

Roles	Description of Responsibilities
Developer	Developers today must take a more holistic, operational mindset approach to their work. Developers often must write code in their "local system", using tools like git, maven and IDEs. They also • are responsible for designing and coding solutions based on user requirements • must use SCM tools, like git, to version control their code changes, and tools like Maven and Jenkins to build their code. • must understand full-stack engineering, including deployment automation, and possess an understanding of the infrastructure supporting their application and the non-functional characteristics of the application.
Automation Engineer	An automation engineer is responsible for • identifying and automating manual processes to promote continuous integration, testing, staging, and then deployment and operations. • for defining the Continuous Integration / Continuous Delivery (CI/CD) processes and implementing them using such tools as git, Jenkins, Artifactory, Maven, Black Duck and others In addition, automation engineers work closely with cloud operations to streamline workflows (such as user administration, security and infrastructure provisioning) to help the organization adopt infrastructure as code.
Developer Lead	While the exact responsibilities Developer Lead may vary from company to company, in general they are responsible for the underlying software architecture, overseeing the work being done by the other developers on the team and often act as the Integration when critical pieces of code must be delivered and tested.
Tester	A Tester is responsible for verifying and validating the application being tested. Where verification is about proving that the application is working properly and doing the job that the developer intended. While validation, on the other hand, confirms that the program is performing the task requested by the customer.

DevOps Roles – cont.…

Roles	Description of Responsibilities
Project Lead	A Project Lead often plays multiple roles of such as Project Manager, Team Lead and sometimes implementer as part of an agile team. • The Project Lead is intimately familiar with the product's user needs and related features. • They know the team's implementation plan and can creatively consider alternatives if constraints challenge the original plan. • They also must be able to anticipate constraints early on and manage scope appropriately.
Application Owner	An Application Owner is the individual, usually from the Business organization, responsibility to ensure that the software projects, which make up the application, meet the specified objective set by the business organization and user requirements established for that application.
Release Coordinator	A Release Coordinator typically is responsible for planning and coordination of all phases and activities involved in the release of a system update into the production environment. Typically this roles: • facilitates release meetings and develops the release recommendation and release deployment plan • identify priorities, conflicts, dependencies, and risks for the release. • Works with other Ops resources such as the SRE, Project Lead and Developer Leads to ensure that the plans are in place to mitigate those risks (e.g., rollback plans)
Site Reliability Engineer	A Site Reliability Engineer (SRE) will spend up to 50% of their time doing "ops" related work such as issues, on-call, and manual intervention. Typically the Site Reliability Engineer role will involve some or all of the following tasks • eliminating performance bottlenecks by refactoring services into more scalable units. • isolating failures through use of the cloud design patterns like the 'circuit breaker' and 'bulkhead' • creating runbooks to ensure fast service recovery. • automation of day to day ops processes.

Terminology

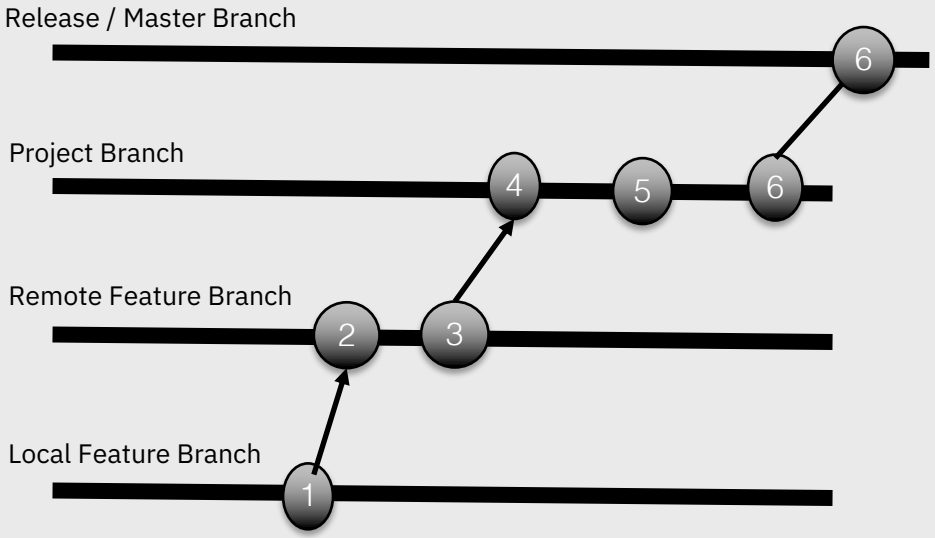
No	Term	Description
1	git	Git is a distributed version control system used for tracking changes in computer files and coordinating work on those files among multiple people. Created by Linus Torvalds, git has become one of the most widely used source code management in software development
2	Jenkins	Jenkins is an open source continuous integration (CI) / continuous delivery (CD) tool used for software development. Jenkins has a large number of integrations, called “plugins”, which are used to extend its functionality such as integrations with git, Artifactory, UrbanCode, SonarQube, etc.
3	Black Duck	Black Duck's multi-factor open source detection capabilities used to identify vulnerability, and license information to mitigate security and license compliance risks. Black Duck is often integrated with your , existing DevOps tools and processes.
4	SonarQube	SonarQube is an open source continuous inspection tool used for code quality, automatic reviews with static analysis of code to detect bugs, code smells, and security vulnerabilities on 20+ programming languages. SonarQube provides fully automated analysis and integration with Maven, Ant, Gradle, MSBuild and continuous integration tools such as Jenkins
5	Artifactory	Artifactory is a Binary Repository Manager for software artifacts. It offers advanced proxying, caching and security facilities and provides a robust, reproducible build environment when using Maven, Ant/Ivy, Gradle or parallel build technologies.
6	UrbanCode Deploy	UrbanCode Deploy is built to support mission-critical deployments to thousands of servers in numerous data centers. Master server clustering support provides high availability and horizontal scalability of the deployment automation tool. UrbanCode Deploy uses light-weight deployments agents which provide an immediate presence on or near the target.

Git Branches Mapped to Environments

In this scenario we will use a single Git repository to support a 3 - 8 regular code contributors. We will also follow the Git workflow pioneered by Vincent Driessen's "GitFlow".

In this scenario, the Git repo will consist of a

- Release / Master branch,
- Project branch, and
- Fluctuating number of feature, release, and hotfix branches.



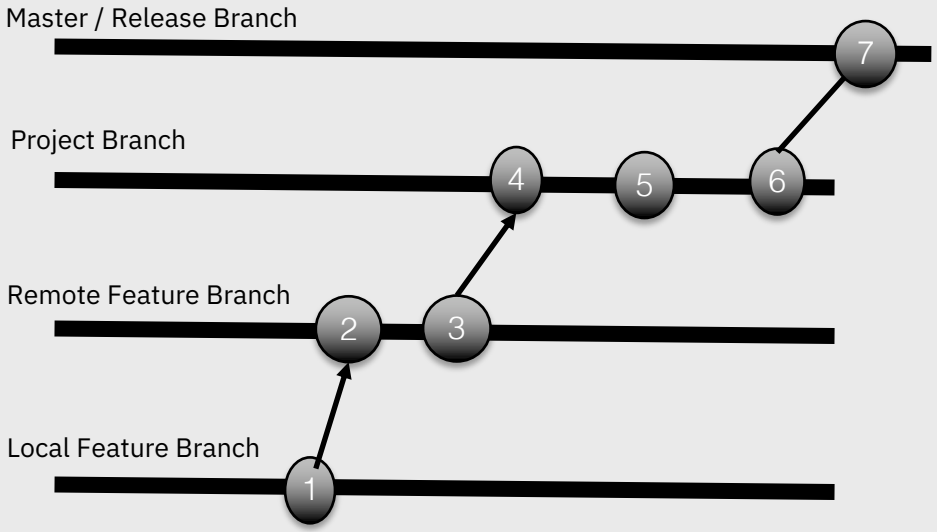
1. Developer modifies source in SANDBOX for a single line code change requiring very little testing (e.g., adding an image)
2. Developer pushes change to Remote Branch, Jenkins build pushed to UrbanCode which deploys update to DEVELOP
3. Developer completes Unit and Functional in their DEVELOP namespace, may also run any automated testing created by QA team, Add Quality tags to UCD Components under test
4. Developer, Tester, Lead are notified that new code promoted to SYSTEM, automated tests cases executed, updates Quality tags in UCD

Mapping Git Branches to Staging Environments

In this scenario we will use a single Git repository to support a 3 - 8 regular code contributors. We will also follow the Git workflow pioneered by Vincent Driessen's "GitFlow".

In this scenario, the Git repo will consist of a

- Master branch,
- Develop branch, and
- Fluctuating number of feature, release, and hotfix branches.



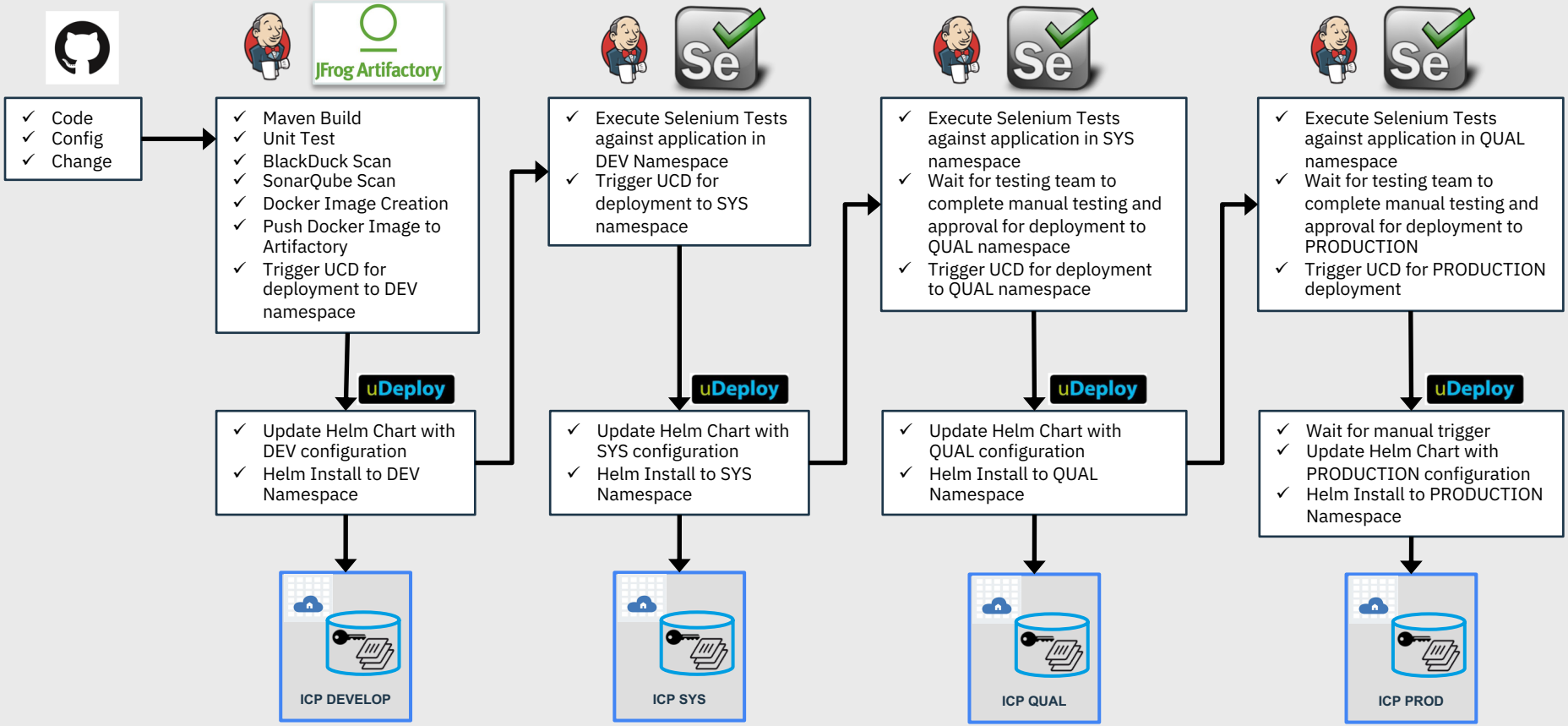
QUAL NAMESPACE
(ICP APPLICATION Namespace)

SYSTEM NAMESPACE
(ICP TEAM Namespace)

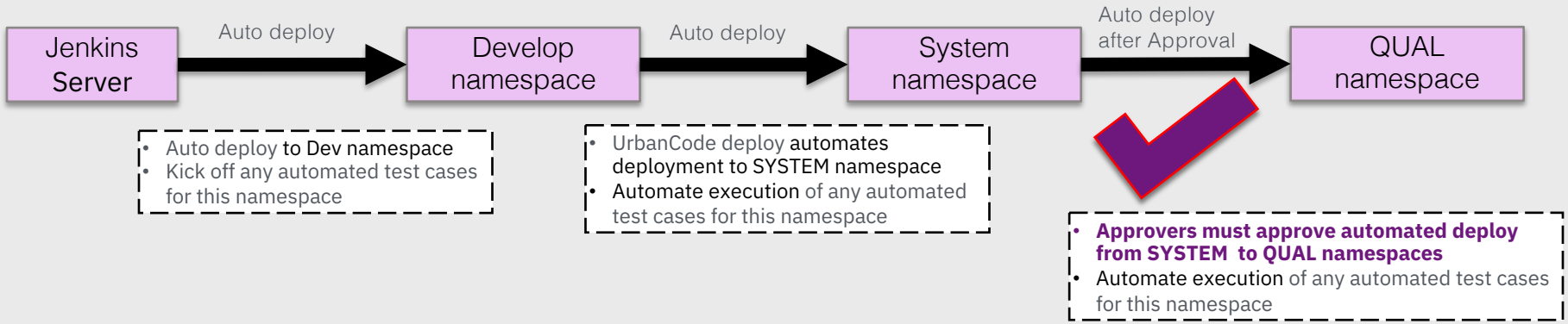
DEVELOP NAMESPACE
(ICP personal Namespace)

(Local Development)

Deployment to ICP Clusters



Approvals and Quality Gates



Approvals

- Deployment approvals are created in a process that specifies the job that needs approval and the role of the approver. When a request for approval is made, the users with the corresponding role
- UrbanCode Deploy uses Quality gates to ensure the code changes passes specific quality checks prior to being deployed
- Each stages usually has different requirements based on the needs of the team, governance
- For example, if the code satisfies the defined quality requirements; for instance,

1. the local build may need to run successfully and have all tests pass locally.
2. Build, test, and metrics should pass out of the central development environment, and then
3. automated and manual acceptance tests are needed to pass the system test.

In our case, we have identified one quality gate to pass is the one from the SYSTEM to QUAL