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# Chapter 1 – Key CI/CD/Jenkins Concepts

## Continuous Delivery/Continuous Integration Concepts

### Define continuous integration, continuous delivery, continuous deployment

* Continuous integration – everyone commits to the mainline at least daily and automated build to verify
* Continuous delivery – can release to prod at any time via a push button deployment
* Continuous deployment – actually deploying to production continually
* DevOps is cultural and is broader than continuous delivery
* Pipeline has visibility, feedback and continuous delivery
* CI practices
  + Single source repository
  + Automate the build
  + Make your build self testing
  + Everyone commits everyday
  + Every commit triggers a build
  + Fix broken builds immediately
  + Keep the commit build fast (and use pipeline for slower builds)
  + Test in a clone of the prod environment
  + Make it easy to get the latest build
  + Visibility
  + Automate deployment
* CD principles
  + Check in
  + Build and unit tests
  + Automated acceptance tests
  + User acceptance test
  + Release

### Difference between CI and CD

* CI doesn’t require deploying

### Stages of CI and CD

* Start with the commit stage which compiles and runs unit tests.
* Then run longer tests/quality tools/ Ex: acceptance tests (given/when/then)
* Finally, deploy

### Continuous delivery versus continuous deployment

* Delivery means the ability to deploy to production. Deployment means actually doing so

## Jobs

### What are jobs in Jenkins?

* Job/Project – Runnable tasks

### Types of jobs

* Freestyle project
* Maven project
* Pipeline
* Multi configuration
* Multi branch
* Long running

### Scope of jobs

* *Not sure what this means – Maybe that there is a long running job type?*

## Builds

### What are builds in Jenkins?

* Build – Result of one run of a job/project

### What are build steps, triggers, artifacts, and repositories?

* Build step – a single operation withing a build
* Triggers – something that starts a build (time, SCM polling, etc)
* Artifact – output of a build
* Repository – the SCM system where the code to be built lives

### Build tools configuration

* In Manage System, set up location of tools like the JDK, Ant and Maven

## Source Code Management

### What are source code management systems and how are they used?

* Use to track code
* Client/server – one source of truth such as SVN.
* Distributed version control – every developer has copy of repository, peer to peer, such as Git.

### Cloud-based SCMs

* Ex: Git hub

### Jenkins changelogs

* List commits since last build

### Incremental updates v clean check out

* Incremental updates – faster
* Clean check out – guarantees no extra or changed local files

### Checking in code

* Should be at least daily with CI

### Infrastructure-as-Code

* Storing everything needed to build your environment

### Branch and Merge Strategies

* Branch by release
* Branch by feature – by user story
* Branch by abstraction – one branch, but turn features on/off by release
* Merge regularly

## TESTING

### Benefits of testing with Jenkins

* Fast feedback!

### Define unit test, smoke test, acceptance test, automated verification/functional tests

* Unit test – test one class, often involves test doubles
* Integration/functional test – test components together
* Smoke test – sanity check to reject a release. Looking for major errors.
* Acceptance test – user level test for feature

## Notifications

### Types of notifications in Jenkins

* Failure, second failure, success, etc
* Active/push – radiators/SMS vs passive/pull – rss/dashboard
* RSS - /rssAll, /rssFailed and rssLatest
* Radiator view plugin uses the entire screen
* Extreme feedback – physical/audio devices

### Importance of notifications

* Fixing a build is high priority so need to know it is broken
* Communicating the status to all parties

## Distributed Builds

### What are distributed builds?

* Running builds on a different machine than master

### Functions of masters and slaves

* Master – basic Jenkins install
* Slaves – just for running jobs

## Plugins

### What are plugins?

* Add functionality to core Jenkins

### What is the plugin manager?

* UI for uploading/managing plugins

## Jenkins Rest API

### How to interact with it

* Format: XML or JSON
* Python and Ruby wrapper APIs

### Why use it?

* Programmatic access

## Security

### Authentication versus authorization

* Authentication – identify a user
* Authorization – what user can do

### Matrix security

* Maps roles to permissions
* Major categories: overall, slave, job, run, view and SCM

Definition of auditing, credentials, and other key security concepts

* Auditing – logging user operations and changes
* Credentials – username/password or the like for access

## Fingerprints

### What are fingerprints?

* MD5 checksum of files
* UI says for jar files, but works for any type of file

### How do fingerprints work?

* The first time you run a job with a post build step to generate a fingerprint, a new left navigation option shows up to check a file’s fingerprint.
* You can upload a file you have to see if any file Jenkins knows the fingerprint of matches.

## Artifacts

### How to use artifacts in Jenkins

* Download, put in Nexus, deploy, etc

Storing artifacts

* Can archive
* Can control discard policy

## Configuration Management (Tools such as Chef, Puppet, etc.)

### Elements of software configuration management

* Tracking/controlling changes in the software
* Includes version control

### Change management policies

* *Not sure what they mean here. This is a big topic*

### Importance of software configuration management

* Need to know what you deploy!

## Using 3rd party tools

### How to use 3rd party tools with Jenkins

* Setup in Manage System the location on disk or download from there
* Ex: JDK, Maven, Git
* Can install automatically or from file system

# Chapter 2 – Jenkins Usage

## Jobs

### Organizing jobs in Jenkins

* Jobs are organized in folders

### Parameterized jobs

* Check “This build is parameterized” and enter parameters/default values
* Run directly with “Build with Parameters” or call from upstream job with “trigger parameterized build” post build action and passing parameters

### Usage of Freestyle/Pipeline/Matrix/Maven/Literate

* Freestyle – most flexible job
* Pipeline – enter code in DSL. There is a snippet generator which generates the Groovy for common operations and lists the available environment variables.
* Matrix (multi-config) – Specify a configuration matrix with one or more dimensions. Runs all combinations when build.
  + Axis: slave, label (for slave) or user defined (string)
  + Combination filter: if don’t want cross product of all axis to run
  + Can execution “touchstone” builds first to specify which job(s) should run first and if this should skip the others
* Maven - less options than Freestyle since can assume based on Maven conventions
* Literate – brand new plugin (Dec 2015) – allows specifying build commands in README.md file in source control. A literate job is a type of multi-branch job. (searches for new branches and creates jobs in folder automatically)

## Builds

### Setting up build steps and triggers

* Common build steps include Maven/Ant, execute shell, start/stop Docker container
* Common triggers include time/periodic, SCM polling, upon completion of another job

### Configuring build tools

* In Manage Jenkins > Manage System
* Install automatically or via system

### Running scripts as part of build steps

* Can run OS script or Groovy script
* Groovy scripts can run as system or user level. System has access to Jenkins object model

## Source Code Management

### Polling source code management

* Set schedule using cron format
  + minute hour dayOfMonth month dayOfWeek
  + For dayofWeek, 0 is Sunday and 7 is Saturday
  + Can use H (or H/2 etc) for minute column to use a hash based on the job name to distribute jobs so don’t all start at the top of the hour.
  + Also support, @yearly, @annually, @monthly, @weekly, @daily, @hourly and @midnight
  + @Midnight means between midnight and one am since uses hash to distribute
* Required URL
* Optional credentials
* Options vary by repo. Ex: SVN lets you specify infinity/immediates/etc as checkout depth. Git lets you specify a branch specifier

### Creating hooks

* Hook script in repository triggers job
* Ex: Github plugin provides hook

### Including version control tags and version information

* Git allows you to create a tag for every build
* Version Number plugin lets you include info in build name

## Testing

### Testing for code coverage

* In build, must create XML file with data
* Post Build Action to publish
* For Java: Cobertura and JaCoCo
* In Cobertura, can set thresholds for weather icons:
  + Sunny - % higher than threshold
  + Stormy - % lower than threshold
  + Unstable - % lower than threshold
* In Jacoco, can set thresholds for sunny and stormy

### Test reports in Jenkins

* Publish JUnit or TestNG reports
* In JUnit, can set amplification factor - 1.0 means 10% failure rate scores 90% health. .1 means 10% failure rate scores 99% health.

### Displaying test results

* Configure as Post Build Action
* Point to xml files: ex: reports/\*.xml
* Can drill down to see details of tests runs and durations

### Integrating with test automation tools

* Can run acceptance tests later in pipeline than unit/component tests

### Breaking builds

* JUnit allows choosing whether to fail builds on test failures - default is “unstable” not failure

## Notifications

### Setup and usage

* Setup in post build action section

### Email notifications, instant messaging, build radiators

* Email
  + Same recipient for each one (except can add committers since passed)
* Email ext
  + lets you customize the message and tailor the recipients per trigger
  + can send on failing, still failing, unstable, still unstable, successful, etc
* Jabber and IRC for instant messaging
* Since build radiators are full screen, the only way to edit is to add /configure to the URL

### Alarming on notifications

* Extreme notifications can have a video or audio cue in the real world

## Distributed Builds

### Setting up and running builds in parallel

* Builds run on different executors
* Multi-configuration jobs run the pieces in parallel

### Setting up and using SSH slaves, JNLP slaves, cloud slaves

* Can launch local slaves with SSH (blocking or non-blocking IO), Java Web Start, command line on master or Windows service

### Monitoring nodes

* Monitoring page uses JMelody
* Memory/CPU/etc stats
* Can see heap dump/GC/etc

## Plugins

### Setting up and using Plugin Manager

* Can provide a HTTP proxy if needed
* Can specify alternate update center URL for JSON
* Listed installed plugins
* Can install/upgrade/uninstall plugin
* Can unpin plugin so doesn’t use specific version of plugin

### Finding and configuring required plugins

* Updates tab – for upgrading plugin already have
* Available tab – for downloading new plugins
* Advanced tab – for uploading plugin hpi/jpi file from disk
* Configure plugins on Manage Jenkins -> Manage System

## CI/CD

### Using Pipeline (formerly known as Workflow)

* Use DSL to specify jobs to be built
* Example: node { stage ‘x’ echo ‘1’ stage ‘y’ echo ‘2’ }
* Sample commands:
  + build 'jeanne-test'
  + svn - checkout
  + retry – retry body up to X times
  + timeout – limit time spent in block
  + stash/unstash
  + load – include a Groovy script
  + parallel – specify two branches to run in parallel and whether to failFast
* When run build, see table with column and duration for each stage. Row is build #. Cell color coded for pass/fail. Can see log for each stage.

### Integrating automated deployment

* Have the pipeline itself triggered by SCM
* Then the pipeline triggers the commit job first followed by the rest of the jobs in the pipeline
* The docker variable can be used as a build step in the pipeline or to surround other lines

### Release management process

* *Not sure what this refers to. Gates/approvals?*

### Pipeline stage behavior

* Stages run one at a time unless specify parallel
* A subsequent stage only runs if the prior one was successful

## Jenkins Rest API

### Using REST API to trigger jobs remotely, access job status, create/delete jobs

* /api shows docs for the REST API at that level of the object model
* /api/xml, /api/json, /api/json?pretty=true, /api/python and /api/python?pretty-true
* Choose “trigger builds remotely” on build and set token to allow POST call.
  + Run build: POST to JENKINS\_URL/job/job-name/build?token=MY\_TOKEN
  + Run build with reason: POST to JENKINS\_URL/job/job-name/build?token=MY\_TOKEN&cause=xyz
  + Run Parameterized Build: POST to JENKINS\_URL/job/job-name/buildWithParameters?token=MY\_TOKEN&param=xyz
* Error handling:
  + If try to call /build for parameterized job, get a 400 error
  + If try to call with wrong token, get a 403 error
  + If don’t choose “trigger builds remotely”, it worked
* CSRF
  + Get token at JENKINS\_URL/crumbIssuer/api/xml
  + Pass .crumb as header with POST
* All job (at top level) latest status: JENKINS\_URL/api/xml
* Build numbers and urls for a job: JENKINS\_URL/job/jobName/api/xml
* Build result and details: JENKINS\_URL/job/jobName/buildNumber/api/xml
* Create job: POST to JENKINS\_URL/createItem?name=jobName and post config.xml
* Delete job: POST to JENKINS\_URL/job/jobName/doDelete
* Enable job: POST to JENKINS\_URL/job/jobName/enable
* Disable job: POST to JENKINS\_URL/job/jobName/disable

## Security

### Setting up and using security realms

* Choices include Servlet Container, Google SSO, OpenId, Jenkins user database, LDAP, UNIX group/user database, JCOC SSO

### User database, project security, Matrix security

* People link shows user list + committers
* Matrix based security – control privileges granularly using user ids/groups
* Project based matrix authorization security – Matrix based + set privileges on job configuration page as well
* Role based matrix authorization security – Manage Roles to control permissions by group. Adds groups/roles tabs to projects

### Setting up and using auditing

* Manage Jenkins > System Log – for logging
* Job Configuration History plugin – for job config
* Audit Trail plugin – for Jenkins config

### Setting up and using credentials

* Domain – URL, host etc
* Credentials – username/password, cert, etc
* Use by choosing from pull down in job

## Fingerprints

### Fingerprinting jobs shared or copied between jobs

* Used to determine if a dependency has changed
* See which projects use a dependency
* See where fingerprinted files came from

## Artifacts

### Copying artifacts

* Build step to copy artifacts from another build
* Can choose which ones want to include/exclude by pattern

### Using artifacts in Jenkins

* Can refer to artifacts after build
* Treated specially not just as part of workspace

### Artifact retention policy

* By default, kept same length of time as build log.
* Can keep less time to save disk space

## Alerts

### Making basic updates to jobs and build scripts

* *Not sure what they mean here*

### Troubleshooting specific problems from build and test failure alerts

* *Not sure what they mean here*

# Chapter 3 – Building Continuous Delivery Pipelines

## Pipeline Concepts

### Value stream mapping for CD pipelines

* Entire process from concept to cash for a product
* Includes non code aspects such as product discovery
* Shows were time goes in process and where waits/delays are
* CD pipeline is subset of value stream map

### Why create a pipeline?

* Automated manifestation of process for getting software from version control to users
* Allows for phases of increasing fitness

### Gates within a CD pipeline

* Provide a point for approval before continuing.

### How to protect centralized pipelines when multiple groups use same tools

* *Not sure what this means. Approvals? Security?*

### Definition of binary reuse, automated deployment, multiple environments

* Binary reuse – Use other components as packaged, artifacts that have passed success criteria
* Automated deployment – using the same script to deploy to every environment
* Multiple environments – resources/configuration needed to work: ex: test, QA, Prod

### Elements of your ideal CI/CD pipeline – tools

* Source control repository
* Binary repository
* Automated testing
* Capacity testing
* Deployment

### Key concepts in building scripts (including security/password, environment information, etc.)

* Credentials plugin for password
* Keep environment information in source control
* Different script for each stage in the pipeline

## Upstreams and downstreams

### Triggering jobs from other jobs

* Build other projects
  + Comma separated list of jobs
  + Can specify to trigger only on good builds, good builds + unstable builds and always (even on failure)
  + All jobs share same trigger
* Trigger parameterized build on other projects
  + Comma separated list of jobs
  + Can control based on success, unstable, failure only, aborted, etc
  + Can set up multiple triggers so each set has different rules on when to run
  + Parameter types include boolean, string, from a property file, current build parameters, etc
  + Can pass through information like slave or Git/SVN trigger info

### Setting up the Parameterized Trigger plugin

* Check “This build is parameterized” and setup parameters
* Can use Node to specify slave by name from select list or label to specify slave’s build label

### Upstream/downstream jobs

* If A depends on B, B is the upstream job

## Triggering

### Triggering Jenkins on code changes

* For a commit build

### Difference between push and pull

* Pull - Set up a SCM polling trigger
* Push – Set up a hook from the repository to trigger job

### When to use push vs pull

* Pull for when you don’t control the repository or polling is ok
* Push for when you need an immediate build or don’t want to waste resources on polling

## Pipeline (formerly known as Workflow)

### Benefits of Pipeline vs linked jobs

* Scripted – can code loops/conditionals
* Resilient – can survive Jenkins restarts
* Pausable – can get manual approval
* Efficient – can restart from checkpoints
* Visualized – can see in dashboard

### Functionalities offered by Pipeline

* Build steps, pauses, parallelization, deploy, stash/unstash, etc
* Can run on certain node with node(‘master’) {}
* Can prompt user with input ‘query’
* Can do anything Groovy can do
* Can create stages

### How to use Pipeline

* Put commands want to run inside node{}
* Use snippet generated or write groovy script
* Can store global libraries in git at git clone <Jenkins>/workflowLibs.git

### Pipeline stage concurrency

* Parallel lets you run stages at same time

## Visualization

### Options to visualize jobs’ relationships

* Build Pipeline view – shows upstream/downstream dependencies for one job
* A pipeline automatically creates a stage view – can click to see “Full Stage View”
* Delivery pipeline view – not on exam? – shows more details about stages

### When to use various options for visualizing jobs’ relationships

* Can restrict to only include successful builds

### Information offered by a build pipeline view

* Dependencies
* Status
* When run

### How to set up build pipeline visualization

* Create a new view
* Choose job to start from
* Can also include in a dashboard view so have more than one per page

## Folders

### How to control access to items in Jenkins with folders

* Role Based Access Control can control folder
* Can control level as current/child/grandchild

### Referencing jobs in folders

* <jenkinsHome>/job/folder/job/name

## Parameters

### Setting up test automation in Jenkins against an uploaded executable

* File parameter in parameterized job
* Prompted to upload it when running manually

### Passing parameters between jobs

* Can type parameters, use property file, etc

### Identifying parameters and how to use them: file parameter, string parameter

* String parameter referred to by variable name ${TEST}
* File parameter placed in the workspace in the parameter name

### Jenkins CLI parameters

* Download jar from <Jenkins>/jnlpJars/jenkins-cli.jar
* Run as java –jar Jenkins-cli.jar –s <jenkinsUrl> help
* Add –noKeyAuth if don’t want to use SSH key

## Promotions

### Promotion of a job

* Can run steps after a gate
* Ex: archive artifacts, deploy, etc

### Why promote jobs?

* Way of communicating a build is good

### How to use the Promoted Builds plugin

* Promote Builds plugins lets you specify actions that require approval
* Adds promotion status link when check “Promote builds when…”
* Approvals include manually, automatically, based on downstream/upstream builds
* Can run multiple build steps (or post build actions) to run after approval – retry-able independently. Like a separate build.
* See icon once approved or if steps after approval fail
* Can have multiple promotion processes

## CD Metrics

### KPIs/metrics for CI/CD

* Cycle time
* Test coverage, cyclomatic complexity, duplication, etc
* Number of defects
* Velocity
* # Commits per day
* # Builds per day – success, failures and total
* Duration of build

### Determining how many builds failed, succeeded

* Dashboard view – build stats, job stats

### Determining how long a build takes

* Trend on individual job

### Determining how often code is checked-in

* Number of commit stage builds

### How to use metrics/KPIs

* Tracking improvement
* Identifying limiting constraint

## Notifications

### How to radiate information on CD pipelines to teams

* Email , radiator, etc

# Chapter 4 – CD as Code Best Practices

## Distributed builds architecture

* Run jobs on slave
* More secure because jobs run on slave
* More scalable because can add slaves
* Vertical growth – master is responsible for more jobs
* Horizontal growth – creation of more masters
* Recommend to virtualize slaves, but not master for performance

## Fungible (replaceable) slaves

* Can configure third party tools to automatically install on slaves
* Best practice is to make slaves interchangeable, but can tie jobs to slaves

## Master-slave connectors and protocol

* SSH connector – preferred option. Slaves need SSHD server and public/private key
* JNLP/TCP connector – Java Network Launch Protocol start web agent on slave through JWS (Java Web Start). Can start via browser or OS service
* JNLP/HTTP connector – like JNLP/TCP except headless and over HTTP
* Custom script – launch via command line

## Tool installations on slaves

* Can install manually or have Jenkins do it

## Cloud slaves

* EC2 for Amazon Cloud
* JCloud – for other clouds

## Containerization

* Docker image to deploy/run application
* “Build inside a Docker Container” option

## Traceability

* Docker Traceability plugin uses fingerprints for images

## High availability

* Master must be on network attached storage device
* Don’t do builds on master or at least not with workspace under JENKINS\_HOME
* HAProxy serves as the reverse proxy

## Automatic repository builds

* *Not sure what this means. It does not exist in any documentation online except the PDF study guide.*

# Chapter 5 – Cloudbees Jenkins Platform

## Reference architecture

* Products
  + Jenkins Enterprise – open source Jenkins plus plugins for High Availability, RBAC, Update Center, folders, etc.
  + Cloudbees Jenkins Operations Center – dashboard, manage multiple masters
* No builds on CJOC or downstream masters
* Recommend hundreds, not thousands of jobs on each downstream master
* Faster recovery and less frequent failures
* Proxy fronts primary master and checks availability
* CJOC master is a master with CJOC installed
* CJOC master knows about all slaves. Like a cloud for slaves
* Can set up different update centers for different downstream masters

## Role-based Access Control (RBAC)

* Setup in manage security. Choose role based matrix authorization strategy (vs matrix based on project matrix based)
* Defaults to logged in users can do anything and anonymous users can do nothing
* Default groups – Administrators, Developers, Browsers
* Default roles – anonymous, authenticated, administer, develop, browse
* Roles > Manage – global matrix of role/permission mappings
* Two types of roles – system defined and user defined
* Can’t get rid of anonymous and authenticated roles
* Extended read permission – can view, but not edit config
* Support group definitions out of the box – Jenkins, jobs, Maven modules, slaves, views and folders
* To prevent folder role from propogating to children - Group icons– blue means pinned
* To prevent folder role from inheriting from parent – Roles > filter

## Folders Plus

Features over folders plugin:

* tie slaves to folders
* move jobs between folders
* health reports other than child with worst health (ex: average health, job status, enabled projects)
* set icons on folder other than default (ex: aggregate of status, built in icons or by URL)
* pass environment variables to all jobs in folder
* display jobs from subfolders on higher level view
* restrict what goes in folder

## Templates

* Types
  + Auxiliary template – nested attributes within another template
  + Builder/publisher template – locked down builder/publisher
  + Folder/job template – configure folder/job
* If define in folder, limited to that folder
* Transformation types
  + Jelly – has ${} and some control tags – like JSTL but different tags.
  + Groovy template transformation – like a JSP in Groovy. Remember to backslash $
  + Groovy template for Pipleine
* Variables instance, model, parent (Folder or Jenkins instance itself) and parentInstance (the folder template where the job template sits)
* When admin updates template, automatically approved. When non-admin updates template, checked against whitelist of approved code or added to “in process script approval” list for admin.
* Groovy sandbox – can whitelist method signatures first time used. Format method class.Name methodName argTypes (or static method). Admins use whitelist too when sandbox on.
* Creating with REST
  + POST to /instantiate
  + Or /createItem and specify JobPropertyImpl for template

## Setting up High Availability (HA)

* HA for Jenkins is multiple JVMs forming a cluster.
* It is a singleon – only one is master at a time
* Config – NFS /shared disk, at least two servers, floating IP
* Jenkins-ha-monitor provides monitoring on when to switch IP between servers
* Need three pieces:
  + Jenkins enterprise war
  + Jenkins enterprise proxy HA war – start this and it proxies/passes through to regular Jenkins.war
  + Jenkins enterprise HA monitoring tool – triggers transfer logic from outside Jenkins
* Data survives failover except builds in progress and user sessions
* Typically takes a few minutes because has to start up secondary

## CloudBees Jenkins Operations Center (CJOC)

### Shared clouds

* Same access logic as shared slaves
* Clouds provision slaves to master
* Local Types: java web start or virtual machine

### Cloud configurations

* Supports Docker, Amazon EC2 and Microsoft Azure clouds
* Instance caps are managed on each master
* Credentials shared across masters

### Shared slaves

* Client masters in the same CJOC can share slave executors
* Client masters must be siblings or in same subfolder
* Slaves are leased to client masters for one job if CJOC is available. If it goes down, client master keeps slave until comes back.
* Client masters prefer slaves in current “folder” then go to parent
* Client masters are not allowed to use slaves at sibling folder level
* Create shared slaves with CJOC

## Analytics

* Jenkins masters report data to CJOC
* Display dashboards
* Can create custom dashboards
* To reindex and get historical data in CJOC
  + new Cluster Operations job
  + operation = masters
  + target masters == from operations root
  + step == reindex
* Can run Elastic Search embedded or remote
* Uses Kibana open source analytics and visualization platform
* Includes System/JVM metrics, Web UI metrics, Jenkins metrics, health checks
* Retention of data (reindexing resets clock)
  + Every 10 seconds metrics – saved 3 days
  + Hourly metrics – saved 3 years
  + Build reporting – saved 3 years
  + Other info saved forever

## Cluster Operations

* Used to performance maintenance operations from CJOC
* Ways to run
  + Checkbox on list view to prepare for shutdown or safe restart with left navigation “cluster operations”
  + Left navigation “cluster operations” on single master
  + Cluster operations job
* Each operation in job has:
  + type = master or update center
  + source = root, parent, parameter, etc
  + optional filter on path, online status, etc
  + steps
    - for master – Backup master, install/enable/disable plugin, execute groovy script, prepare for shutdown, refresh update center metadata, restart now, safe restart, upgrade jenkins, upgrade all plugins
    - for update center – Delete/promote/update core, delete/promote/update plugin, pull everything, pull new versions, refresh upstream sources, track latest core, track latest plugins
  + advanced options
    - # parallel items
    - timeout per step
    - failure mode – immediately, tidy (at end of current step), at end
    - build result to use on failure - unstable, failure, aborted
* If you have multiple items to operate on, they will occur in parallel

## Pipeline Checkpoints (formerly known as Pipeline Checkpoints)

* All pipelines can be resumed
* For a more granular resume, put checkpoint ‘name’ in your script.
* Local variables saved at checkpoint. Call stash if want to store files.
* Restart using Checkpoints link or retry icon
* Call unstash to retrieve files into workspace
* Get new build #, but skips all steps prior to checkpoint
* Place checkpoint outside of node{} so not reliant on state of workspace

## Custom Update Center

* Benefits: restricting plugins, sharing in house developed plugins
* Options:
  + Versions of plugins - Require explicit configuration or Implicitly push latest
  + Signature provider – ex: self signed
  + Upstream sources – like proxied updated centers – Jenkins Enterprise, Open Source or Local. Can also choose types: ex LTS
  + Maintenance tasks – pull new versions (of what already in update center) or pull everything
* Tabs
  + Core – Jenkins itself
  + Plugins – Jenkins plugins
  + Tool installers – ex: Groovy, Chrome Driver
  + Upload core – upload Jenkins war from local machine
  + Upload plugin – upload plugins from local machine
* Click Store button to save a version locally

## Multi-branch

* Benefits of Workflow Multi-Branch: automatic creation/deletion of job for each new/deleted branch in repo

and configuring properties by branch

* Uses marker file Jenkinsfile to define pipeline logic and recognize a job should be created
* Job gets deleted when branch or Jenkinsfile removed
* Create new Multibranch Workflow job
* Can give named branches different properties by specifying exceptions
* Creates a folder for these jobs to exist in

## Docker plugins

* Docker is containers for deployment
* Dockerhub (hub.docker.com) is like github – hosting for Docker
* Plugins
  + Docker – provision slave, run single build and then tear down that slave
  + Dockerhub notification - provides a hook so Docker can trigger Jenkins jobs when the image is updated
  + Docker build and registry - allows publishing to the Docker registry
  + Docker traceability – history of deployments/images
  + Docker pipeline provides docker variable to pipeline plugin
* Examples:
  + Build container: docker.build ‘path/app:${env.BUILD\_TAG}’
  + Run inside container: docker.image(‘name’).inside { /\* commands \*/ }
  + Reference container from outside in docker.withRun(‘name’).inside { /\* commands \*/ }