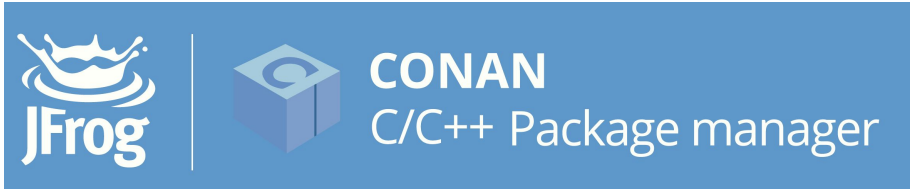
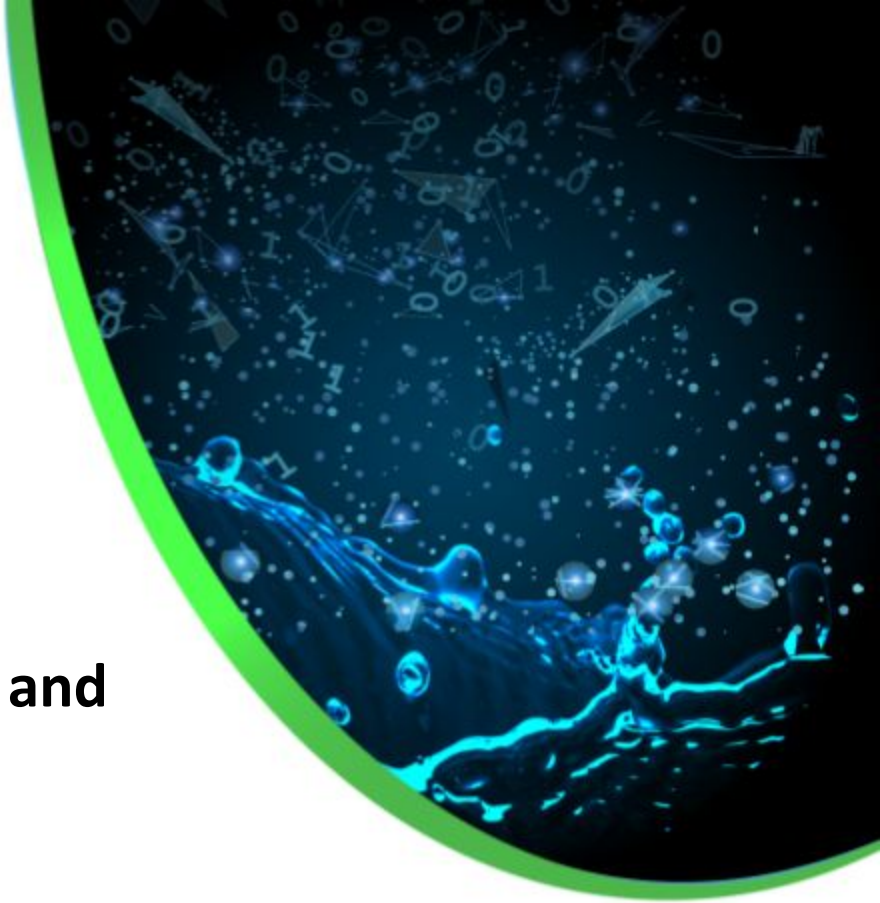




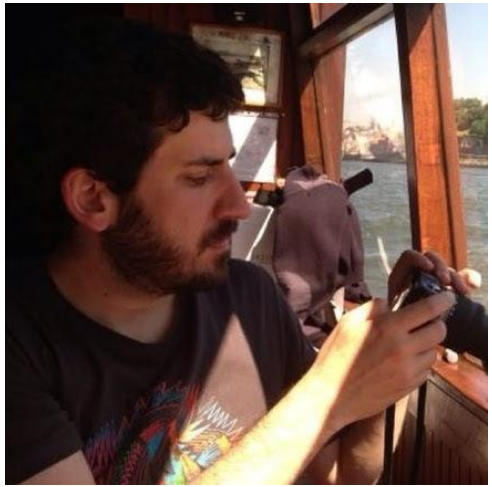
CI/CD in C/C++ Projects with Conan and Artifactory

Jerry Wiltse, Conan Developer @ JFrog
Carlos Zoido, Conan Developer @ JFrog

Coaches

Jerry Wiltse, Conan Developer

Carlos Zoido, Conan Developer



Technical Assistants

- Diego Rodriguez-Losada
- Uilian Ries

[Lab 0] Environment bootstrapping

- Artifactory
  - Create CI user → **conan/conan2020**
  - Create repositories: conan-tmp, conan-develop, conan-metadata
  - Create permissions
- Jenkins
  - Create pipelines for all libraries in Jenkins
- Conan Client
  - Preconfigured with conan remote, conan user, and custom profiles
  - All libraries and apps from the training pre-built and uploaded to Artifactory
- Custom Docker Images
  - Conan and GCC6 pre-installed

[Lab 0] Environment bootstrapping

3:00

```
ssh conan@<orbitera-IP>
# Use password from orbitera

git clone
https://github.com/conan-ci-cd-training/conan_ci_cd.git

cd conan_ci_cd/setup_jenkins

./bootstrap.sh <artifactory_password> <jenkins_credential>
```

```
vm-testdriveinstance-1289-88142
-------------------


------ Outputs ------
Username:
admin

Artifactory URL:
http://34.68.29.120:8082/

Password:
WEs22tORIP

IP:
34.68.29.120

SSH Username:
conan

Jenkins Credential:
zmpoqUUj8z

Jenkins URL:
http://34.68.29.120:8080/
----------------------
```

Outline

- **Recap from Advanced Training**
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix

Recap from Advanced Training: Revisions

- 2 types of Revisions:
  - Recipe :
    - Id for tracking down any changes at the recipe level.
    - **RREV** = hash(sources, recipe, ...)
  - Package:
    - Id for tracking down any changes at the binary package level
    - **PREV** = hash(all the packaged files)
- Package ID:
  - Also a hash, but corresponds to hashing options, settings, and requirements

Recap from Advanced Training: Package ID modes

package_id = f(**settings**, **options**, **requirements**)

- **Settings**: operating systems, compilers, build types,…
- **Options**: shared, fPIC…
- **Requirements**: depending the package_id mode

Package ID modes for binary compatibility

- Can be more strict or more relaxed
- Choosing the right one is important, we will use **recipe_revision_mode** for our CI (quite strict)**, <u>new revisions will affect package id's of dependents</u>**

Recap from Advanced Training: Lockfiles

- A snapshot of a dependency graph at a given time.


```
{
 "version": "0.3",
 "profile_host":
"[settings]\narch=x86_64\narch_build=x86_64\nbuild_type=Release\ncompiler=gcc\ncompiler.libcxx=libstdc++11\ncompiler.version=6\nos=Linux\nos_build=Linux\n[options]\n[build_requ
ires]\n[env]\n",
 "graph_lock": {
   "nodes": {
     "0": {
       "options": "shared=False\nlibA:shared=False",
       "pref": "libB/1.0:ef4c743309e6cde478db59544c22fd8b98d6e0df",
       "path": "/var/lib/jenkins/libB/conanfile.py",
       "requires": [
         "1"
       ]
     },
     "1": {
       "options": "shared=False",
       "pref": "libA/1.0@mycompany/stable#d84a023833ae8b56bd8573d05962c937:57547fe65fffc300f05aa42ee64b3b02eeabb6d7#5bafcbf5f3eb1682dcac8e6810bf6e35"
     }
   }
 }
}
```

Recap from Advanced Training: Lockfiles use in CI

- Start by creating a lockfile, which builds with the **exact graph** of dependencies
- Use the lockfile to calculate the **build order** of a dependencies in the graph
- CI Jobs **update the initial lockfile** as the CI builds each library
- Lockfiles need to be stored somewhere:
  - In this training, we'll use conan-metadata repo on Artifactory
- Lockfiles can be used to copy groups of binaries between Conan repositories
  - In this training, we'll promote from conan-tmp to conan-develop

Recap from Advanced Training: Lockfiles cheatsheet

command	Input lockfile	Output
create / install / export / export-pkg	Yes (optional)	Update **lockfile**
graph lock	No	**lockfile** with the graph
graph build-order	Yes	**JSON** with build order
graph update-lock	Yes (requires 2 lockfiles)	Update oldest **lockfile**

Recap from Advanced Training: Two more things

- We will use SCM mode for our examples:
  - This means that commits of source code will generate new RREV

```
class LibB(ConanFile):

    scm = {"type": "git",
           "url": "https://github.com/conan-ci-cd-training/libB.git",
           "revision": "auto"}
```

- Will share the Conan configuration among developers with a git repo

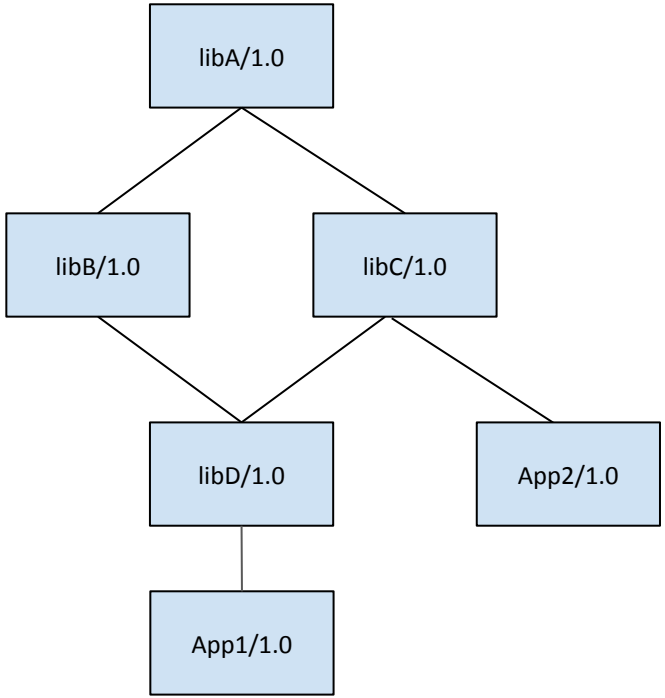
```
conan config install https://github.com/conan-ci-cd-training/settings.git
```

Outline

- Recap from Advanced Training
- **Introduction: The Story**
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix

The Story: Mycompany components

- 1 project providing 2 Apps which consumes libraries
- All libraries are internal to the project
- Some of them are shared by the Apps



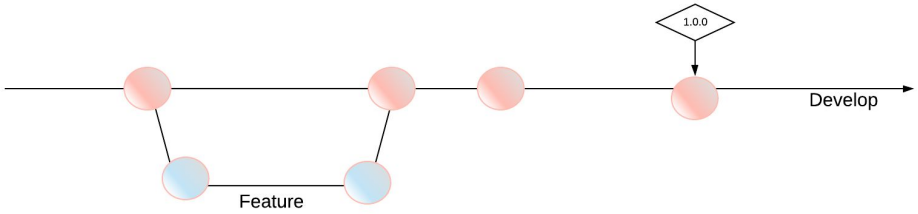
Conan Revisions Vs. Version Bump

In many organizations, unconditionally requiring version bump for every change may be excessive. Conan revisions provide an alternative to bumping versions for every minor change to every file in a pipeline.

- Valid cases exist for both revisions and bumping versions
- Today's focus is on using Conan Revisions
  - Todays pipelines shows a way to validate such changes
  - If tests fail, version bump may be appropriate afterall
  - Revisions with

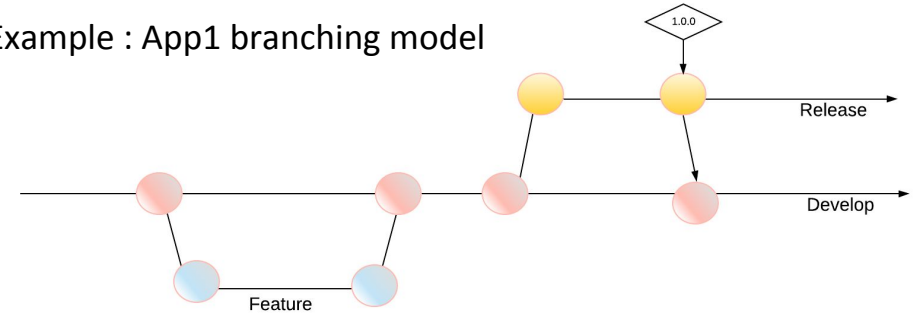
The Story: Code workflow

Example : libA branching model



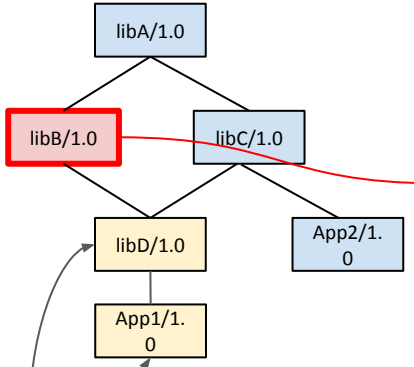
* libB, libC and libD follow the same flow and have their own code repository

Example : App1 branching model



* App2 follows the same flow and has its own code repository

Mycompany development workflow

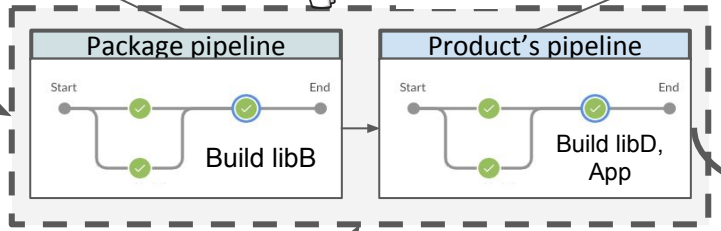


Developer modifies libB

New **revision** of **libB**

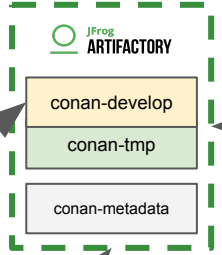
CONAN
C/C++ package manager

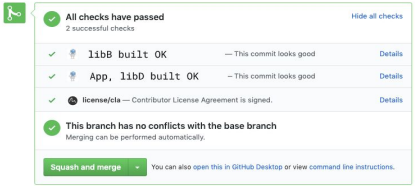
New **binaries** for **libD**, **App**



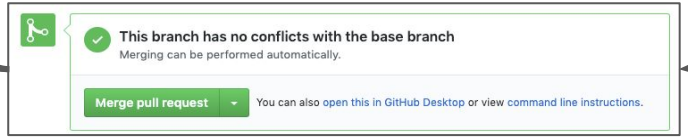
Confirm the changes don't break the products

Changes in **libB** will produce new package id's for **libD** and **App** → we need to build new binaries



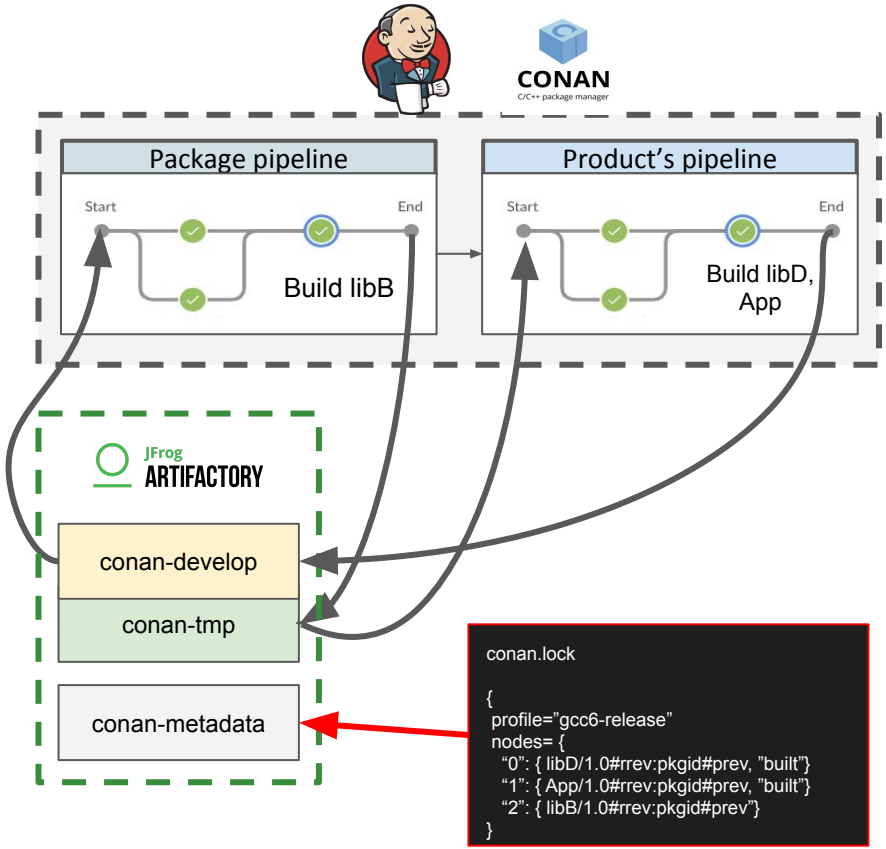


PR merged: relaunch build and upload new packages to conan-develop



CHECKS OK: we could merge the PR to develop

Artifactory repos



Conan repositories

conan-develop → packages that will be used by developers. Packages here were usually "promoted" from conan-tmp

conan-tmp → packages build on the CI which are currently under development or testing, and which may be promoted in the future

Generic repositories

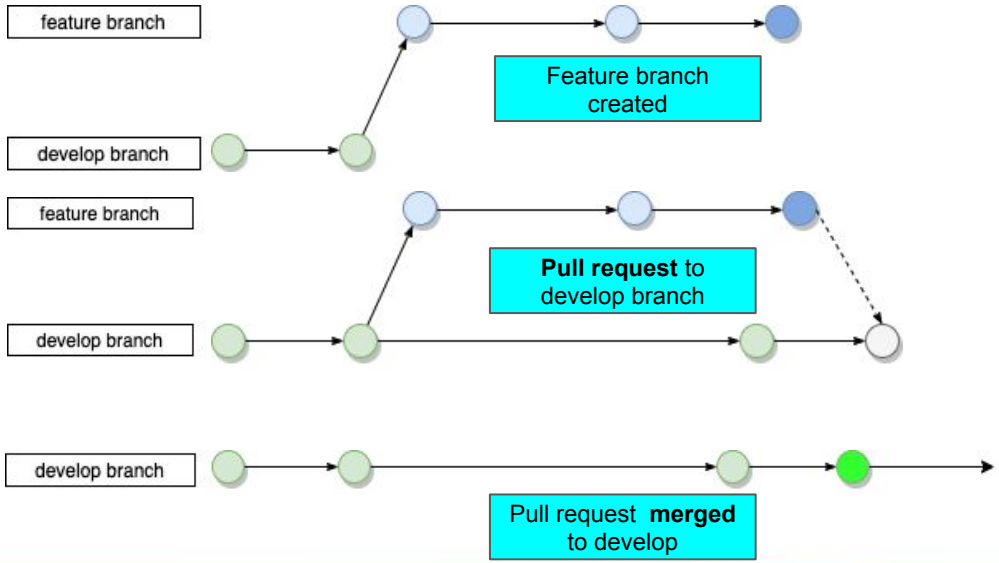
conan-metadata → use to upload metadata associated with the build. We will upload the lockfiles generated creating conan packages

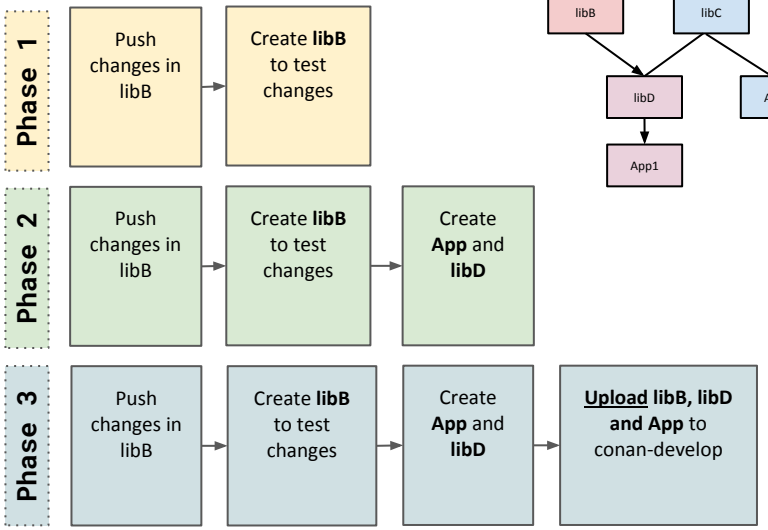
The Story: Goals

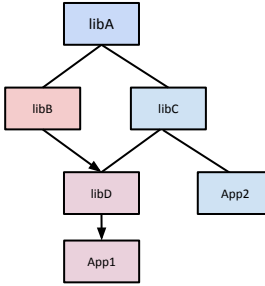
- Know in advance that changes in libraries do not break the products
- Speed up build time by always having binaries available
- Consuming the latest changes
- Managing and monitoring the delivery process

Phases in the workflow

Imagine a developer making changes in one library, e.g. **libB,** and we want those changes to be seamlessly integrated in our products. Different phases:

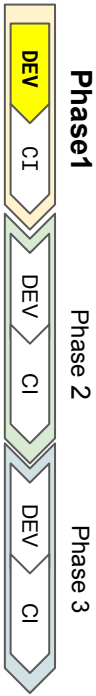






Outline

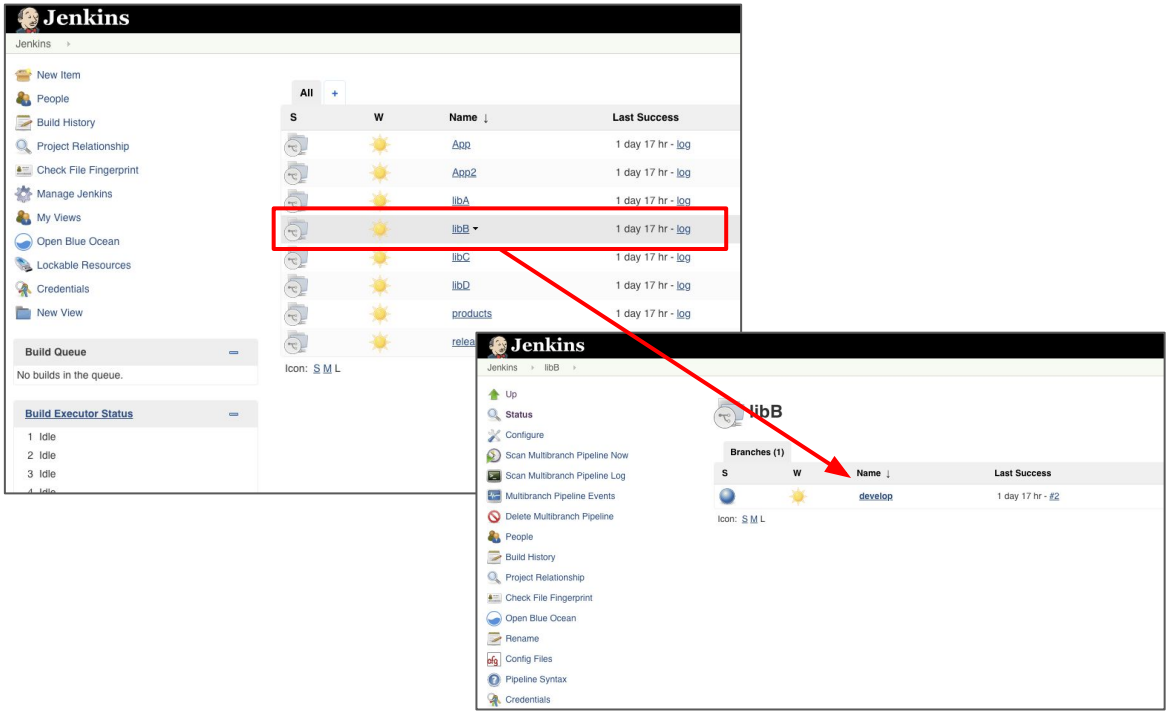
- Recap from Advanced Training
- Introduction: The Story
- **CI Workflow: Phase 1**
  - **Developer creates a feature branch**
  - Operations on CI
    - Package pipeline
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Promotion in Artifactory
- Summary
- Appendix

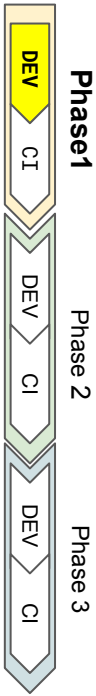


[Reminder] Access Jenkins

Username: **administrator**
Password: **<Jenkins Credential>**

In orbitera e-mail with JFrog Test Drive Details





[Lab 1] The developer creates a feature branch for libB

Goal:

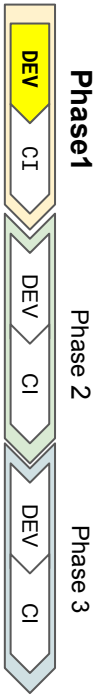
- Check and understand the series of actions that are going to be triggered in the CI when a commit is pushed to the feature branch

Tasks:

- Go to the developer's working folder and create a new feature branch
- Push some changes to the branch
- Jenkins: check the stages of the <u>package pipeline</u> being triggered by the push to the repo

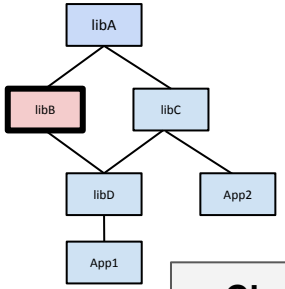
Success:

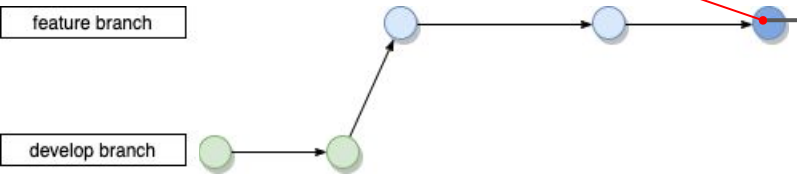
- Check the the package pipeline finishing successfully



[Lab 1] The developer creates a feature branch and pushes

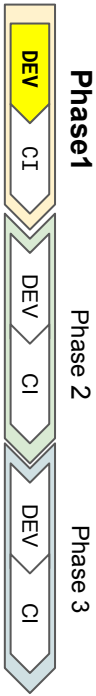
```
docker exec -it jenkins /bin/bash

cd /workdir/libB

git checkout -b cool_feature

echo "// modify libB source" >> src/libB.cpp

git commit -a -m "commit cool feature"

git push origin cool_feature
```





After the push, a **hook** triggers the Jenkins libB pipeline

Check the results in Jenkins



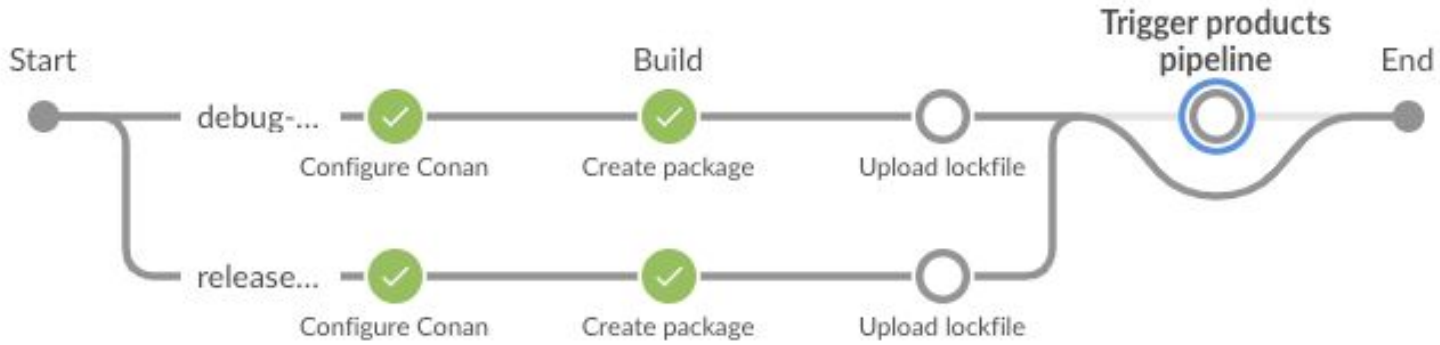
[Lab 1][Result] Check the stages run in the pipelines

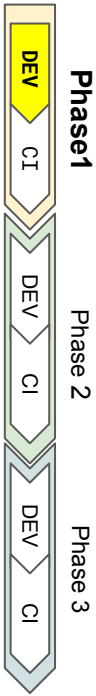
3:00

Here is a link to the code for the **Package pipeline for libB**

Here we point out that:

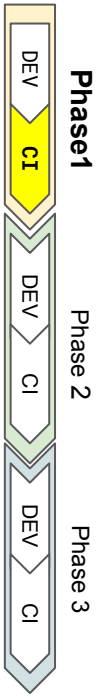
- we build multiple configurations for libB
- We choose not to trigger the products pipeline





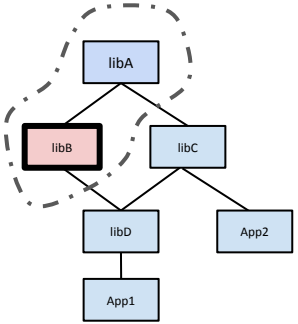
Outline

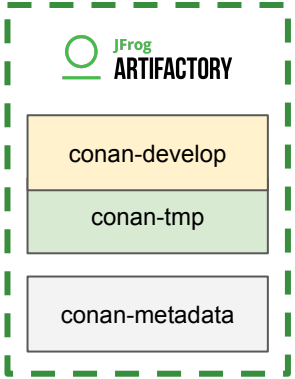
- Recap from Advanced Training
- Introduction: The Story
- **CI Workflow: Phase 1**
  - Developer creates a feature branch
  - **CI Stages**
    - **Package pipeline**
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix

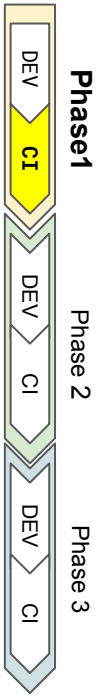


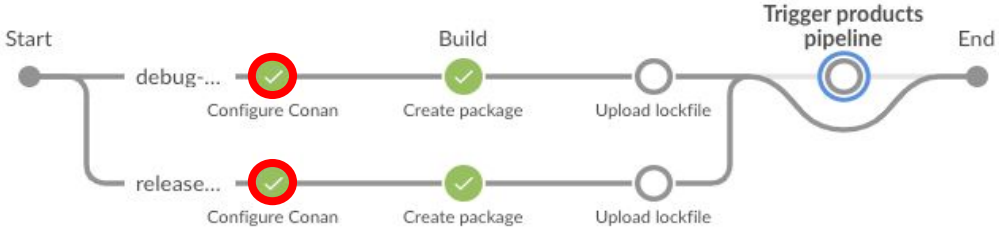
[Phase 1 - Package pipeline] [Configure Conan]

```
# set the CONAN_USER_HOME for each stage

conan config install <config_url>

conan user -p conan2020 -r conan-develop conan
```



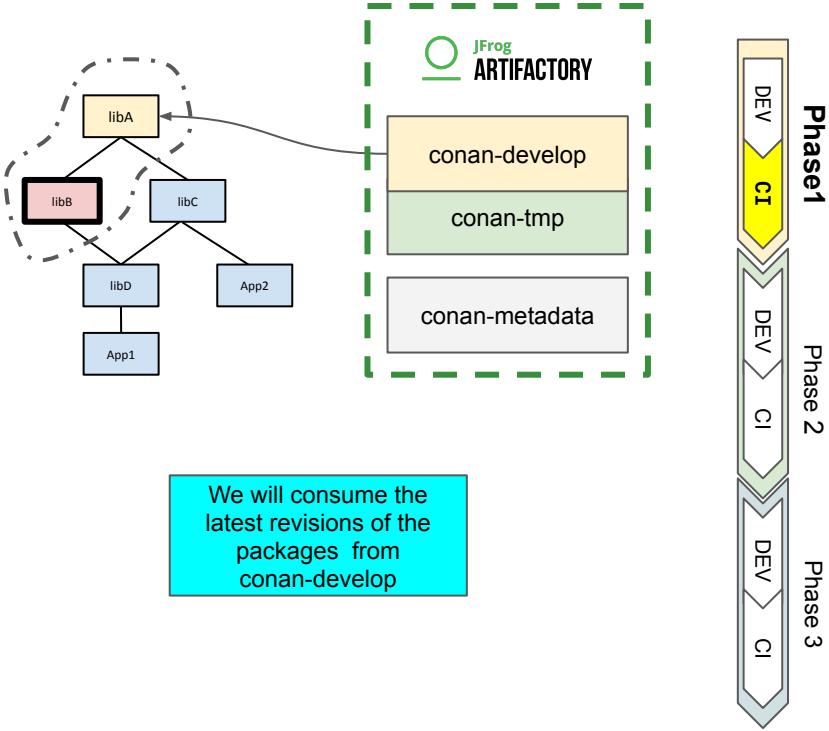




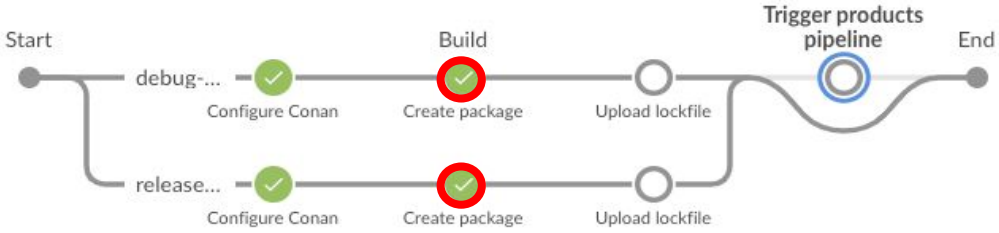


[Phase 1 - Package pipeline] [Create libB]

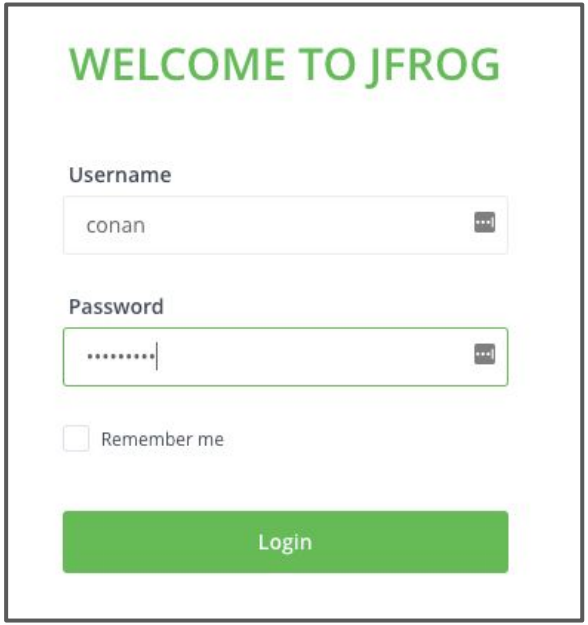
```
conan graph lock . --profile profile
--lockfile=lockfile.lock -r conan-develop

conan create . mycompany/stable --profile profile
--lockfile=lockfile.lock -r conan-develop
```

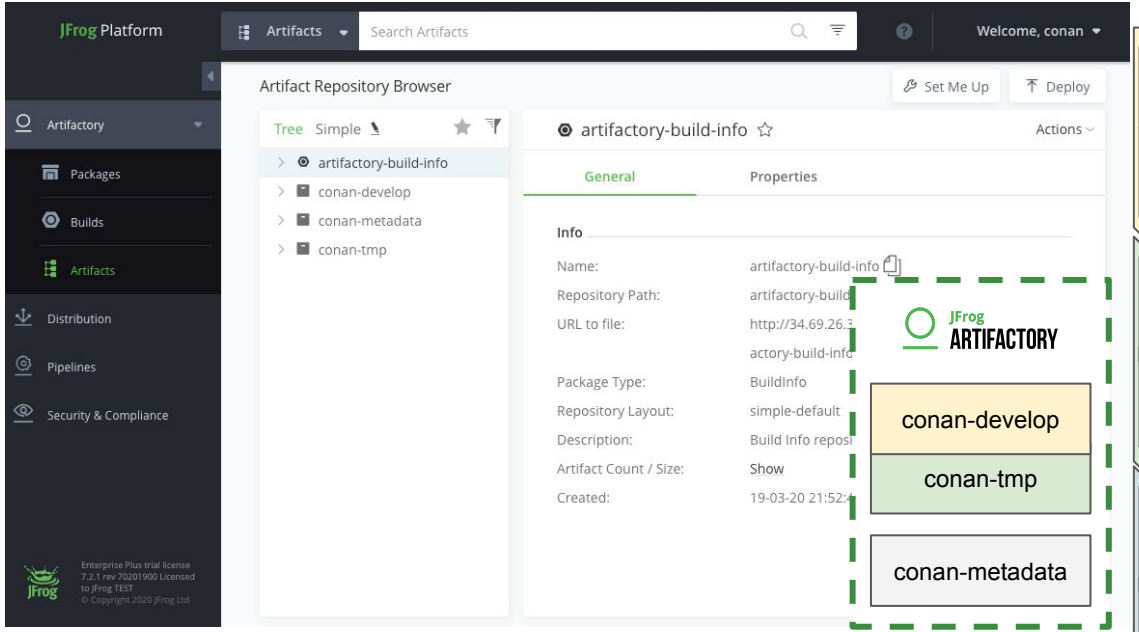


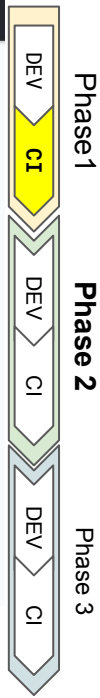
We will consume the latest revisions of the packages from conan-develop



[Reminder] Access Artifactory

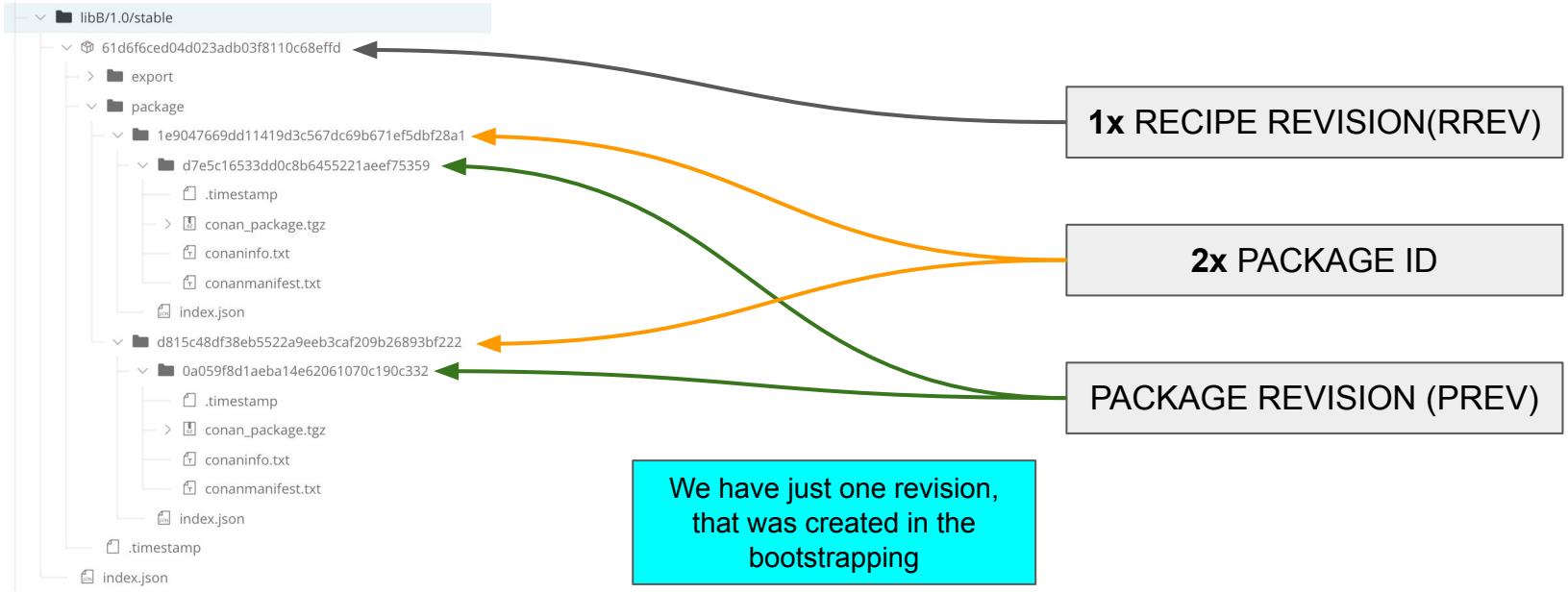


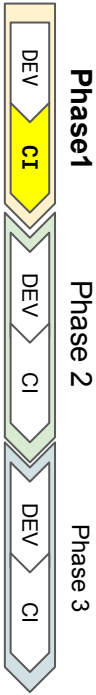




User: **conan**
Password: **conan2020**

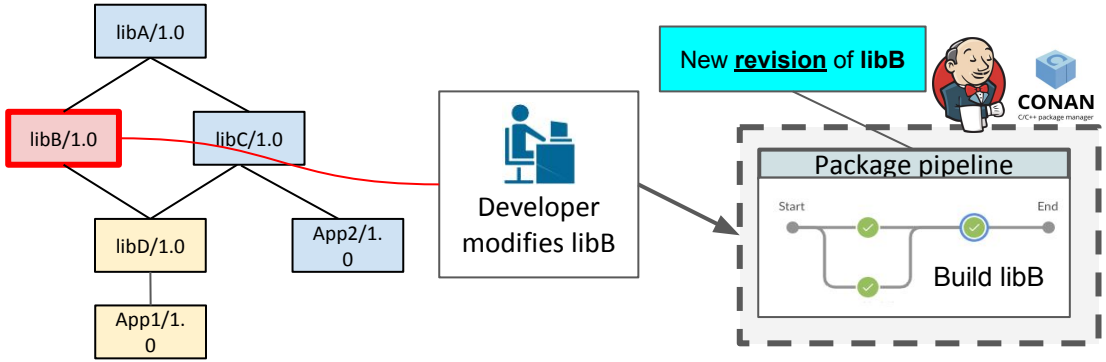
Check libB in conan-tmp in Artifactory

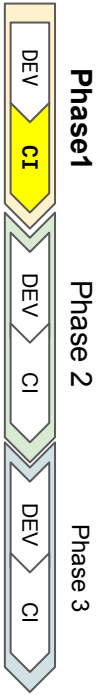




<name>/<version>@<user>/<channel>#<rrev>:<pkg_id>#<prev>

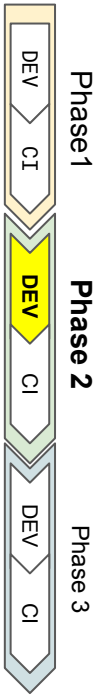
[Phase 1 - Summary]





Outline

- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- **CI Workflow: Phase 2**
  - **Developer opens a PR with the feature branch**
  - CI Stages
    - Package pipeline
    - Products pipeline
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix



[Lab 2] The developer creates a PR to libB's develop branch

Goal:

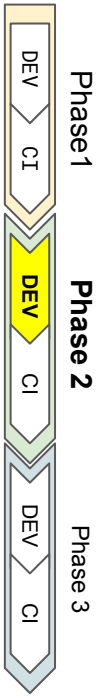
- Have a look at the set of operations that are going to be triggered in the CI when a commit is pushed to a pull request branch

Tasks:

- Command line: Create a new branch for the PR
- Push some changes to the PR
- Check the package pipeline being triggered by the push to the repo
- Check the product's pipeline being triggered at the end of the package pipeline

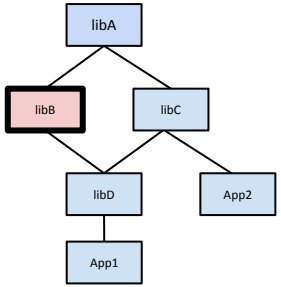
Success:

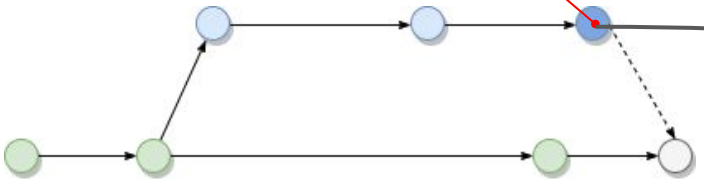
- Find the new revision of libB in conan-tmp repo in Artifactory



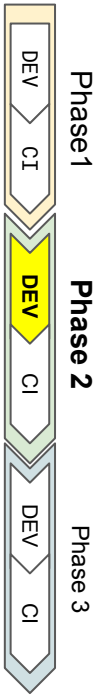
[Lab 2] The developer creates a PR to libB's develop branch

```
git checkout -b PR-01

echo "# Comments in the conanfile.py" >>
conanfile.py

git commit -a -m "simulating a PR to develop"

git push origin PR-01
```



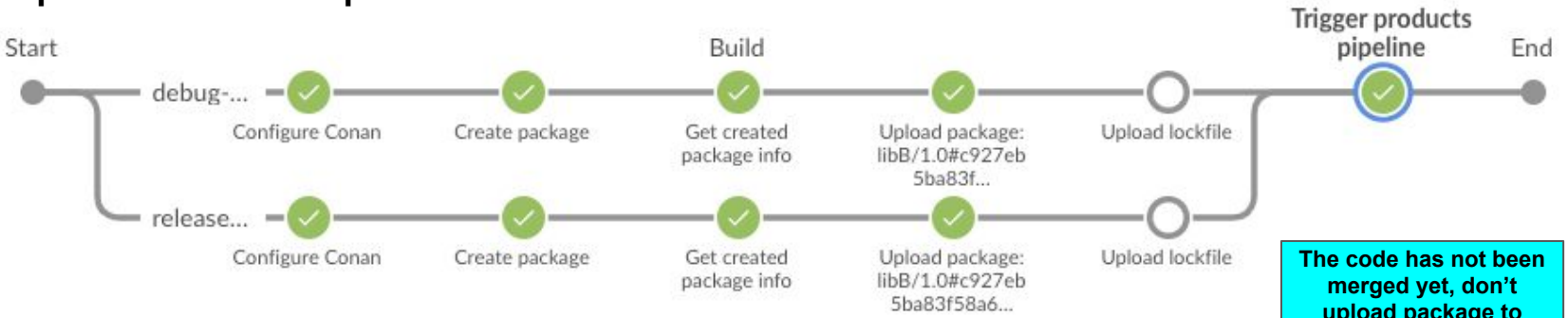


After the push a **hook** triggers the Jenkins libB pipeline



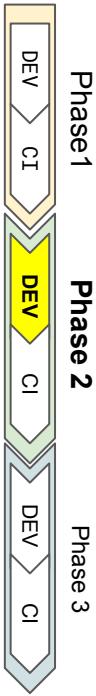
[Lab 2][Result] Check the stages run in Jenkins

Package pipeline for libB: for each configuration create the new revision and upload to conan-tmp



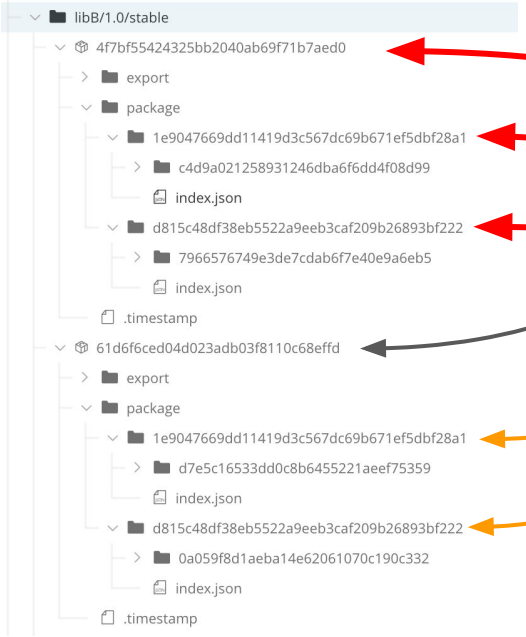
Products pipeline: check if App or App2 are affected and rebuild

The code has not been merged yet, don't upload package to conan-develop



[Lab 2][Result] Check libB in conan-tmp in Artifactory

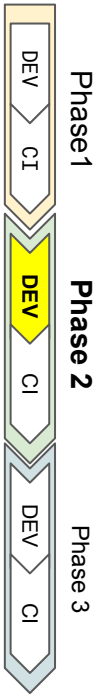
2:00



2x RECIPE REVISION(RREV)

4x PACKAGE ID (2x RREV)

The **new revision of libB** was uploaded to conan-tmp to download it from the products pipeline but now new packages are in conan-develop because the PR is not merged yet



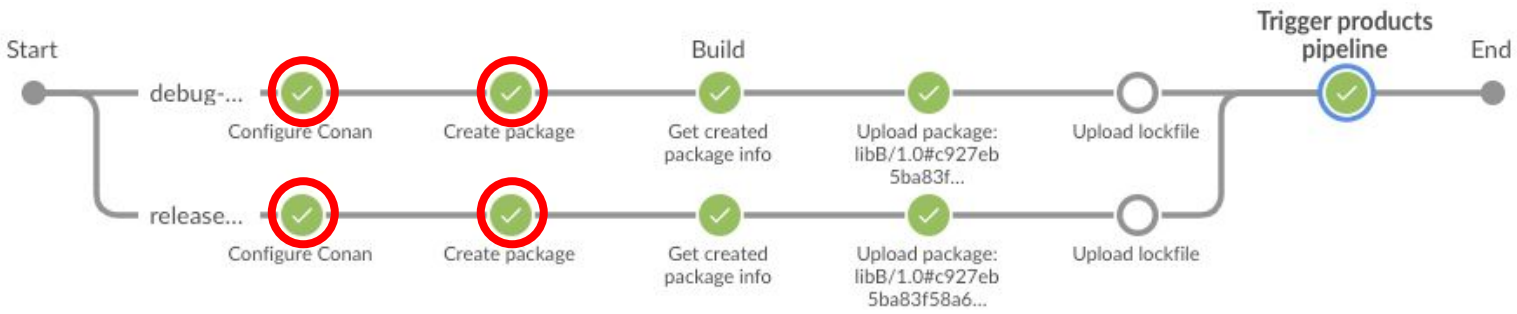
<name>/<version>@<user>/<channel>#<rrev>:<pkg_id>#<prev>

Outline

- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- **CI Workflow: Phase 2**
  - Developer opens a PR with the feature branch
  - **Operations on CI**
    - **Package pipeline**
    - Products pipeline
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix

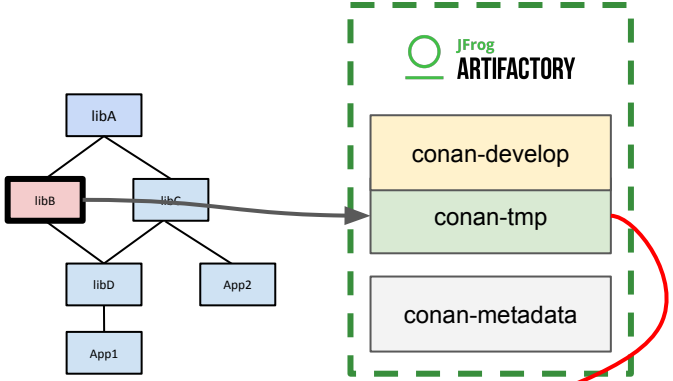
[Phase 2 - Package pipeline] Stages in common with Phase 1

- Configure Conan
- Create new revision of libB with changes

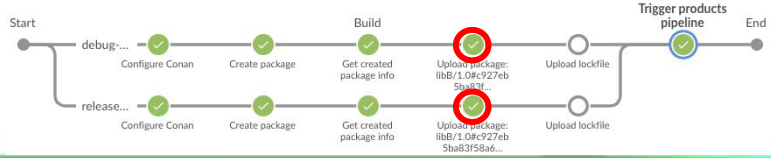


[Phase 2 - Package pipeline] [Upload libB to conan-tmp]

```
# we have just retrieved the name, version and
revision from the created package

conan upload 'libB/1.0' --all -r conan-tmp
--confirm
```

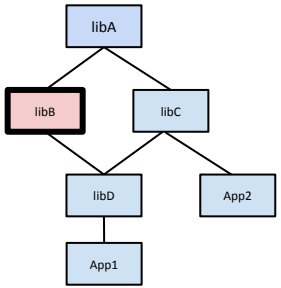


Later, in the products pipeline the CI will retrieve **libB/1.0#rrev** from conan-tmp to integrate its changes into **App**

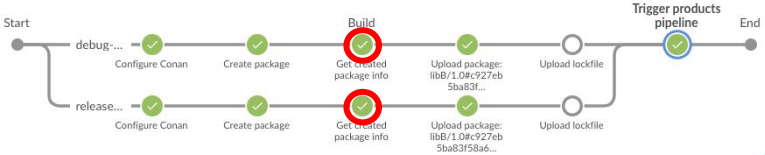


[Phase 2 - Package pipeline] [Get created package information]

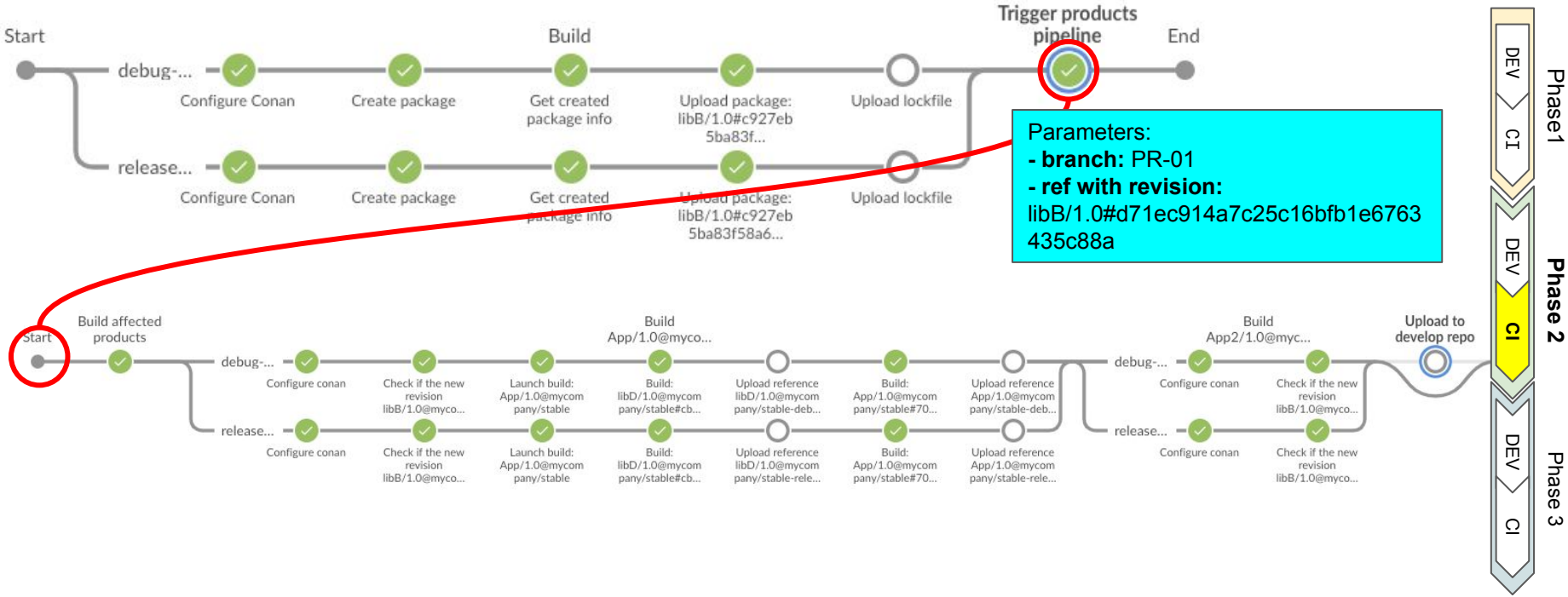
```
# we have just created the new revision of libB
in the local cache, we search for it as we only
have one revision there

conan inspect . --raw name
conan inspect . --raw version
conan search libB/1.0@mycompany/stable
--revisions --raw

# get the output of the commands
# name = libB
# version = 1.0
# revision = c1fb43088d07b9b8f65b75464d6d1c5d
```



We need to pass libB/1.0#rrev as a parameter to the products pipeline so that we know which libB needs to be tested against the products



[Phase 2 - Package pipeline] [Trigger the products pipeline]



Outline

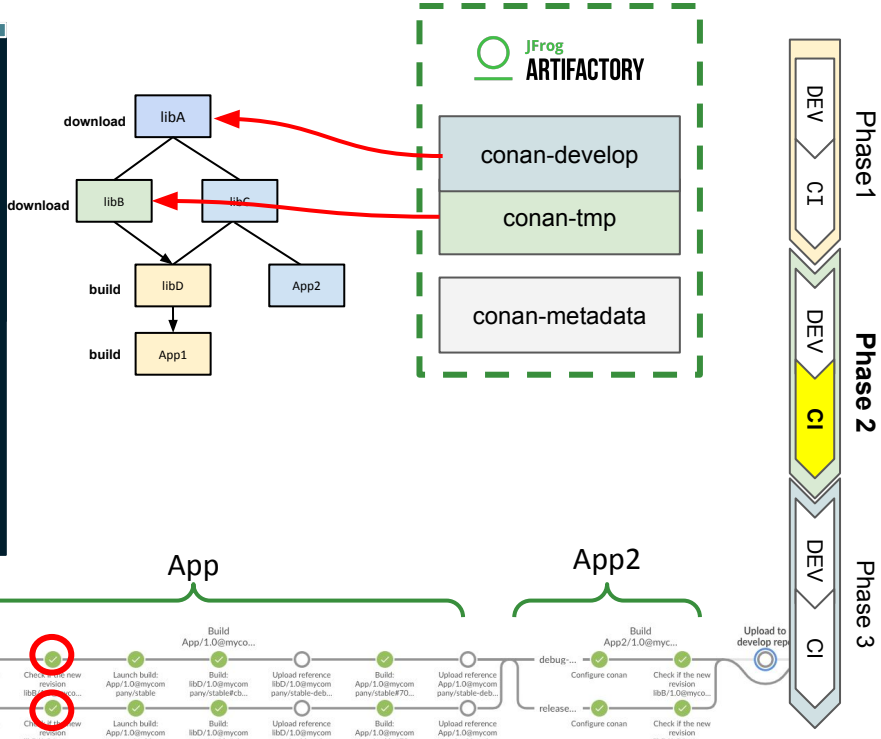
- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- **CI Workflow: Phase 2**
  - Developer opens a PR with the feature branch
  - **CI Stages**
    - Package pipeline
    - **Products pipeline**
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix

[Phase 2 - Products pipeline] [Check if libB/1.0#rrev affects products]

products = ["App/1.0@mycompany/stable", "App2/1.0@mycompany/stable"]

For each product:

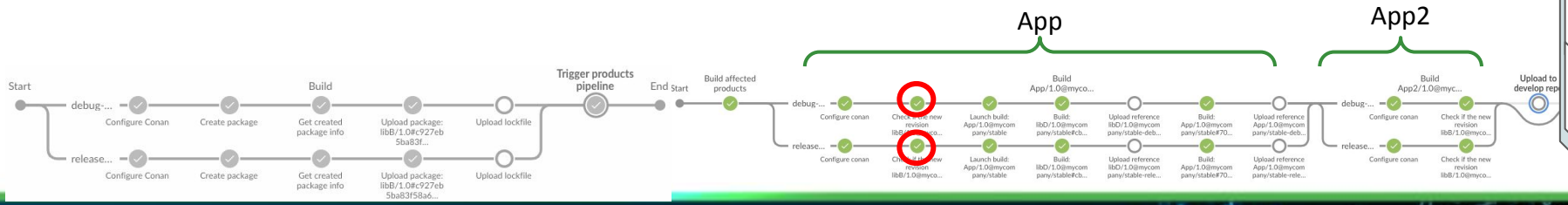
1. **Download** the recipe of the created revision **of libB** from **conan-tmp**
2. Get the **lockfile** of the product we want to check getting the dependencies from **conan-develop**
3. Calculate the **build-order** with the lockfile: if the build-order is empty, the product is not affected



[Phase 2 - Products pipeline][Check if libB/1.0#rrev affects products]

products/Jenkinsfile

```
stage("Check if the new revision ${params.reference} is in ${product} graph") {
 sh "conan download ${params.reference} -r ${conan_tmp_repo} --recipe"
 sh "conan graph lock ${product} --profile=${profile} --lockfile=${lockfile} -r ${conan_develop_repo}"
 sh "conan graph build-order ${lockfile} --json=${bo_file} --build missing"
 build_order = readJSON(file: bo_file)
 if (build_order.size()>0) {
   affected_product = true
 }
}
```



[Lab 3] Check if a new revision of libB affects App

Goal:

- See if the new revision of libB is affecting a product downstream so that they have to be rebuilt

Tasks:

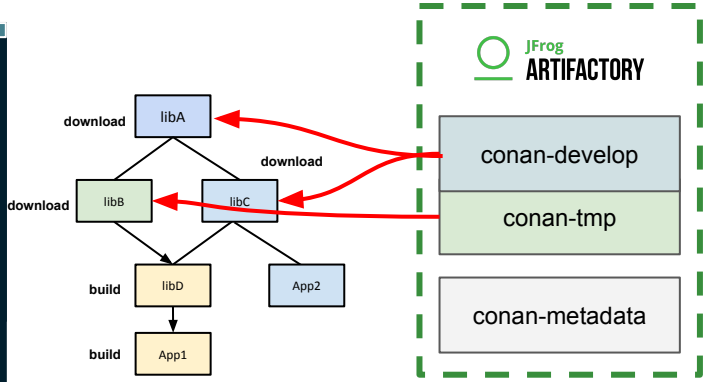
- Search for available revisions in conan-tmp
- Download the recipe for the latest revision of libB from conan-tmp
- Do the graph lock for the product using the conan-develop remote (latest revisions of libs)
- Calculate the build order with --build missing, will tell us if the new revision of libB is affecting App

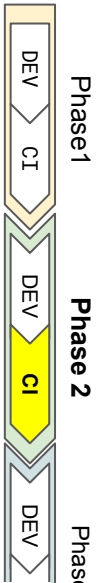
Success:

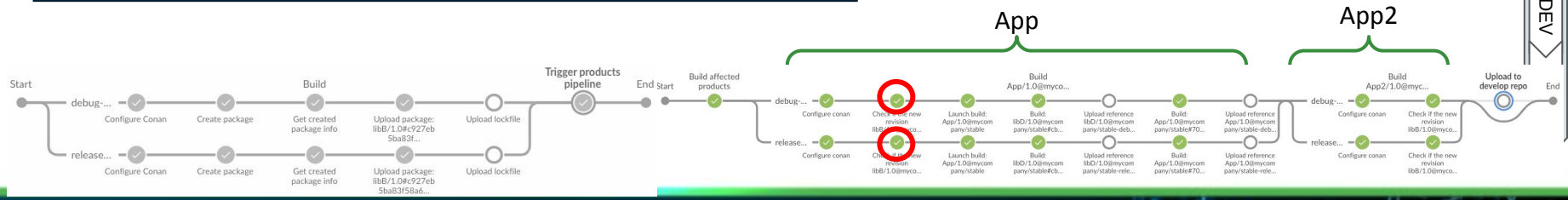
- The build order for App contains libD and App

[Lab 3] Check if App is affected by libB/1.0#rrev

```
cd /ci_labs
# Get the revision list from the server (just for the lab, not made by
the CI) and get the latest revision
conan search libB/1.0@mycompany/stable -r conan-tmp --revisions

# Download the recipe of the created revision of libB from conan-tmp
conan download libB/1.0@mycompany/stable#<rrev> -r conan-tmp --recipe

# Get the lockfile of the product we want to check getting the
dependencies from conan-develop
conan graph lock App/1.0@mycompany/stable --profile=debug-gcc6
--lockfile=App.lock -r conan-develop

# Calculate the build-order with the lockfile: if the build-order is
empty, the product is not affected
conan graph build-order App.lock --json=bo.json --build missing

cat bo.json
```







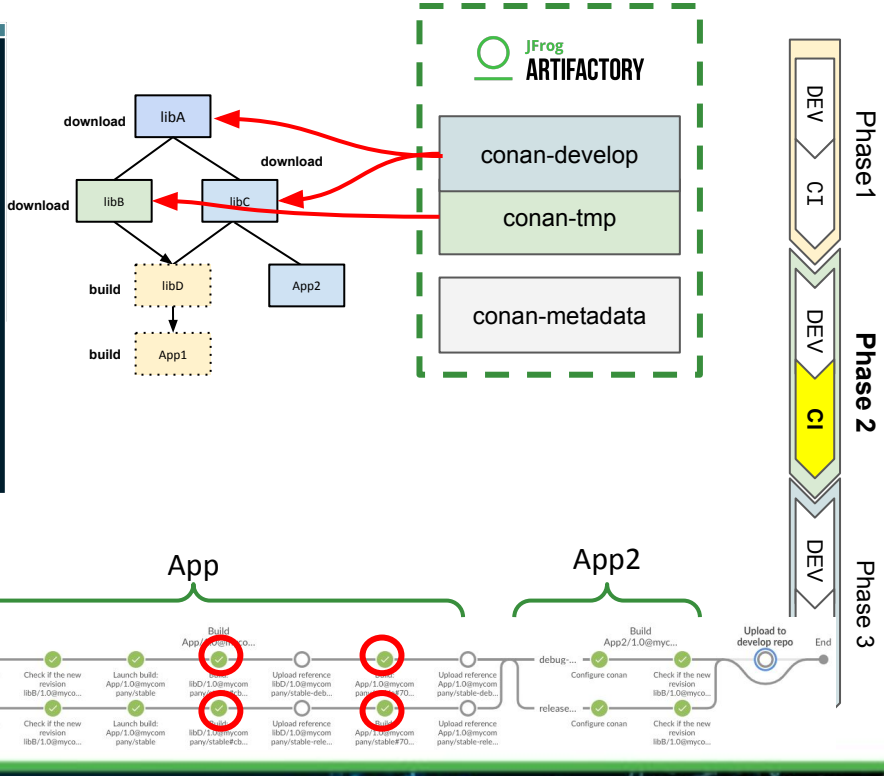
[Phase 2 - Products pipeline][App/1.0 affected → Build libD, App]

We already have calculated the lockfile for App and got the build order → iterate through the build order [libD, App]:

1. cp App.lock conan.lock
2. Create libD: conan install libD/1.0@... --build libD --lockfile conan.lock
3. cp conan.lock libD.lock

4. conan graph update-lock App.lock libD.lock

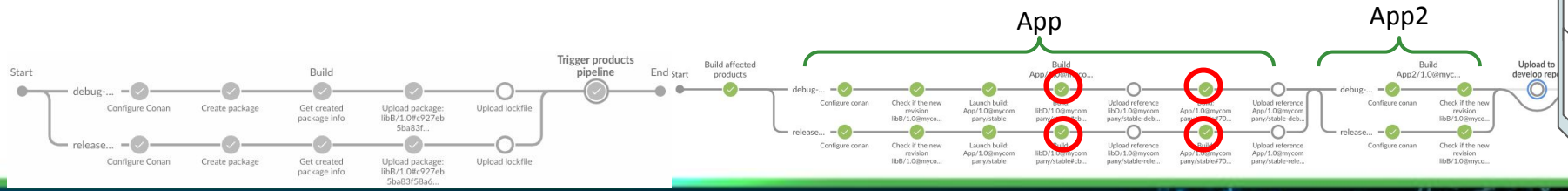
5. cp App.lock conan.lock
6. Create App: conan install App/1.0@... --build App --lockfile conan.lock

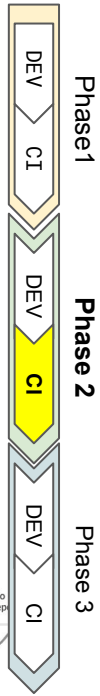


[Phase 2 - Products pipeline][App/1.0 affected → Build libD, App]

products/Jenkinsfile

```
stage("Launch build: ${product}")
{
 stash name: lockfile, includes: lockfile
 build_order.each { references_list ->
   def stage_jobs = references_list.each { index_reference ->
     def lib_name = index_reference[1].split("/")[0]
     def lib_name_profile = "${lib_name}-${profile}.lock"
     def upload_ref = (params.library_branch == "develop") ? true : false
     build_ref_with_lockfile(index_reference[1], lockfile, profile, upload_ref).call()
     unstash lib_name_profile
     sh "conan graph update-lock ${lockfile} ${lib_name_profile}"
     stash name: lockfile, includes: lockfile
   }
 }
}
```





[Lab 4] Build App using lockfiles and build order

Goal:

- Understand the process of building downstream packages using a lockfiles and build order

Task:

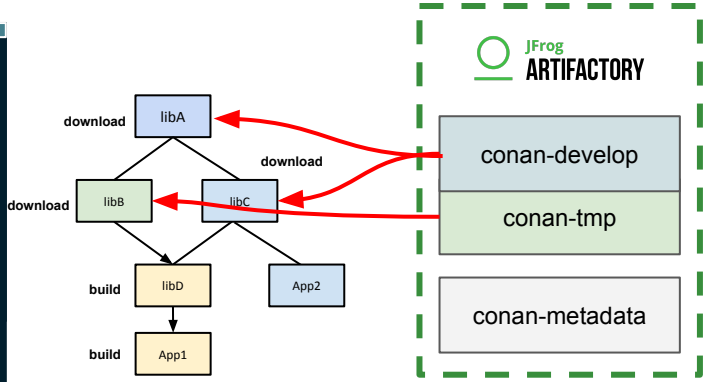
- Calculate the build order of App using the lockfile
- Build libD → update lockfile

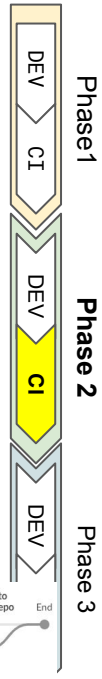
Success:

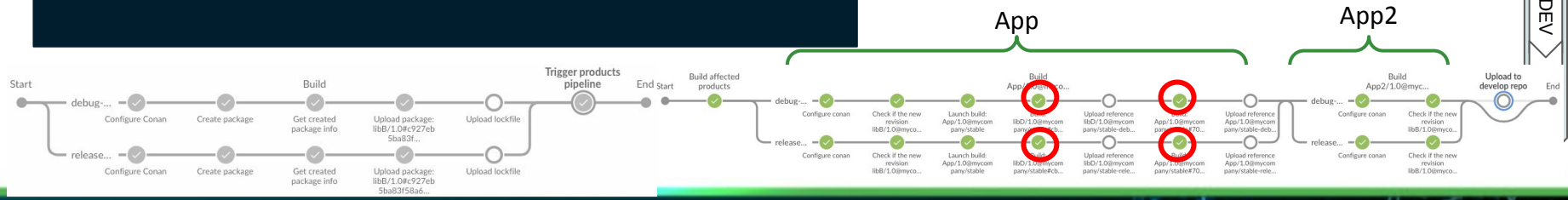
- Check libD being marked as built in libD.lock and App.lock

[Lab 4] Build App using lockfiles and build order

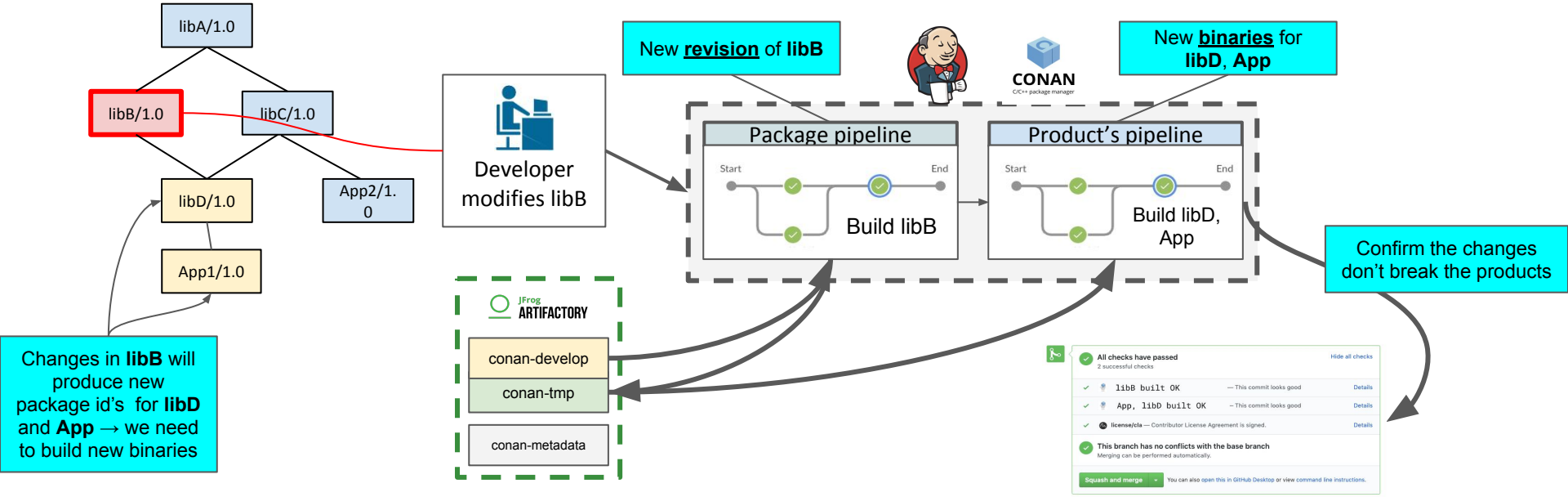
```
cat bo.json

cp App.lock conan.lock

conan install libD/1.0@mycompany/stable --build libD --lockfile
conan.lock

cp conan.lock libD.lock

# the install marked libD as modified="built" in the lockfile
cat libD.lock

# we bring those changes to App.lock and continue iterating
until we build all the nodes in bo.json
conan graph update-lock App.lock libD.lock

cat App.lock
```





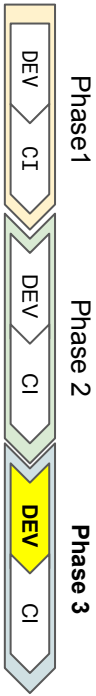


[Phase 2 - Summary]



Outline

- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- **CI Workflow: Phase 3**
  - **The PR is merged to the develop branch**
  - CI Stages
    - Package pipeline
    - Products pipeline
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix



[Lab 5] The PR is merged to develop

Goal:

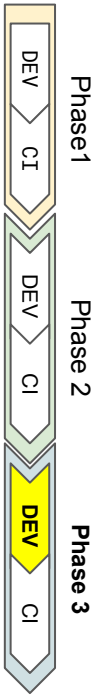
- Have a look at the set of operations that are going to be triggered in the CI when the PR-01 is merged to develop and the changes are pushed

Tasks:

- Checkout develop branch
- Merge PR-01
- Push to origin
- Check the package pipeline being triggered by the push to the repo
- Check the product's pipeline being triggered at the end of the package pipeline

Success:

- Find the new revision of libB in conan-develop repo in Artifactory
- Find the new binaries of libD and App in conan-develop repo in Artifactory
- Check conan-metadata repo

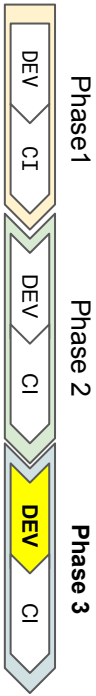


[Lab 5] The PR is merged to develop

```
cd /workdir/libB

git checkout develop

git merge PR-01 --no-ff -m "merge PR-01"

git push origin develop
```

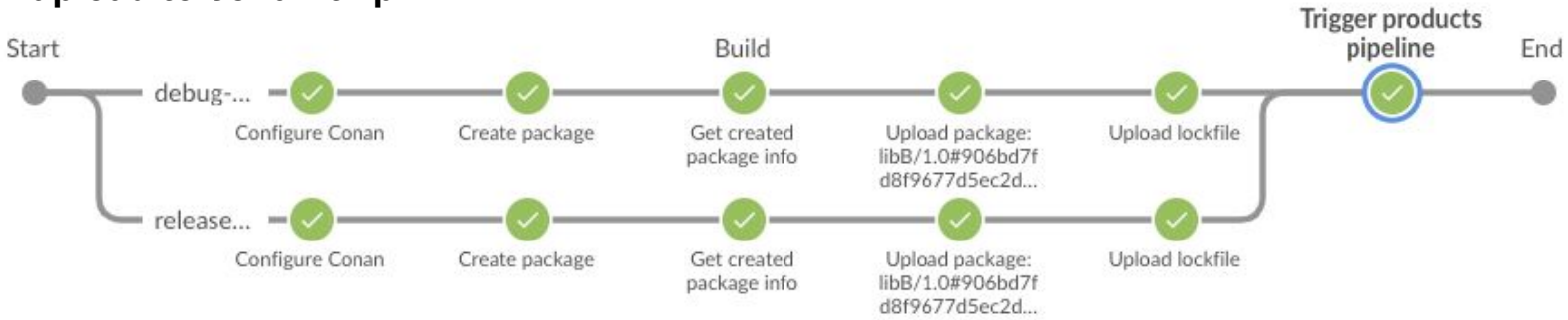
We will have a new commit so we need to launch the pipelines again and rebuild

After the push a **hook** triggers the Jenkins libB pipeline and starts the job for the develop branch

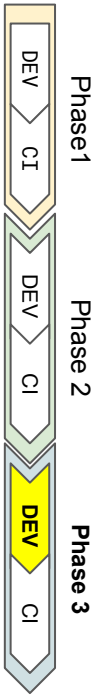


[Lab 5][Result] Check the stages run in the pipelines

Package pipeline for libB: for each configuration create the new revision and upload to conan-tmp



Products pipeline: check if App or App2 are affected and rebuild, upload artifacts and lockfiles to conan-develop



[Lab 5][Result] Check conan-develop and conan-metadata

2:00

- conan-develop
  - mycompany
    - App/1.0/stable
    - App2/1.0/stable
    - libA/1.0/stable
    - libB/1.0/stable
      - 49a7066a7fbe09d681bde1a25c3a26ad
      - 977295a4a866ca4e07b5d9ec3994677a
      - index.json
    - libC/1.0/stable
    - libD/1.0/stable
      - 3c53819b8edcf327e16dd275f7a1c103
        - export
        - package
          - 2e9e2c77ca150ea2282f1836ad7b296201ad4b7d
          - 3f683615ce650fcadb110c2378a1fc73dd473270
          - 47e8963e688336d05692d3806e5d9ea33da83d6f
          - 7f9a0d6f1593b5af70e986a9cd6ea5ab573d1793
        - .timestamp
      - index.json

New revision of libB

New binaries for libD and App

Lockfiles for libB and App uploaded to conan-metadata for the different profiles built

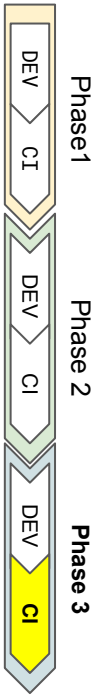
- conan-metadata
  - libB/develop/5/libB/1.0@mycompany/stable
  - products/master/21/App/1.0@mycompany/stable
    - debug-gcc6
      - App-debug-gcc6.lock
    - release-gcc6
      - App-release-gcc6.lock

Property	Value(s)
profile	debug-gcc6
name	App
build.name	products/master
build.number	21
version	1.0

Phase1: DEV → CI
Phase 2: DEV → CI
Phase 3: DEV → CI

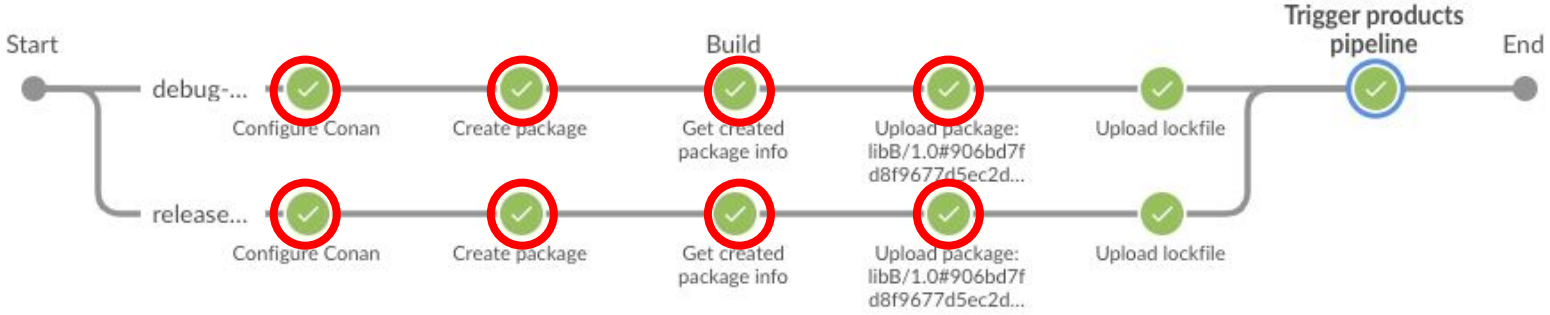
Outline

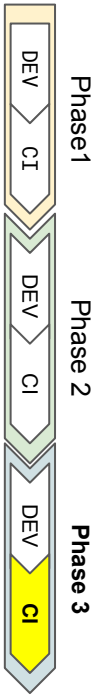
- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- **CI Workflow: Phase 3**
  - The PR is merged to the develop branch
  - **CI Stages**
    - **Package pipeline**
    - Products pipeline
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix



[Phase 3 - Package pipeline] Stages in common with Phase 2

- Configure Conan
- Create new revision of libB with changes
- Get libB's revision, name and version
- Upload new revision of libB to conan-tmp

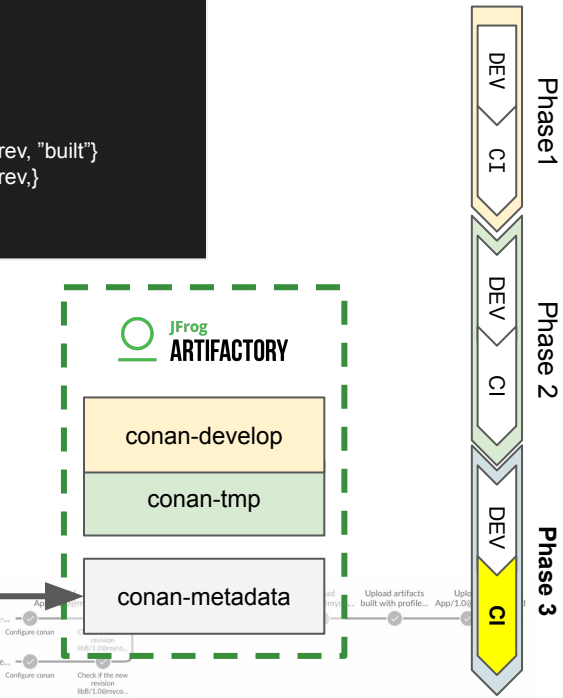


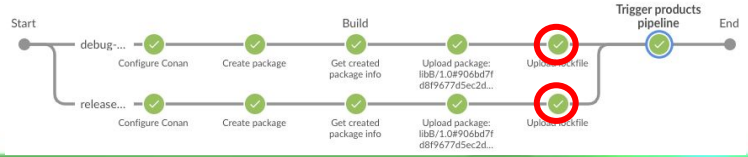


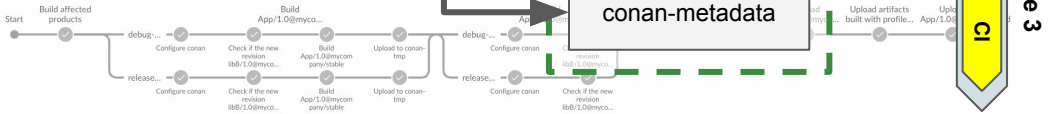
[Phase 3 - Package pipeline][Upload libB lockfile to conan-metadata]

```
# upload the lockfile to conan-metadata repo using the
artifactory REST API
# you can use the build_name and number for the path

curl -u conan:conan2020 -X PUT
http://<artifactory_url>/conan-metadata/<path>/ -T conan.lock

# you can also assign properties to the uploaded files

curl -u conan:conan2020 -X PUT
http://<artifactory_url>/api/storage/<path>/conan.lock?propertie
s=build.name=conan-app%7Cbuild.number=1%7Cprofile=gcc6-release%7
ClibB.version=1.0
```

```
libB.lock

{
 profile="gcc6-release"
 nodes= {
   "0": { libB/1.0#rrev:pkgid#prev, "built"}
   "1": { libA/1.0#rrev:pkgid#prev,}
}
```



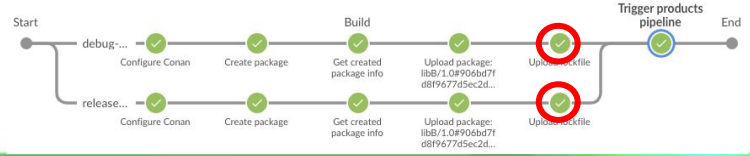


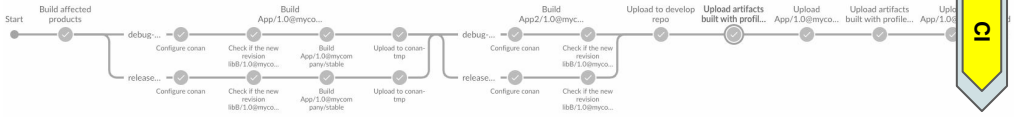


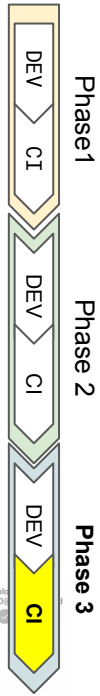
[Phase 3 - Package pipeline][Upload libB lockfile to conan-metadata]

libB/Jenkinsfile

```
stage("Upload lockfile") {
   if (env.BRANCH_NAME == "develop") {
       def lockfile_path =
"/${artifactory_metadata_repo}/${env.JOB_NAME}/${env.BUILD_NUMBER}/${name}/${version}@${user_channel}/${profile}/conan.lock"
       def base_url = "http://${artifactory_url}:8081/artifactory"
       def properties =
"?properties=build.name=${env.JOB_NAME}%7Cbuild.number=${env.BUILD_NUMBER}%7Cprofile=${profile}%7Cname=${name}%7Cversion=${version}"
       withCredentials([usernamePassword(credentialsId: 'artifactory-credentials', usernameVariable: 'ARTIFACTORY_USER', passwordVariable:
'ARTIFACTORY_PASSWORD')]) {
           // upload the lockfile
           sh "curl --user \"\${ARTIFACTORY_USER}\":\"\${ARTIFACTORY_PASSWORD}\" -X PUT ${base_url}${lockfile_path} -T ${lockfile}"
           // set properties in Artifactory for the file
           sh "curl --user \"\${ARTIFACTORY_USER}\":\"\${ARTIFACTORY_PASSWORD}\" -X PUT ${base_url}/api/storage${lockfile_path}${properties}"
       }
   }
}
```







[Phase 3 - Package pipeline][Upload libB lockfile to conan-metadata]

Artifact Repository Browser

Set Me Up | Deploy

Tree | Simple

- app-debian-sit-local
- app-debian-uat-local
- artifactory-build-info
- conan-develop
- conan-metadata
  - App/develop/5/App/1.0@mycompany/stable
  - App2/develop/5/App2/1.0@mycompany/stable
  - libA/develop/5/libA/1.0@mycompany/stable
  - libB/develop/5/libB/1.0@mycompany/stable
    - debug-gcc6
      - conan.lock
    - release-gcc6
      - conan.lock
  - libC/develop/5/libC/1.0@mycompany/stable
- conan-tmp

conan.lock

Download | Actions

General | Properties | Builds

Add: Property | Property Set

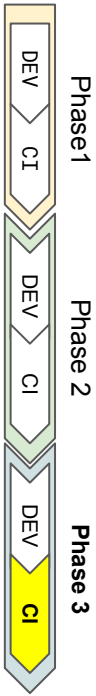
Name * | Value | Add

Recursive

5 Properties

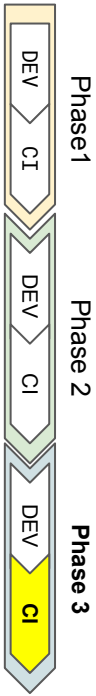
Filter by Property | Delete

Property	Value(s)
profile	release-gcc6
name	libB
build.name	libB/develop
build.number	5
version	1.0



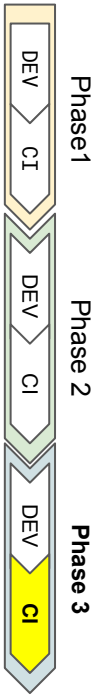
Outline

- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- **CI Workflow: Phase 3**
  - The PR is merged to the develop branch
  - **CI Stages**
    - Package pipeline
    - **Products pipeline**
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- Appendix



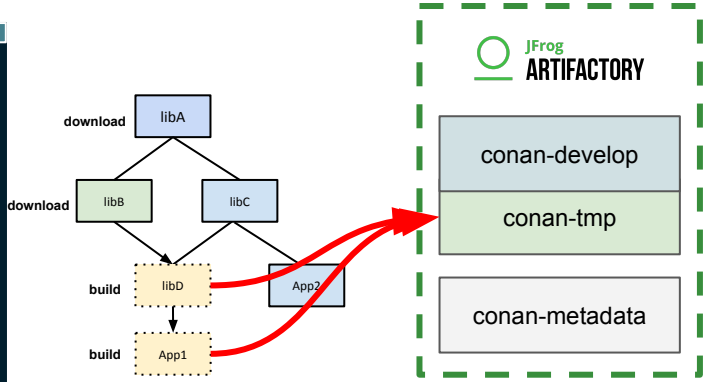
[Phase 3 - Products pipeline] Stages in common with Phase 2

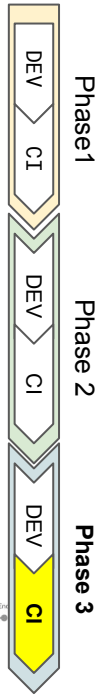
- Configure Conan
- Check if App or App2 are affected by the changes
- Build needed packages

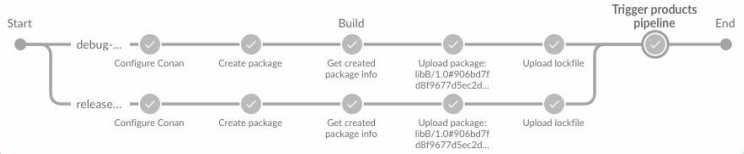


[Phase 3 - Products pipeline][Upload packages to conan-tmp]

```
conan upload libD --all -r conan-tmp --confirm

conan upload App --all -r conan-tmp --confirm
```







[Phase 3 - Products pipeline][Copy built packages from tmp to develop repo]

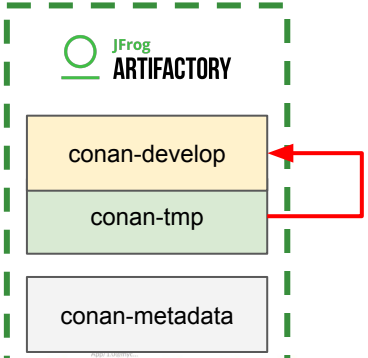
The information for all the built packages is stored in the lockfile we have used for building. We'll need code which does the following:

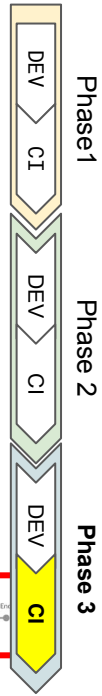
1. Iterate through all the nodes in the lockfile and add all those marked as modified="built" to a list. Also add the new revision of libB for promotion (it's not marked as "built" in the lockfile).
2. Copy export folder: sources, recipe, manifest…
3. Copy packages id's marked as built in the lockfile

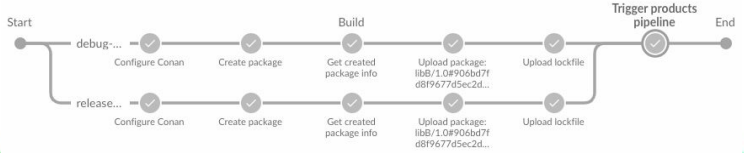
* The copies are made using Artifactory's API

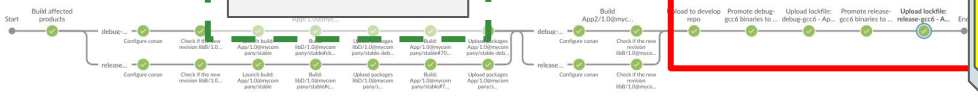
conan.lock

```
{
 profile="gcc6-release"
 nodes= {
   "0": { libD/1.0#rrev:pkgid#prev, "built"}
   "1": { App/1.0#rrev:pkgid#prev, "built"}
   "2": { libB/1.0#rrev:pkgid#prev"}
}
```





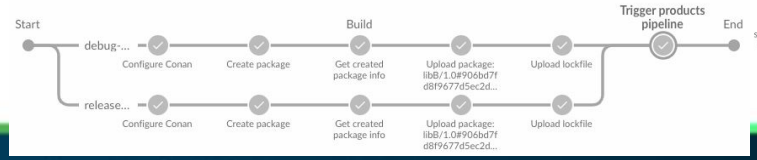


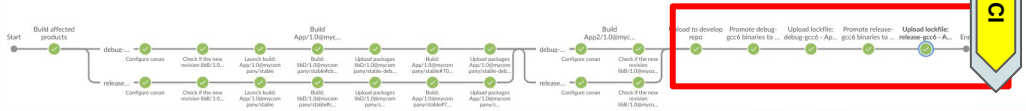


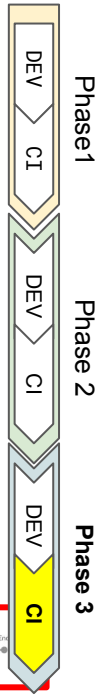
[Phase 3 - Products pipeline][Copy built packages from tmp to develop repo]

products/Jenkinsfile

```
def promote_with_lockfile(lockfile_json, source_repo, target_repo, additional_references=[]) {
 def references_to_copy = []
 def nodes = lockfile_json['graph_lock'].nodes
 nodes.each { id, node_info ->
   // iterate through the nodes and get those marked as built in the lockfile
   // add to those references the additionals (in this case libB, find the full reference and add)
   references_to_copy.add ...
 }
 references_to_copy.each { pref ->
   def recipe_source_path = "${source_repo}/${user}/${name_version}/${channel}/${rrev}/"
   def recipe_target_path = "${target_repo}/${user}/${name_version}/${channel}/${rrev}"
   def package_source_path = "${source_repo}/${user}/${name_version}/${channel}/${rrev}/package/${pkgid}/${prev}"
   def package_target_path = "${target_repo}/${user}/${name_version}/${channel}/${rrev}/package/${pkgid}/${prev}"
   withCredentials([usernamePassword(credentialsId: 'artifactory-credentials', usernameVariable: 'ARTIFACTORY_USER', passwordVariable: 'ARTIFACTORY_PASSWORD')]) {
     sh "curl -u\"\${ARTIFACTORY_USER}\":\"\${ARTIFACTORY_PASSWORD}\" -XPOST
\"http://${artifactory_url}:8081/artifactory/api/copy/${recipe_source_path}/export?to=${recipe_target_path}\""
     sh "curl -u\"\${ARTIFACTORY_USER}\":\"\${ARTIFACTORY_PASSWORD}\" -XPOST
\"http://${artifactory_url}:8081/artifactory/api/copy/${package_source_path}?to=${package_target_path}\""
   }
 }
}
```

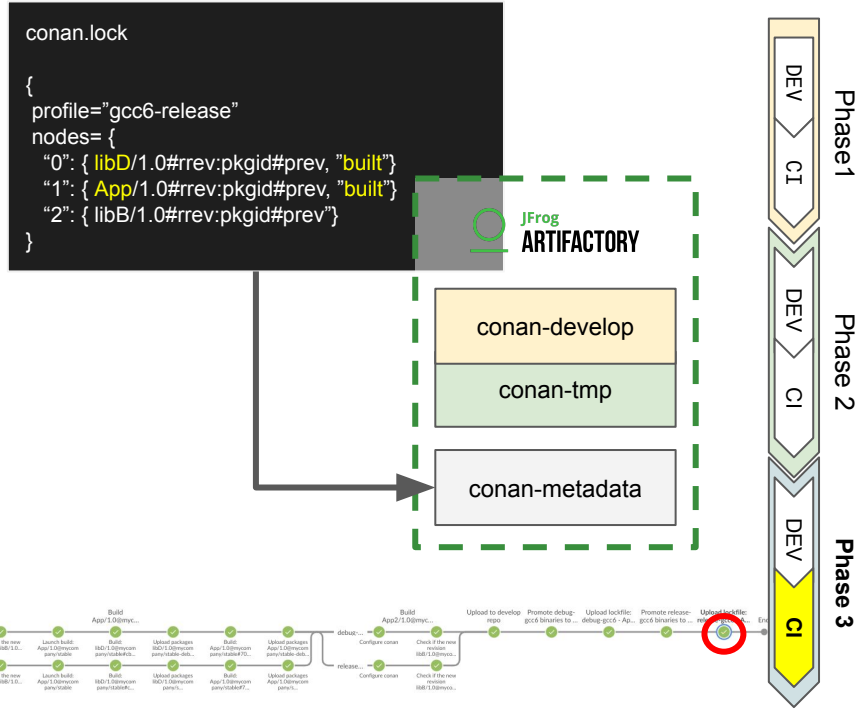


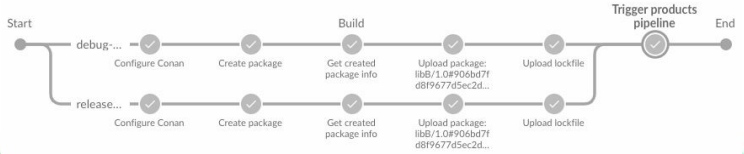




[Phase 3 - Products pipeline][Upload App lockfile to conan-metadata]

```
# upload the lockfile to conan-metadata repo using the
artifactory REST API
# you can use the build_name and number for the path

curl -u conan:conan2020 -X PUT
http://<artifactory_url>/conan-metadata/<path>/ -T conan.lock

# you can also assign properties to the uploaded files

curl -u conan:conan2020 -X PUT
http://<artifactory_url>/api/storage/<path>/conan.lock?propertie
s=build.name=...build.number=..version..
```





[Phase 3 - Products pipeline][Upload App lockfile to conan-metadata]

Artifact Repository Browser

Set Me Up

Tree Simple

- app-debian-sit-local
- app-debian-uat-local
- artifactory-build-info
- conan-develop
- conan-metadata
  - libB/develop/2/libB/1.0@mycompany/stable
  - products/master/3/App/1.0@mycompany/stable
    - debug-gcc6
    - release-gcc6
      - conan.lock
- conan-tmp

conan.lock

Downl

General | Properties | Builds

Add: Property | Property Set

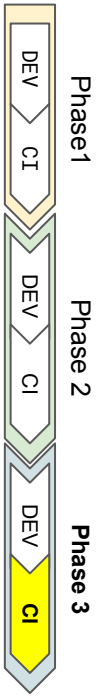
Name * | Value | Add

Recursive

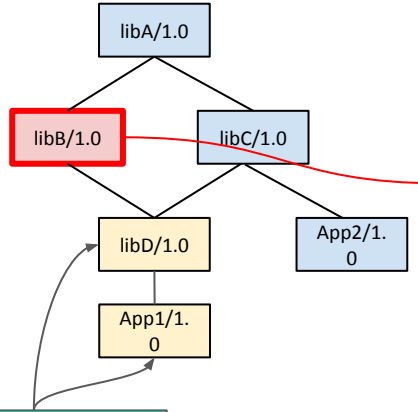
5 Properties

Filter by Property

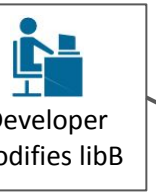
Property	Value(s)
profile	release-gcc6
name	App
build.name	products/master
build.number	3
version	1.0



[Phase 3 - Summary]

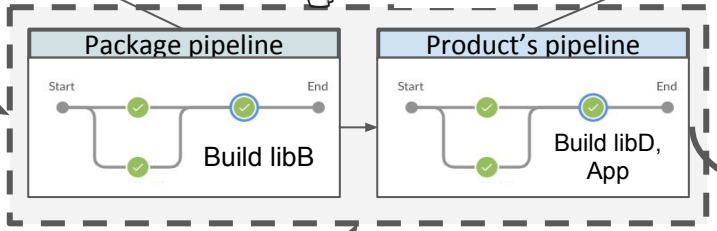


Changes in **libB** will produce new package id's for **libD** and **App** → we need to build new binaries

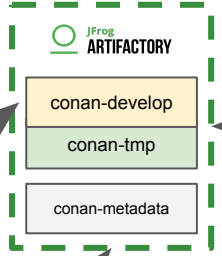


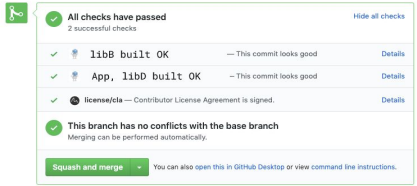
New **revision** of **libB**

New **binaries** for **libD**, **App**

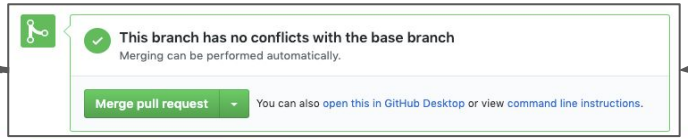


Confirm the changes don't break the products





PR merged: relaunch build and upload new packages to conan-develop



CHECKS OK: we could merge the PR to develop

Outline

- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- **Artifactory: Build Info**
- Artifactory: Promotion
- Summary
- Appendix

Build Info

What is it and how do we use it?

- Bill Of Material (JSON file):
  - List of generated binaries
  - Includes all consumed dependencies
- Can be generated from a Conan Lockfile, by conan_build_info --v2 client
- Can be published by CI plugins and JFrog CLI
- Only Jenkins and Azure devops plugins have specific instruction for Conan
- Possibility to merge multiple Build Info via the conan_build_info client

Build Info

Artifactory

Packages

Builds

Artifacts

Builds > conan-app > 1

Build Name	Agent	Build Agent	Started	Duration	Principal	Artifactory Principal
conan-app		Conan Client/1.X	20-04-20 13:55:25 +0...	0.0 seconds	-	conan

Published Modules | Environment | Xray Data | Issues | Diff

3 Modules

App

Export folder (recipe, conanmanifest)

Module ID	Number Of Artifacts	Number Of Dependencies ...
App/1.0@mycompany/stable	2	8
App/1.0@mycompany/stable:5047d1057c0c45d06b11808d62295bb77a1646e7	3	12
App/1.0@mycompany/stable:6268d174e50afd7bfd3886043cdce8f0abbb229b	3	12

Package folder (binaries)

Build Info

All artifacts have to be in Artifactory !

Module Details: App/1.0@mycompany/stable:6268d174e50afd7bfd3886043cdce8f0abbb229b

Compare with Previous Build

3 Artifacts

Filter by Artifact Name

Artifact Name	Type	Repo Path
conan_package.tgz		conan-develop/mycompany/App/1.0/stable/1ccb616db7ff7812d83ec91e1fb6dadc/package/6268d174e50afd7bfd38...
conaninfo.txt		conan-develop/mycompany/App/1.0/stable/1ccb616db7ff7812d83ec91e1fb6dadc/package/6268d174e50afd7bfd38...

12 Dependencies

Filter by Dependency ID

Dependency ID	Sc...	Ty...	Repo Path
libA/1.0@mycompany/stable:57547fe65fff...			conan-develop/mycompany/libA/1.0/stable/13c5d4cb6adbd64dfa223e8d1775c3db/package/5...
libA/1.0@mycompany/stable:57547fe65fff...			conan-develop/mycompany/libA/1.0/stable/13c5d4cb6adbd64dfa223e8d1775c3db/package/5...
libA/1.0@mycompany/stable:57547fe65fff...			conan-develop/mycompany/libA/1.0/stable/13c5d4cb6adbd64dfa223e8d1775c3db/package/5...
libB/1.0@mycompany/stable:fdb7b014			conan-develop/mycompany/libB/1.0/stable/e736204bc19388683c3c4de92b474f5c/package/
libB/1.0@mycompany/stable:fdb7b0148ff...			conan-develop/mycompany/libB/1.0/stable/e736204bc19388683c3c4de92b474f5c/package/fd...
libB/1.0@mycompany/stable:fdb7b0148ff...			conan-develop/mycompany/libB/1.0/stable/e736204bc19388683c3c4de92b474f5c/package/fd...
libC/1.0@mycompany/stable:fdb7b0148ff...			conan-develop/mycompany/libC/1.0/stable/043241c7423a29436a1d3777f3347a15/package/fd...

conan-develop/mycompany/libC/1.0/stable/043241c7423a29436a1d3777f3347a15/package/fdb7b0148ffcfd6c47fd2e69abeddace50e2f221/01be93db323df6f788570caaa3933eb2/conaninfo.txt

Build Info - WARNING

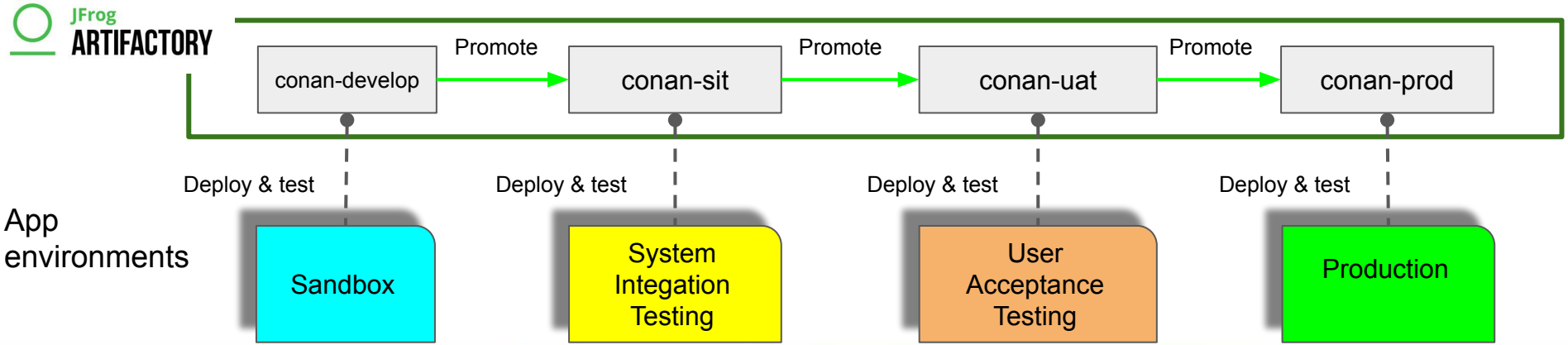
- Initially covering Java use case
- Doesn’t FULLY support some use cases including **Conan**
  - **We don’t recommend to use it for Conan for now**
  - See Appendix for :
    - How to create a Conan Build Info
    - Build Info limitation
- It’s possible to create a custom Build Info where result of a build and dependencies are specified manually

Outline

- Recap from Advanced Training
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Artifactory: Build Info
- **Artifactory: Promotion**
- Summary
- Appendix

Promotion mechanism

- Monitor your binaries during the delivery process
- The component lifecycle is represented by a chain of repositories
- Consist in copying/moving a single or group of artifacts from a source repository to a target repository

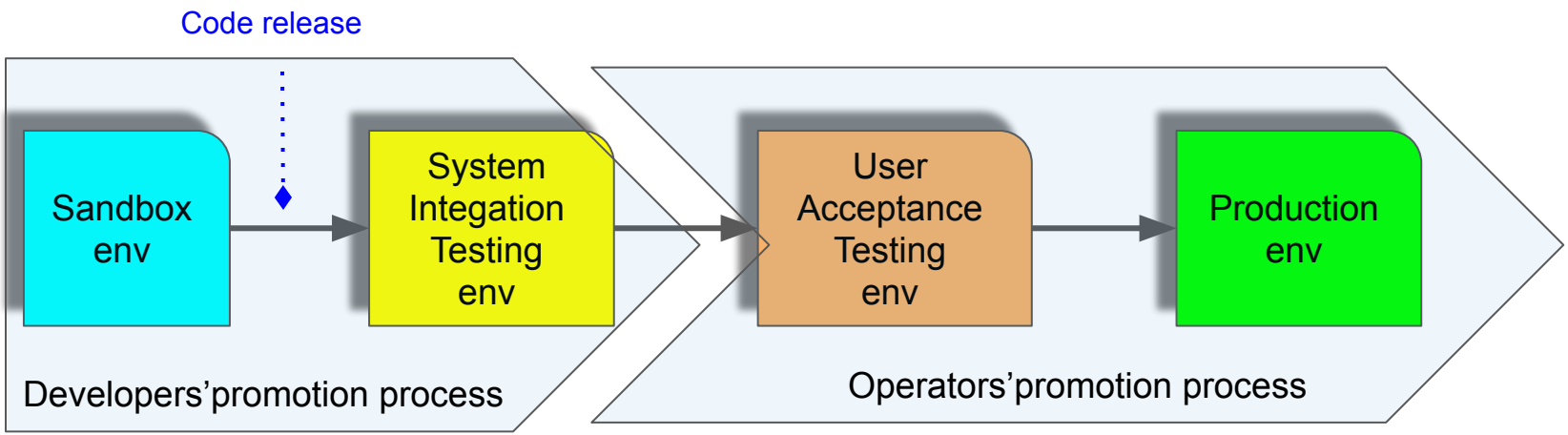


Promotion mechanism

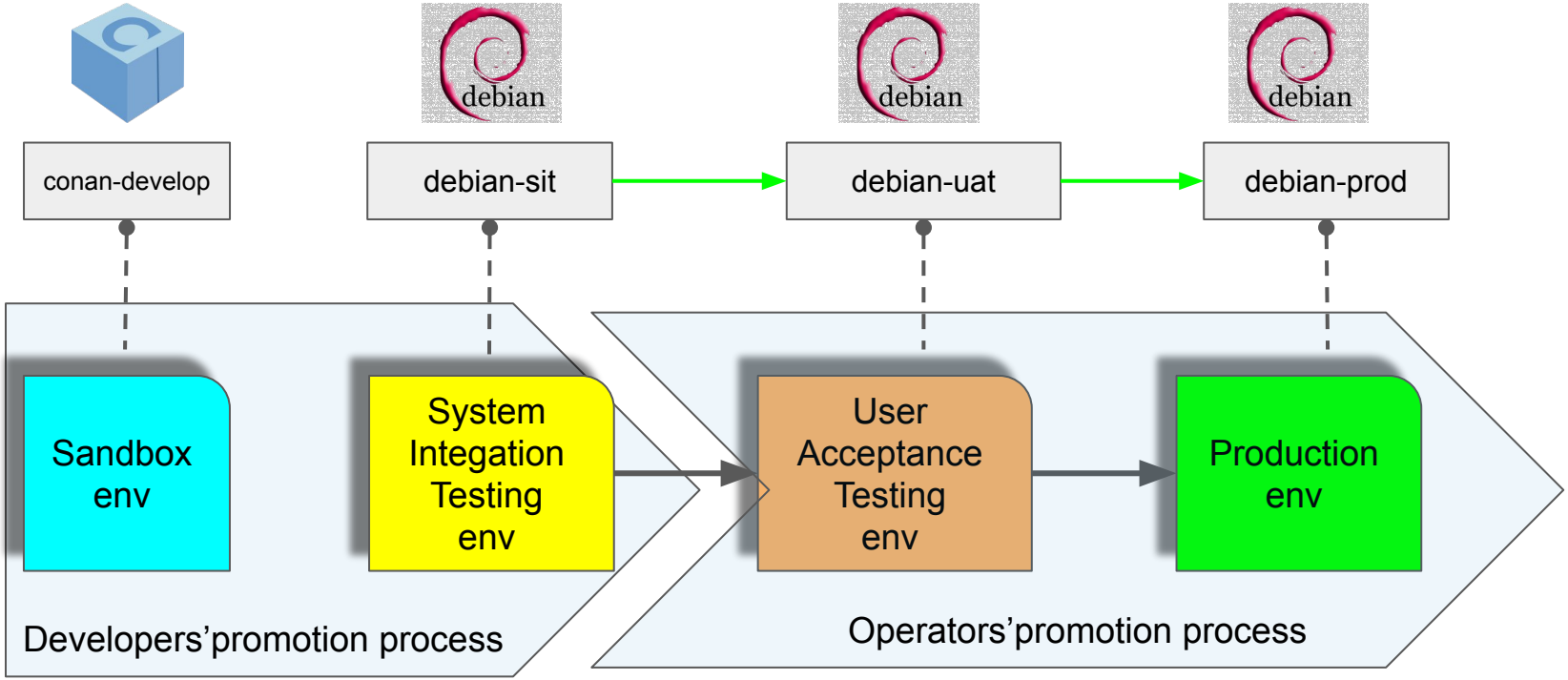
- Triggered automatically (CI/CD tool) or manually after passing a test in the delivery process
- 2 types of promotions
  - Artifact(s) promotion = copy or move 1 or more artifact
  - Build promotion = copy or move artifacts from a Build Info
    - Promotion status
    - Promote generated artifacts with or without build info dependencies

Promotion vs Release

- Artifactory doesn't generate releases. This is still handled by your build/release tools
- To deliver a product to production, there can be distinct promotion processes !



Dev and Ops promotion process



Dev to Ops promotion process

- Goal :
  - Generate a **debian package** embedding App v1.0 (Release) for the ops and ease their promotion process with Build Info
- Implementation :
  - Retrieve App based on specific properties
  - Create a custom Build Info :
    - Artifact section : App debian package
    - Dependencies : lockfile + conan_package.tgz
  - Switching from the **conan_build_info** client to **the JFrog CLI**

Automation with JFrog CLI

- Lightweight tool running on the following OS : linux, windows, mac
- Optimized for massive actions : upload, download, search, update, move, copy, delete
- Checksum aware on uploads and downloads:
  - compute the checksum of the binary to upload and send it in the header request
  - Only upload binaries which checksum doesn’t exist in the Artifactory DB
- Easy way to manage Build Info

[Lab6] Configure the JFrog CLI

Goal:

- Connect the JFrog CLI to Artifactory

Task:

-

Success:

- Ping Artifactory + check read permission

[Lab 6] Configure the JFrog CLI

3:00

```
cd /promotion_labs/

jfrog rt c --interactive=false  --url=http://jfrog.local:8081/artifactory
--user=conan --password=conan2020 art7

# show current art7 profile
jfrog rt c show

# test connection by listing the repo content
jfrog rt search conan-metadata/
```

[Lab 7] Download App based on properties

Goal:

- Use AQL (*) to retrieve a lockfile based on its properties (build.name, build.number, profile)
- Use the Conan Deploy Generator to deploy files locally

Task:

- Download a lockfile based on properties using AQL in a filespec
- Deploy conan_package.tgz in the current path

Success:

- Conan_package.tgz is downloaded and its content is exploded in App folder

* Artifactory Query Language : see Appendix for more details

[Lab 7] Download App based on properties

3:00

```
# show filespec based on AQL
cat automation/filespec.json


# download lockfile based on properties + output “success”
jfrog rt download --spec=automation/filespec.json

# “deploy” the package referenced in the lockfile in the current path
conan install App/1.0@mycompany/stable --lockfile App-release-gcc6.lock -g deploy -r conan-develop
--update

ls -l App/

# execute the deployed App
./App/bin/App
```

[Lab 8] Create and upload a debian package

Goal:

- Create and upload a debian package

Task:

- Create a debian package from the App binary
- Upload the debian package to Artifactory

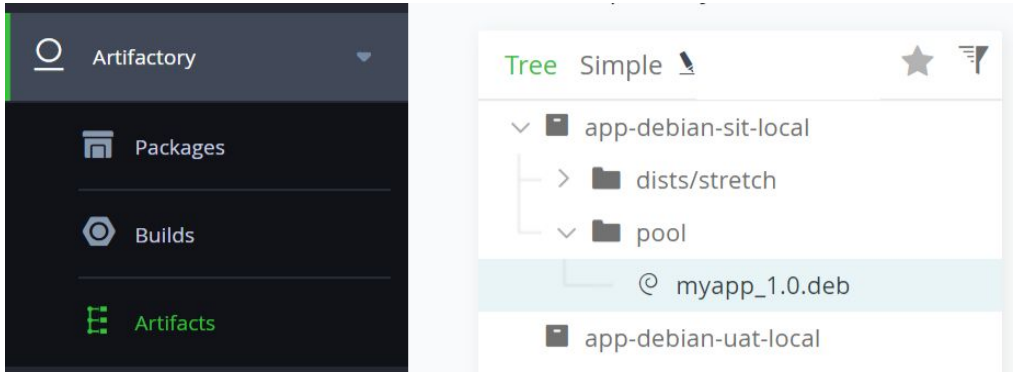
Success:

- Check the Debian package in Artifactory

[Lab 8] Create and upload a debian package

2:00

```
./generateDebianPkg.sh conan conan2020
```



[Lab 9] Create a custom Build info

Goal:

- Create a Build Info using the **JFrog CLI** which can then be promoted by the ops team

Task:

- Create and publish a **custom build info** :
  - Artifact section : debian package
  - Dependencies section : app_release.lock
- Publish the Build Info

Success:

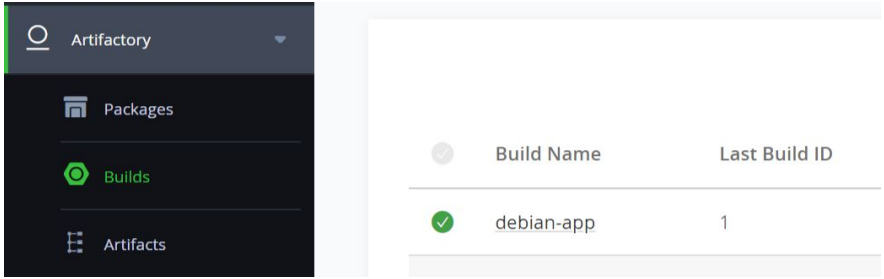
- Check the Build Info in Artifactory

[Lab 9] Create a custom Build info

3:00

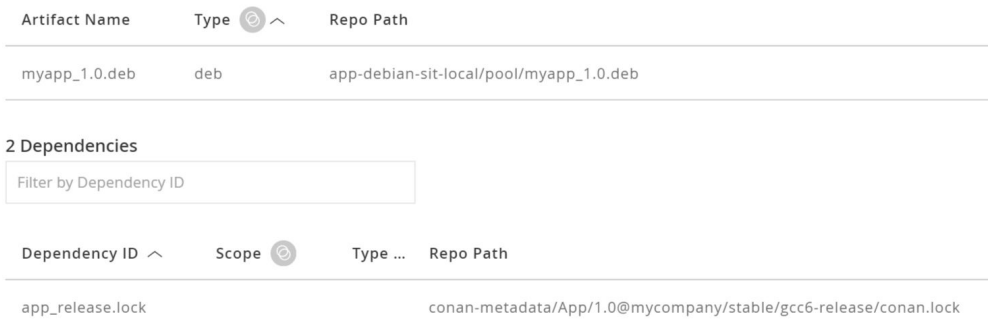
```
# define “artifact section” in build info
# won’t be re-uploaded as the JFrog CLI is checksum aware => output “status”:“success”
jfrog rt u debian_gen/myapp_1.0.deb app-debian-sit-local/pool/ --build-name=debian-app
--build-number=1

# define “dependency section” in build info => output “status”:“success”
jfrog rt bad debian-app 1 App-release-gcc6.lock

# publish build info => check result in Artifactory in the build section
jfrog rt bp debian-app 1
```

[Lab 9] Create a custom Build info



Go to “Build” section and select debian-app

Check the Build Info content



[Lab 10] Build Info Promotion

Goal:

- Promote Build Info by move without dependencies using the **JFrog CLI**

Task:

- Use jfrog rt bpr (build promote) instruction

Success:

- See the Build Info Promotion in Artifactory
  - Check path in “published modules” tab
  - Check “Release history” tab

[Lab 10] Build Info Promotion

3:00

```
jfrog rt bpr debian-app 1 app-debian-uat-local --status="SIT_OK"
--comment="passed integration tests" --include-dependencies=false --copy=false
```

Check the Build Info content and Release History tab

Published Modules | Environment | Xray Data | Issues | Diff | Release History

SIT_OK

Repository:	app-debian-uat-local
Comment:	passed integration tests
Artifactory User:	conan
Timestamp:	20-04-20 00:29:35 +0200

Promotion - Good to know

- When promoting by copy :
  - This will create more artifacts (not binaries)
  - Any AQL and filespec have to target a repository name
- Build Info promotion with / without dependencies
  - Depends on your project structure and delivery process
- Limitation : A unique target repository

Outline

- Conan reminder
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- **Summary**
- Appendix

[Last Lab] Homework :)

Have a look at the different Jenkinsfiles:

- Package pipeline: https://github.com/conan-ci-cd-training/libC/blob/develop/Jenkinsfile
- Products pipeline: https://github.com/conan-ci-cd-training/products/blob/master/Jenkinsfile
- Promotion process: https://github.com/conan-ci-cd-training/release/blob/master/Jenkinsfile

Summary

- Use different Artifactory repos
  - conan-tmp: exchange repo
  - conan-develop: storing binaries for developers to consume and for CI builds
  - conan-metadata (generic repo): store lockfiles
- Revisions + recipe_revision_mode → “automatic versioning” to integrate your changes quickly
- Use lockfiles
  - For reproducibility: calculate the build order of a graph with fixed recipe revisions and install binaries
  - To generate build info for Artifactory
- Always use config install to have the same configuration in all Conan clients
- Properties
  - To retrieve easily artifacts based on specific criterias
- Build promotion
  - Monitor your binaries via a chain of repositories in Artifactory
  - Should reflect you own delivery process

Resources

- Docs: https://docs.conan.io/
  - Read carefully, explore.
- Issues:
  - CppLang slack (community)
  - Github issues (https://github.com/conan-io/conan) “official” support
- Following trainings:
  - conandays@jfrog.com
- Other Conan questions?
  - info@conan.io
- Twitter:
  - @conan_io

THANK YOU !

Outline

- Conan reminder
- Introduction: The Story
- CI Workflow: Phase 1
- CI Workflow: Phase 2
- CI Workflow: Phase 3
- Artifactory: Build Info
- Artifactory: Promotion
- Summary
- **Appendix**

Conan features

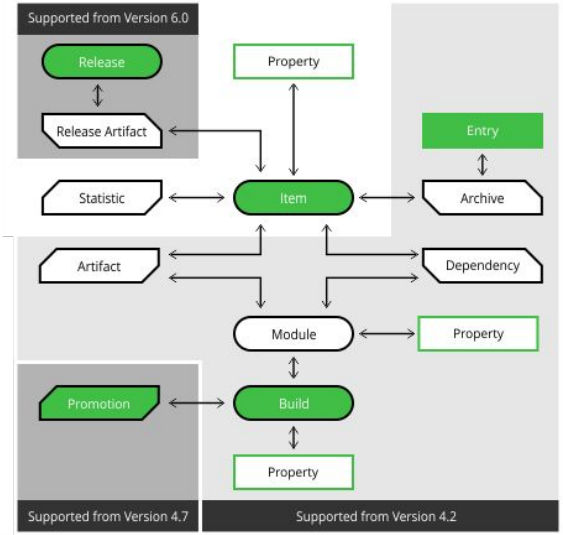
- Revisions
  - https://docs.conan.io/en/latest/versioning/revisions.html
- Package ID mode
  - https://docs.conan.io/en/latest/creating_packages/define_abi_compatibility.html#versioning-schema
- Custom Package ID
  - https://docs.conan.io/en/latest/creating_packages/define_abi_compatibility.html
- Lockfiles
  - https://docs.conan.io/en/latest/versioning/lockfiles.html#versioning-lockfiles
- Versioning
  - https://docs.conan.io/en/latest/versioning/introduction.html
- Conan Build Info client
  - https://docs.conan.io/en/latest/reference/commands/misc/conan_build_info.html

Artifactory features

- Checksum based storage
  - https://www.jfrog.com/confluence/display/JFROG/Checksum-Based+Storage
- Properties
  - https://www.jfrog.com/confluence/display/JFROG/Using+Properties+in+Deployment+and+Resolution
- Build Info
  - https://www.jfrog.com/confluence/display/JFROG/Build+Integration
- Promotion
  - https://jfrog.com/knowledge-base/how-does-build-promotion-work/
- JFrog CLI
  - https://www.jfrog.com/confluence/display/CLI

Automation with AQL

- Artifactory Query Language ~ SQL for Artifactory
- JSON formatted requests and responses
- String, Date, Time operators
- Sorting, limiting results
- Non admin can only use item domain



List artifact of a Build Info

build_info_artifacts.json

```
builds.find({
    "name": "app1",
    "number": "2",
}).include("module.artifact.item.name", "module.artifact.item.path")
```

```
# with creds or access token
curl -uadmin:<PASS> -XPOST -T build_info_artifacts.json
http//jfrog.local:8081/artifactory/api/search/aql
```

List dependencies filtered on property

build_info_deps.json

```
builds.find({
    "name": "app1",
    "number": "2",
    "module.artifact.dependency.@conan.settings.os" : "Linux"
}).include("module.dependency.item.name", "conan.settings.build_type",
"module.dependency.item.path")
```

```
# with creds or access token
curl -uadmin:<PASS> -XPOST -T build_info_deps.json
http//jfrog.local:8081/artifactory/api/search/aql
```

List artifacts based on a property value

artifact_search.json

```
items.find({
    "repo": "conan-develop",
    "name": "conaninfo.txt",
    "$or": [
        { "@conan.settings.os": "Linux" }, { "@conan.settings.os": "Windows" }
    ]
}).include("repo","path","name","@conan.settings.os","@conan.settings.arch","@conan.settings.build_type")
```

```
# with creds or access token
curl -uconan:conan2020 -XPOST -T artifact_search.json
http//jfrog.local:8081/artifactory/api/search/aql
```

Download a file using the CLI and filespec with AQL

automation/filespec.json

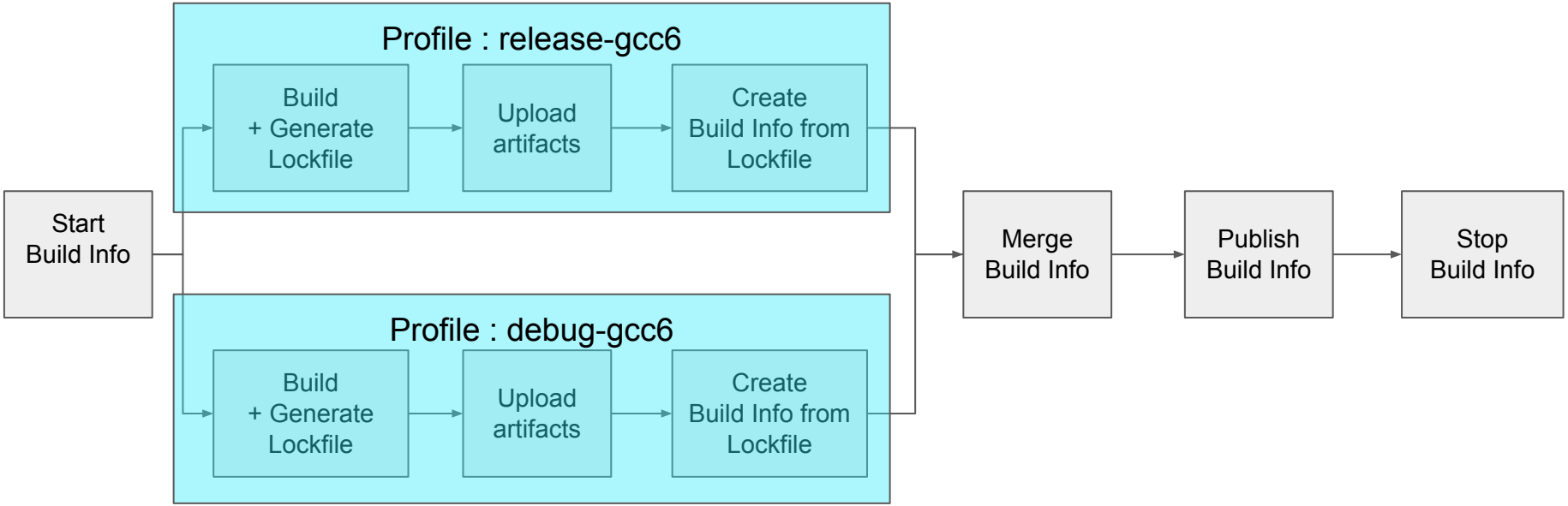
```
{
  "files": [{
    "aql": {
      "items.find": {
        "repo": "conan-metadata",
        "name" : { "$match" : "*.lock"},
        "$and": [
          { "@build.name": "conan-app" }, { "@build.number": "1" }
        ]}
  }}]
```

```
# JFrog CLI should have be configured before
jfrog rt download --spec=automation/filespec.json
```

Build Info - General explanation

- An artifact in the "**Artifacts" section** is located if the following requirements are met :
  - Checksum/hash exists in the Artifactory DB
  - Build properties set on the artifacts
- An artifact in the **"Dependencies" section** is "located" if
  - its checksum/hash exists in the Artifactory DB
- No artifact upload = no Build properties assigned to the artifact

Conan Build Info in parallel pipelines (1/3)



Conan Build Info in parallel pipelines (2/3)

```
# disable/enable build properties
conan_build_info --v2 stop && cat ~/.conan/artifacts.properties
conan_build_info --v2 start conan-app 1 && cat ~/.conan/artifacts.properties

# create build info for release from the release lockfile for App1
conan_build_info --v2 create release_bi.json --lockfile=app_release.lock --user=conan --password=conan2020 &&
cat release_bi.json

# generate libs in Debug + upload App in Debug
# current path : ~/conan_ci_cd/labs
./genAppDebug.sh

# create build info
conan_build_info --v2 create debug_bi.json --lockfile=app_debug.lock --user=conan --password=conan2020 && cat
debug_bi.json
```

Conan Build Info in parallel pipelines (3/3)

```
# create the aggregated build info
conan_build_info --v2 update --output-file app_bi.json debug_bi.json release_bi.json && cat app_bi.json

# publish the build info and remove build properties
conan_build_info --v2 publish app_bi.json --url=http://jfrog.local:8081/artifactory --user=conan
--password=conan2020

conan_build_info --v2 stop && cat ~/.conan/artifacts.properties
```

Build Info - Limitation

- MAY NOT fit the use case when :
  - An artifact is referenced by multiple Build Info (like unchanged recipe)
  - An artifact is NOT considered as a Build Info dependency
- Possible workaround :
  - All the files from the Artifact section should be packaged into an archive which will be the result of your Build Info
- Stay tuned about Build Info improvements !