



CONAN

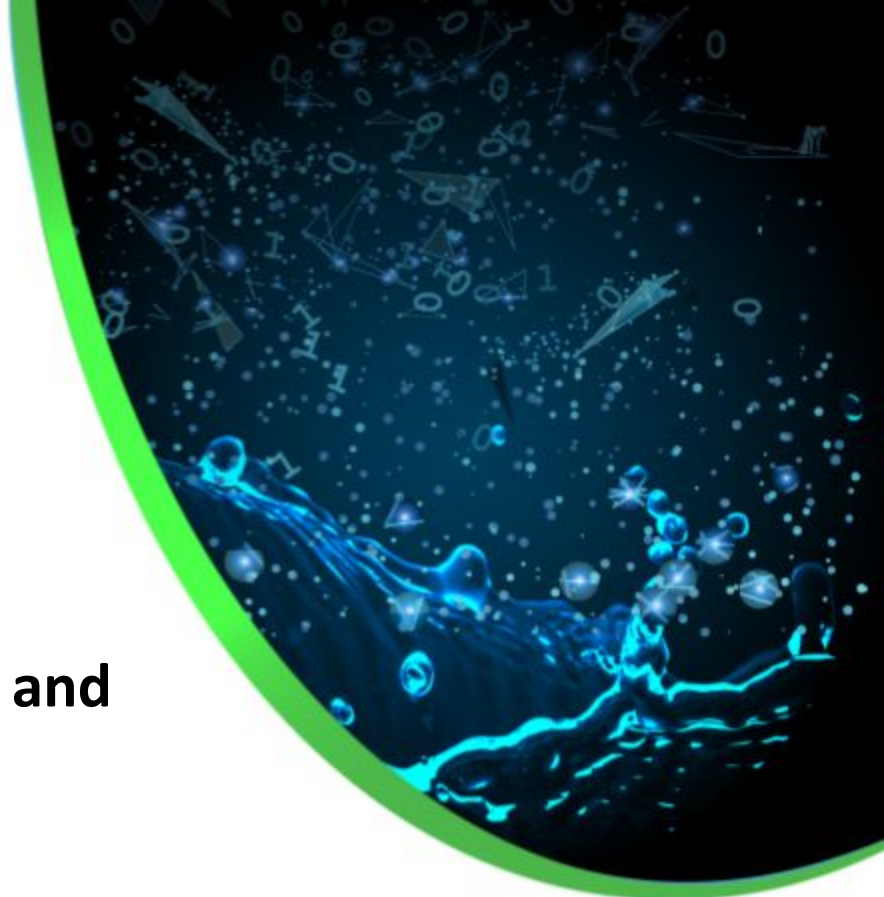
C/C++ Package manager

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

Diego Rodriguez-Losada, Conan Co-Founder @ JFrog

Carlos Zoido, Conan developer @ JFrog

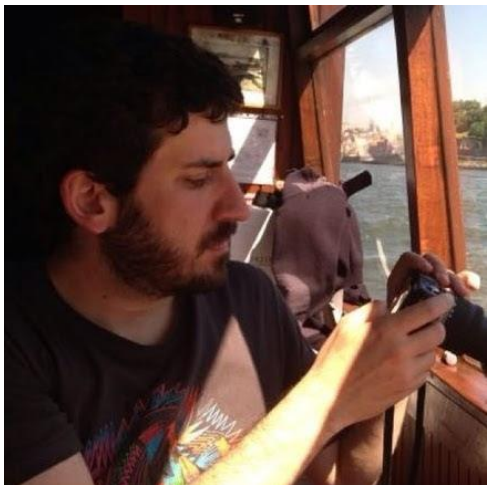
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Coaches



Carlos Zoido, Conan SW engineer



Diego Rodriguez-Losada, Conan co-founder





[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



3:00



[Lab 0] Environment bootstrapping

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

git clone https://github.com/conan-io/training-ci.git
cd training-ci/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), **new revisions will affect package id's of dependents**



Recap from Advanced Training: Lockfiles

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

```
{
  "version": "0.3",
  "profile_host":
"[settings]\narch=x86_64\nnarch_build=x86_64\nbuild_type=Release\ncompiler=gcc\ncompiler.libcxx=libstdc++11\ncompiler.version=6\nos=Linux\nos_build=Linux\n[options]\n[build_requires]\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

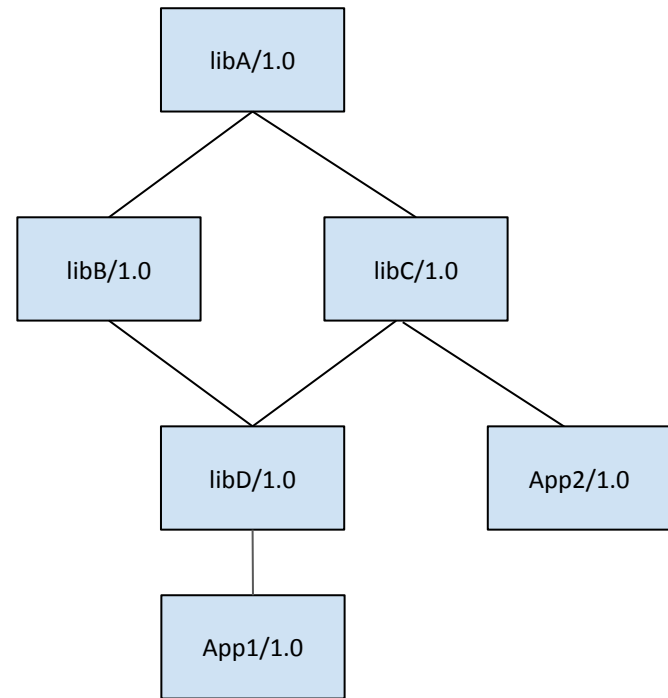
```
conan config install https://github.com/conan-ci-cd-training/settings.git
```

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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

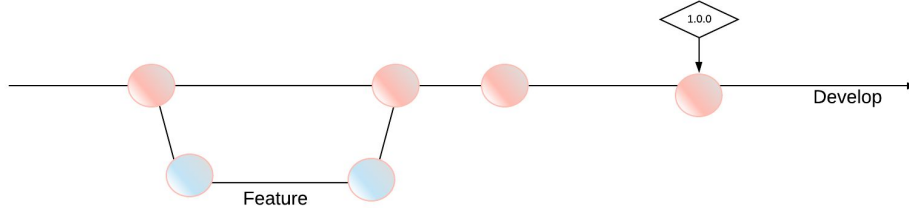


Conan Revisions Vs. Version Bumping

- Version bumping for breaking changes is a standard
- Unconditionally version bump for every change may be excessive
- Conan revisions provide an alternative
- Valid cases still exist for both revisions and version bumping
- Today's focus is on using Conan Revisions, without version bumping
 - We'll show one way to test consumers before promoting
 - If tests fail, version bump may be appropriate afterall
 - This strategy allows us to safely measure impact of a change

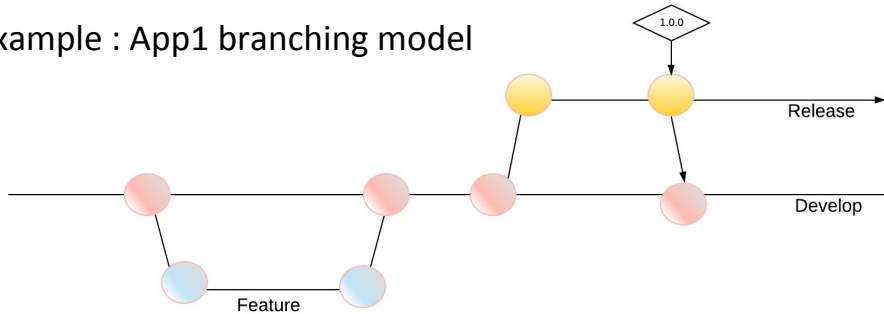
The Story: Code workflow

Example : libA branching model



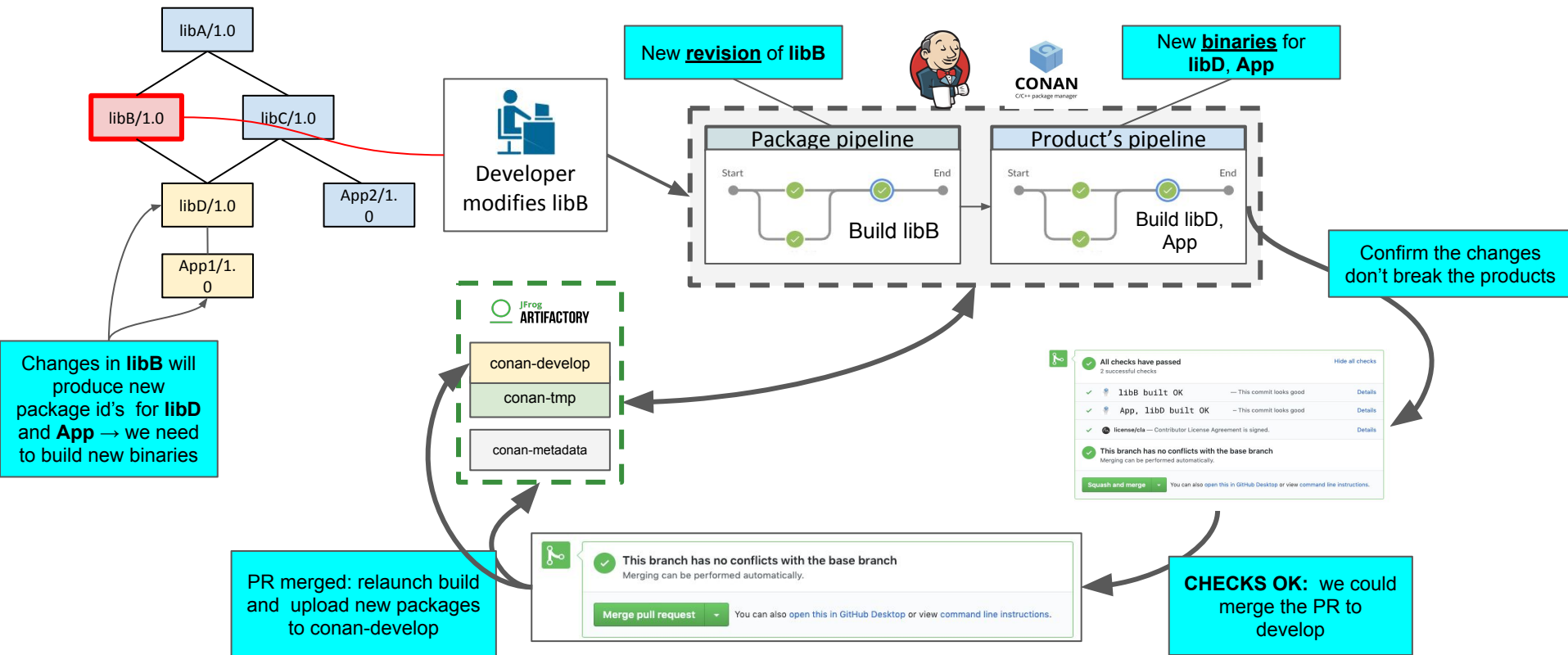
* libB, libC and libD follow the same flow and have their own code repository

Example : App1 branching model

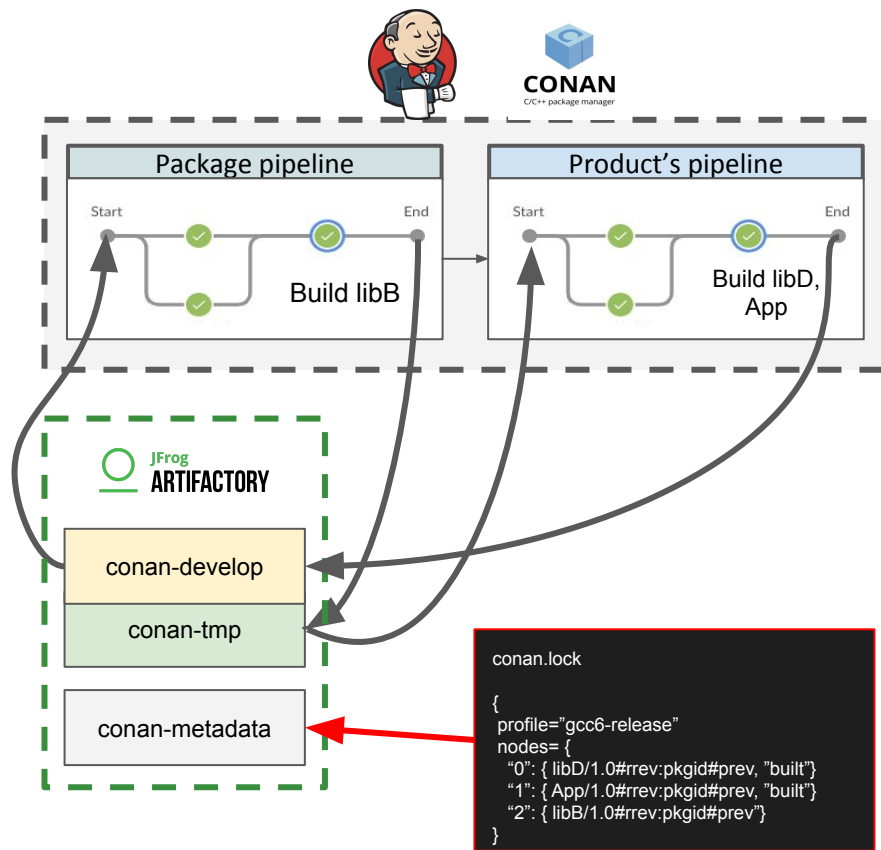


* App2 follows the same flow and has its own code repository

Mycompany development workflow



Artifactory repos



Conan repositories

conan-develop → packages that will be used by developers and other CI jobs. Packages here were usually “promoted” from **conan-tmp**

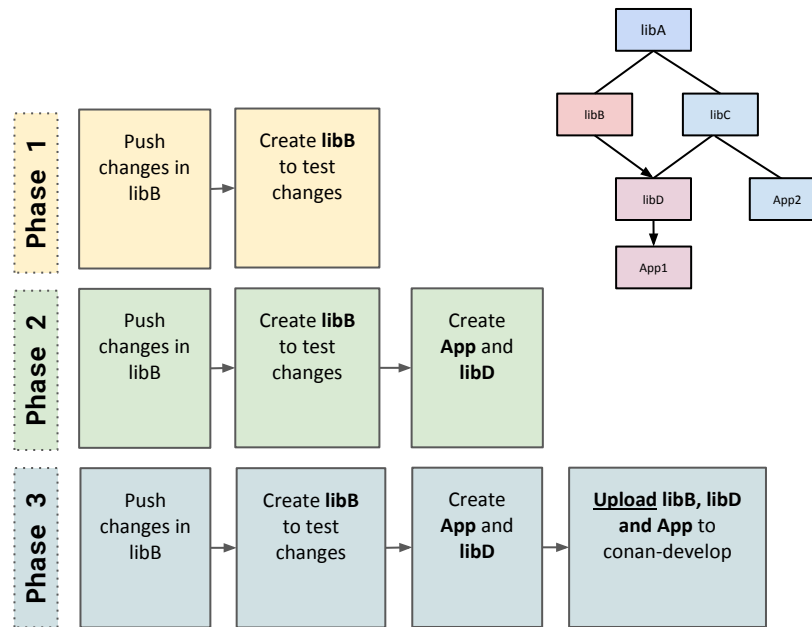
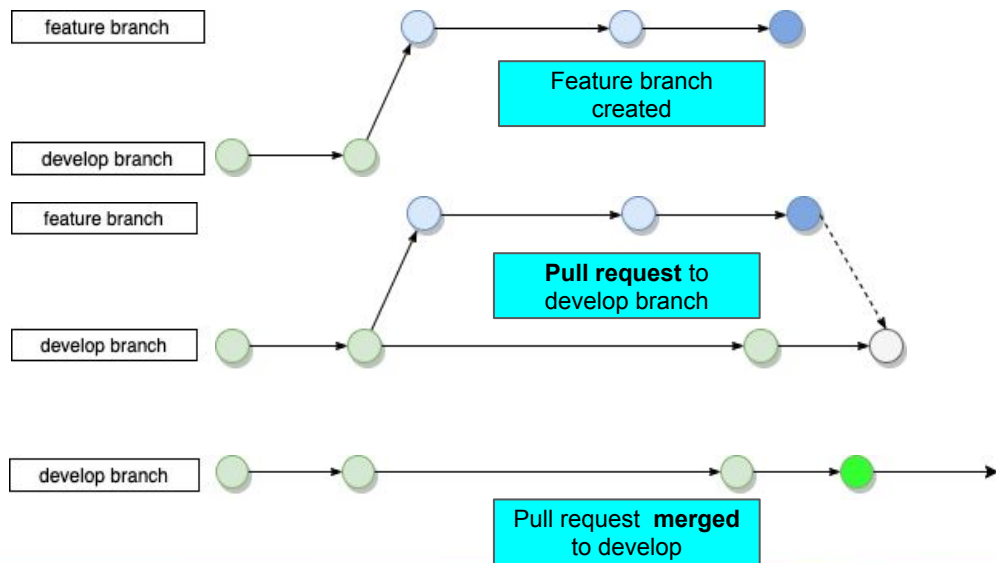
conan-tmp → packages build on the CI which are currently under development or testing, and which may be promoted in the future

Generic repositories

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

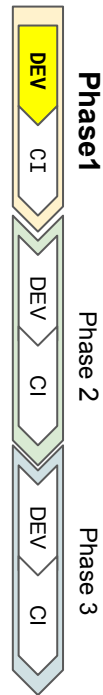
Phases in the workflow

Three phases for testing changes in **libB**




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[Reminder] Access Jenkins



Welcome to Jenkins!

administrator

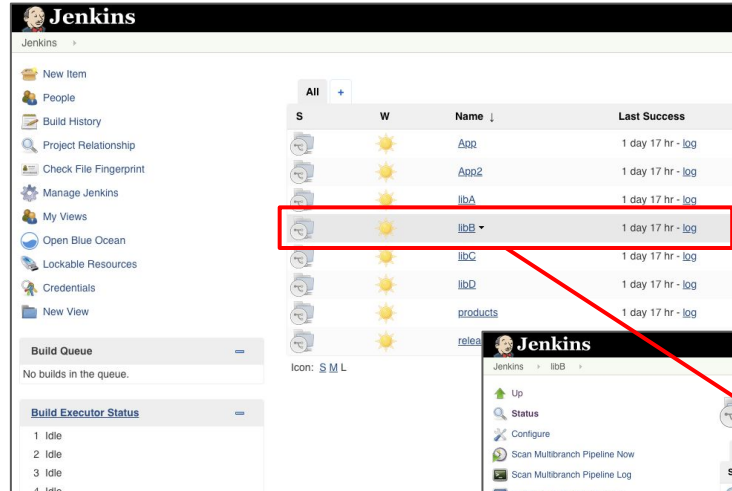
.....

Sign in

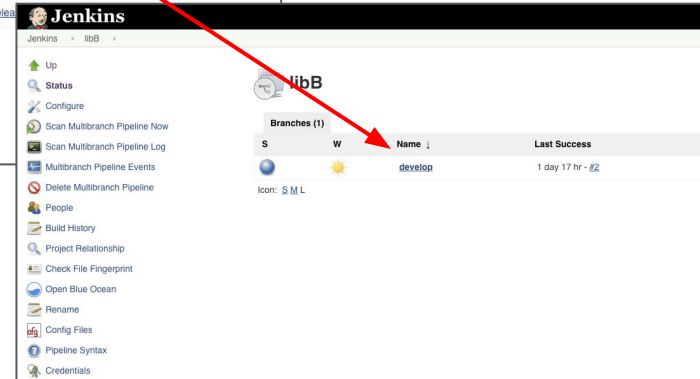
☐ Keep me signed in

Username: administrator
Password: <Jenkins Credential>

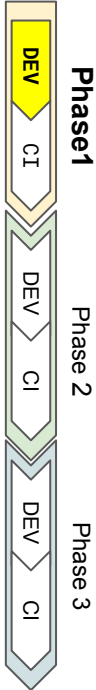
In orbitera e-mail with JFrog Test
 Drive Details



S	W	Name	Last Success
		App	1 day 17 hr - log
		App2	1 day 17 hr - log
		libA	1 day 17 hr - log
		libB	1 day 17 hr - log
		libC	1 day 17 hr - log
		libD	1 day 17 hr - log
		products	1 day 17 hr - log
		relen	



S	W	Name	Last Success
		develop	1 day 17 hr - E2





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

Goal:

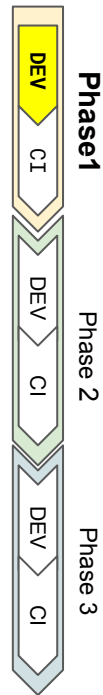
- Check and understand the series of actions that are going to be triggered in the CI when a commit is pushed to the feature branch

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 package pipeline being triggered by the push

Success:

- Check the the package pipeline finishing successfully



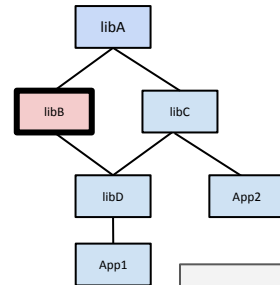


3:00



[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
```



Check the results in Jenkins

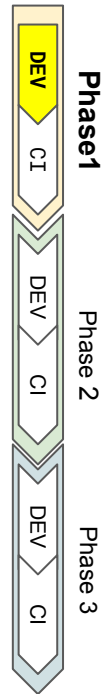


Branches (2)

S	W	Name ↓	Last Su
		<u>cool_feature</u>	N/A
		develop	1 day 1

Icon: S M L

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



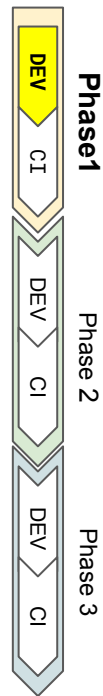
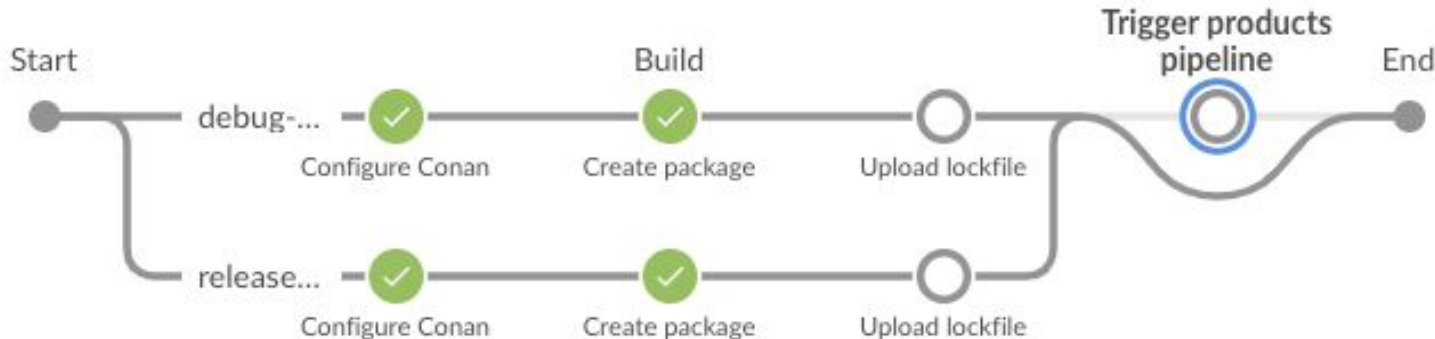


[Lab 1][Result] Check the stages run in the pipelines

Here is a link to the code for the [Package pipeline for libB](#)

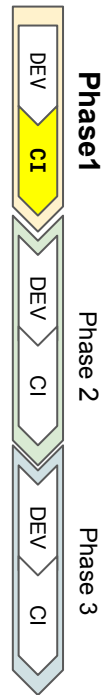
Here we point out that:

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



Outline

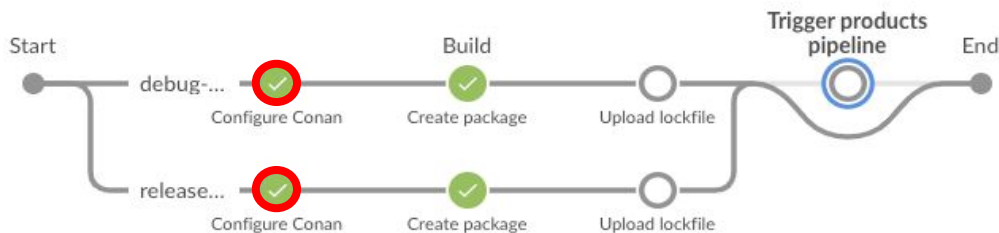
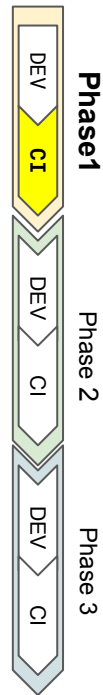
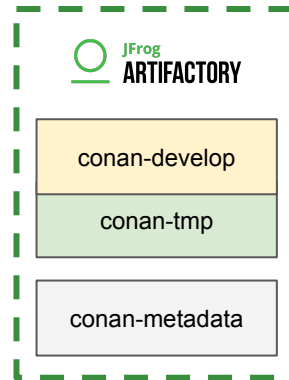
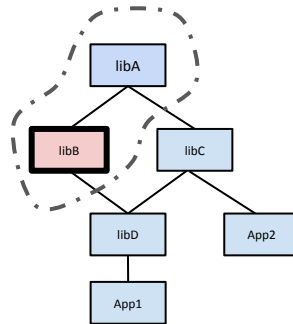
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[Phase 1 - [Package pipeline](#)] [[Configure Conan](#)]

```
# set the CONAN_USER_HOME for each stage
conan config install <config_url>

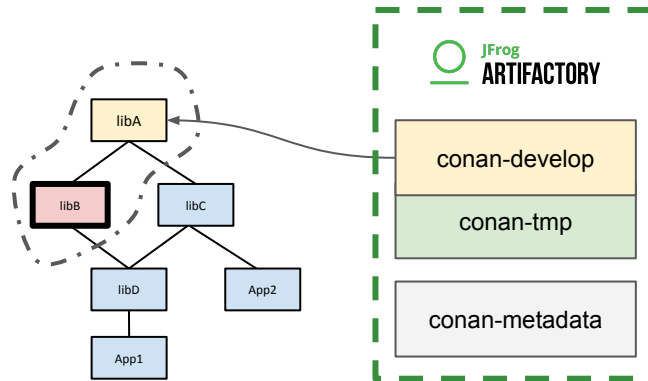
conan user -p conan2020 -r conan-develop conan
```



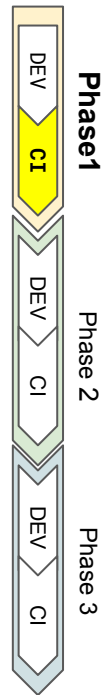
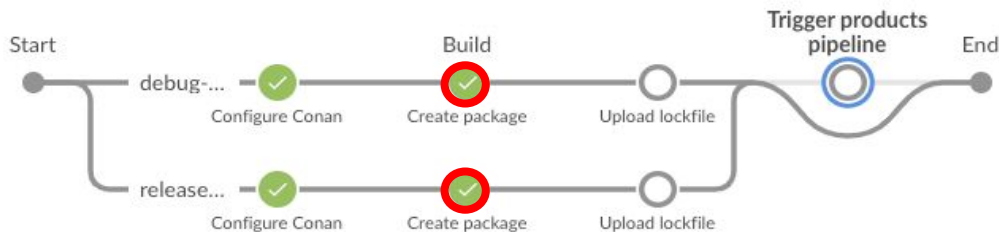
[Phase 1 - [Package pipeline](#)] [[Create libB](#)]

```
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

WELCOME TO JFROG

Username

conan

Password

.....

☐ Remember me

Login

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

JFrog Platform

Artifacts Search Artifacts Welcome, conan

Artifactory Packages Builds Artifacts Distribution Pipelines Security & Compliance

Enterprise Plus Trial License
7.2.1 rev 70201900 Licensed
to JFrog TEST
© Copyright 2020 JFrog Ltd

Artifact Repository Browser

Tree Simple

- artifactory-build-info
- conan-develop
- conan-metadata
- conan-tmp

artifactory-build-info

General Properties

Info

Name: artifactory-build-info

Repository Path: artifactory-build

URL to file: http://34.69.26.3/artifactory-build-info

Package Type: BuildInfo

Repository Layout: simple-default

Description: Build Info repository

Artifact Count / Size: Show

Created: 19-03-20 21:52

conan-develop

conan-tmp

conan-metadata

DEV CI DEV CI DEV CI

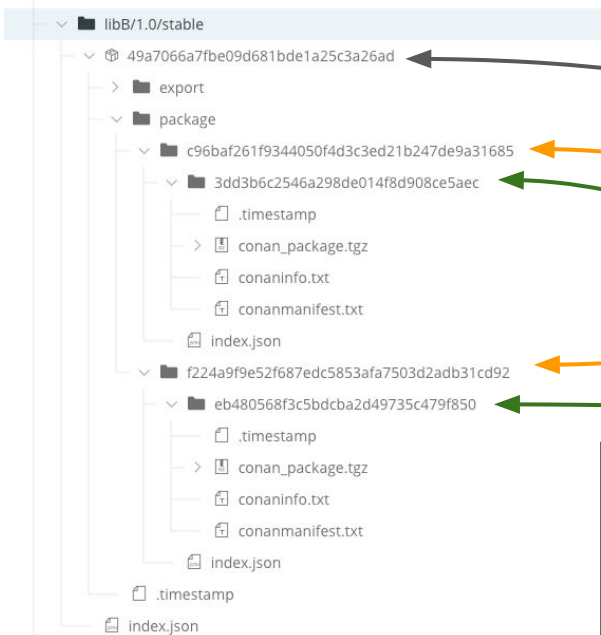
Phase 1 Phase 2 Phase 3



2:00



Check libB in conan-tmp in Artifactory

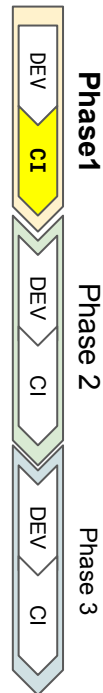


1x RECIPE REVISION(RREV)

2x PACKAGE ID

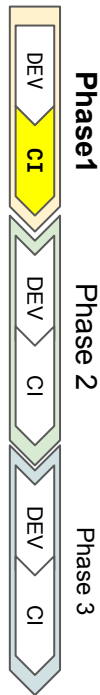
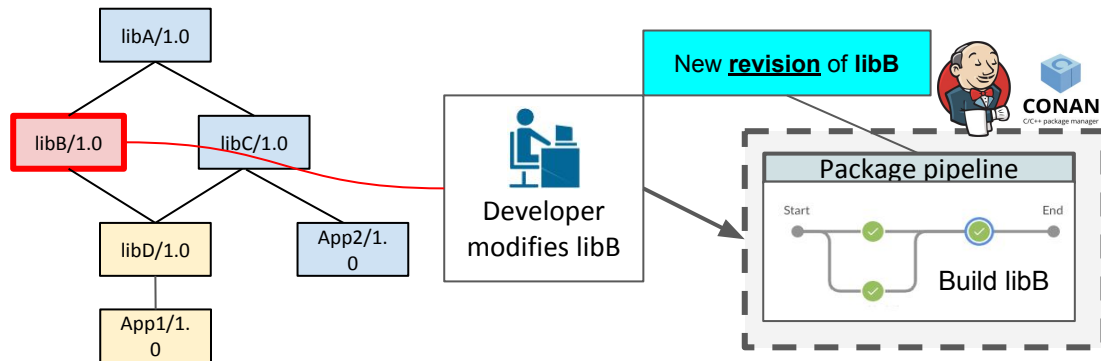
PACKAGE REVISION (PREV)

We have just one revision, that was created in the **bootstrapping**.
No packages were uploaded by the CI at this point



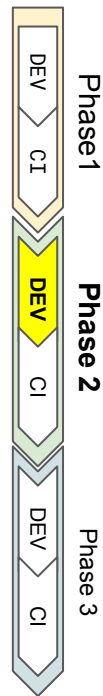
`<name>/<version>@<user>/<channel>#<rrev>:<pkg_id>#<prev>`

[Phase 1 - Summary]



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

Goal:

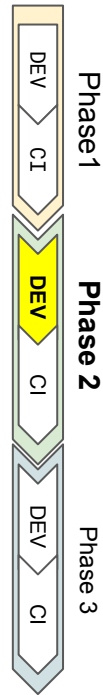
- Have a look at the set of operations that are going to be triggered in the CI when a commit is pushed to a pull request branch

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



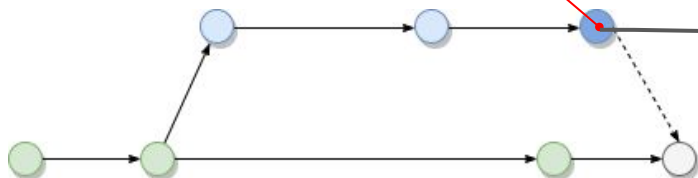
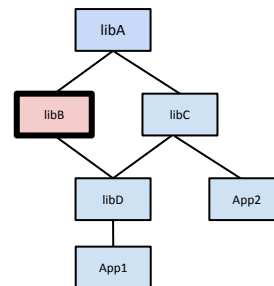


2:00



[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
```

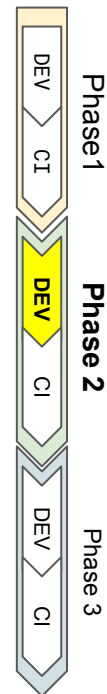


After the push a **hook**
triggers the Jenkins libB
pipeline



Branches (3)					
S	W	Name ↓	Last Success	Last Fail	
		cool_feature	11 min - #1	N/A	
		develop	21 hr - #2	N/A	
		PR-01	4 min 28 sec - #1	N/A	

Icon: [S](#) [M](#) [L](#) Legend [RSS for all](#) [RSS for](#)



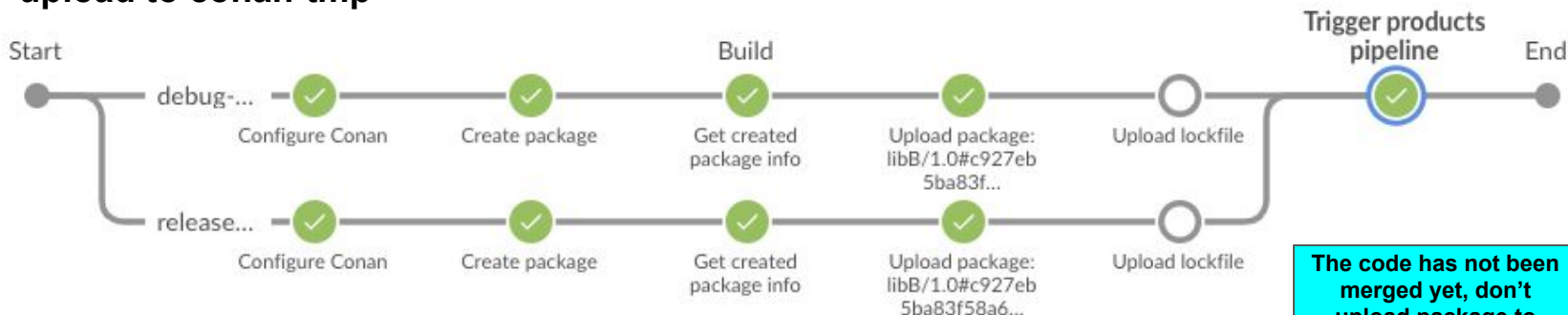


2:00

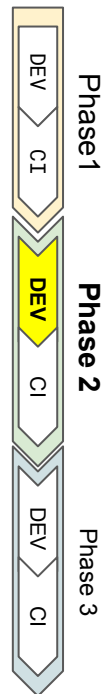


[Lab 2][Result] Check the stages run in Jenkins

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

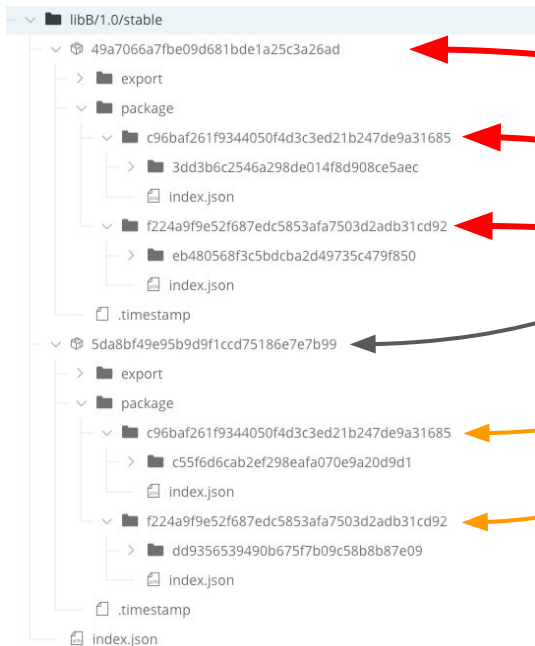




2:00



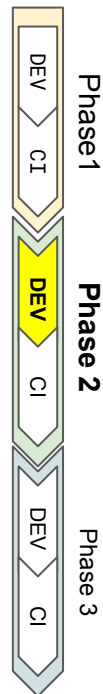
[Lab 2][Result] Check libB in conan-tmp in Artifactory



2x RECIPE REVISION(RREV)

4x PACKAGE ID (2x RREV)

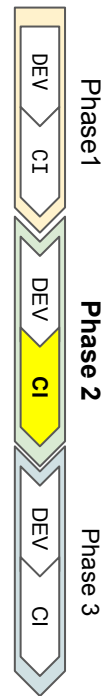
The **new revision of libB** was uploaded to conan-tmp to download it from the products pipeline but now new packages are NOT in conan-develop because the PR is not merged yet



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

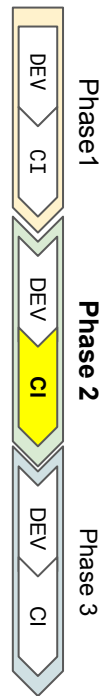
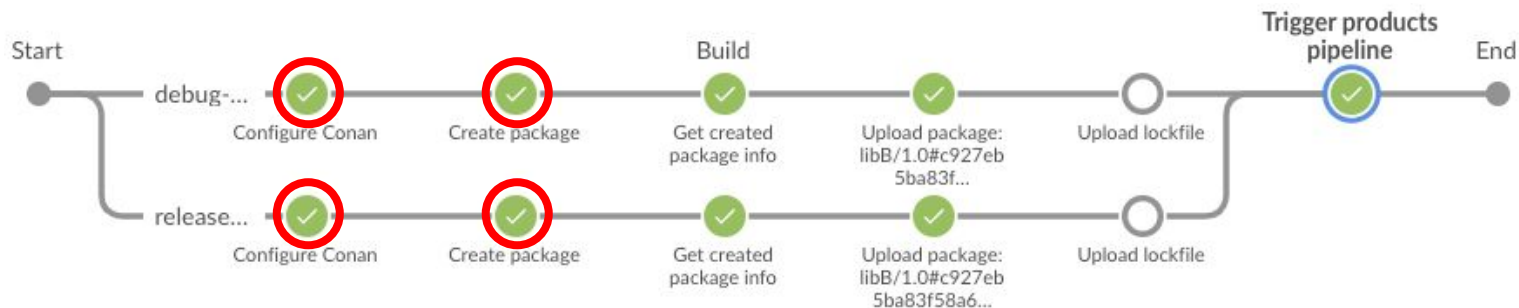
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[Phase 2 - Package pipeline] Stages in common with Phase 1

- Configure Conan
- Create new revision of libB with changes



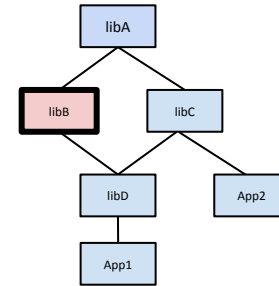
[Phase 2 - [Package pipeline](#)] [[Get created package information](#)]

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

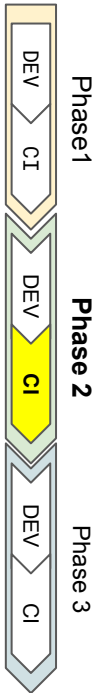
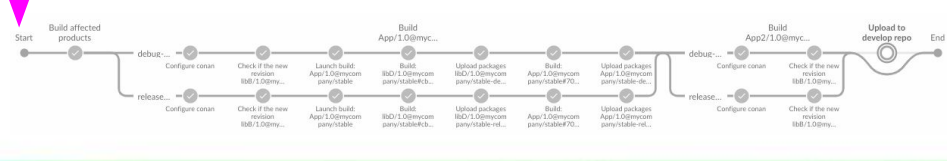
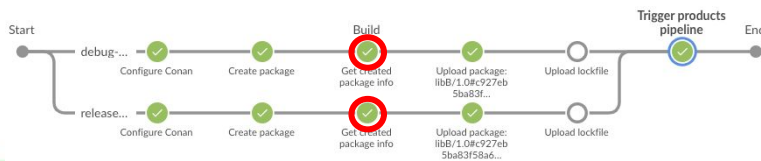
```
conan inspect . --raw name
conan inspect . --raw version
conan search libB/1.0@mycompany/stable
--revisions --raw
```

```
# get the output of the commands
```

```
# name = libB
# version = 1.0
# revision = 5da8bf49e95b9d9f1ccd75186e7e7b99
```



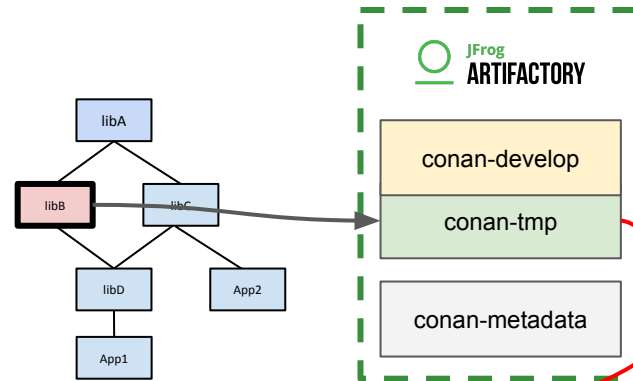
We need to pass libB/1.0#rrev as a parameter to the products pipeline so that we know which libB needs to be tested against the products



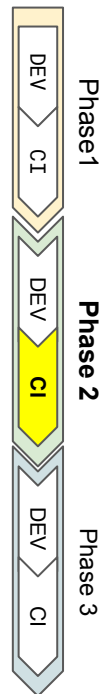
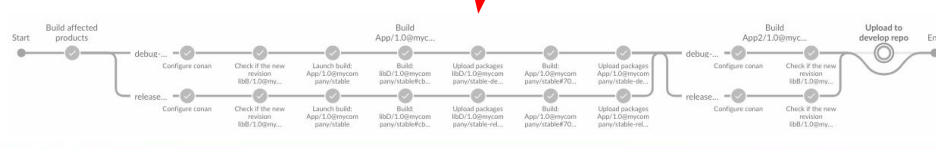
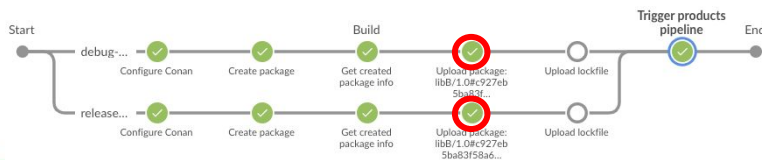
[Phase 2 - Package pipeline] [Upload libB to conan-tmp]

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

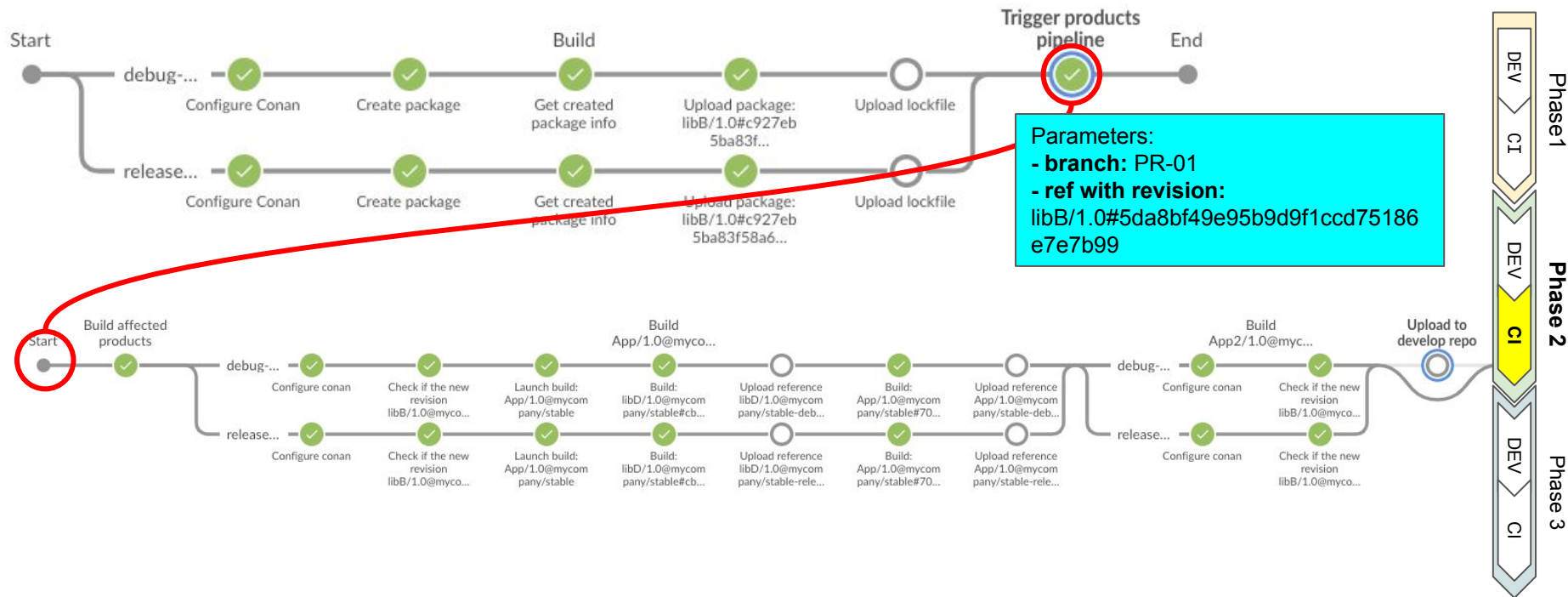
```
conan upload 'libB/1.0' --all -r conan-tmp
--confirm
```



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

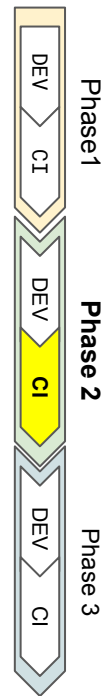


[Phase 2 - Package pipeline] [Trigger the products pipeline]



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

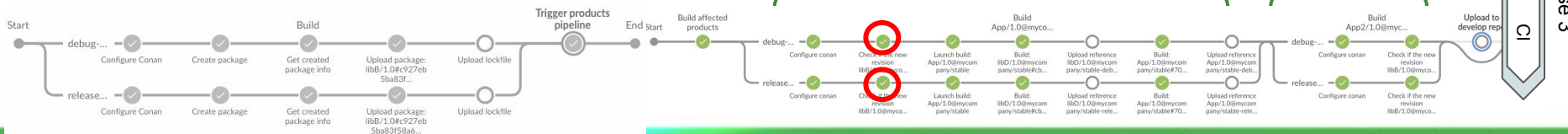
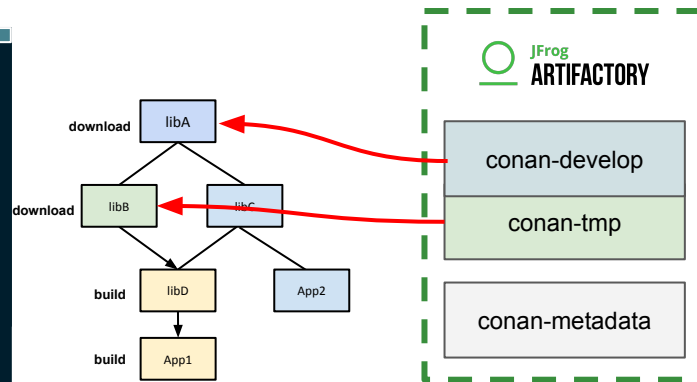


[Phase 2 - Products pipeline] [Check if libB/1.0#rrev affects products]

```
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

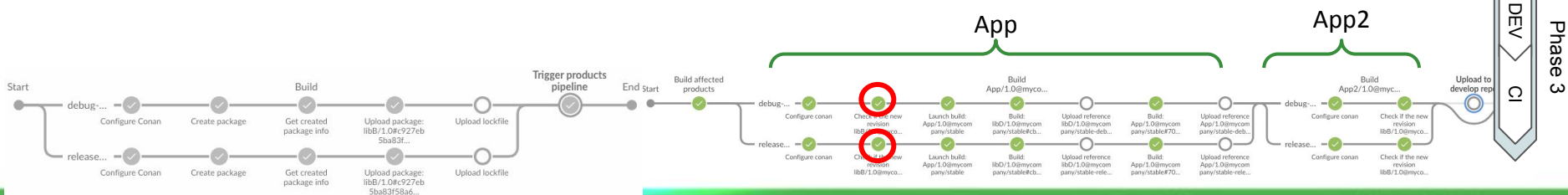
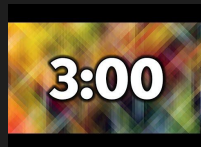




[Phase 2 - Products pipeline][Check if libB/1.0#rrev affects products]

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:

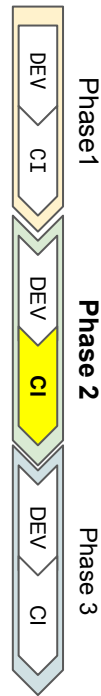
- See if the new revision of libB is affecting a product downstream so that they have to be rebuilt

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

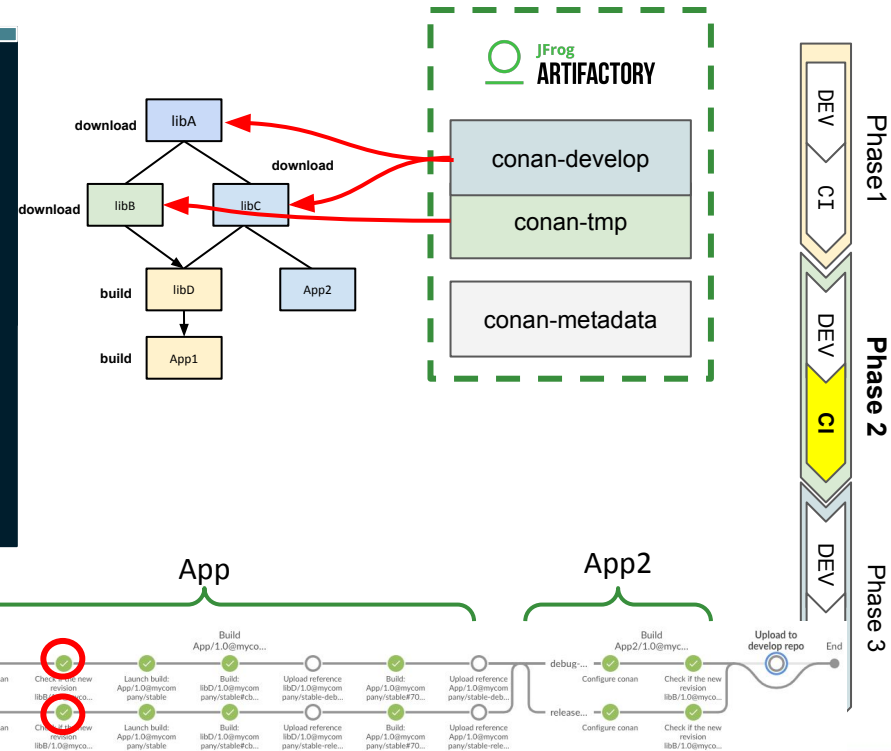
```
cd /ci_labs
# Get the revision list from the server (just for the lab, not made by
the CI) and get the latest revision
conan search libB/1.0@mycompany/stable -r conan-tmp --revisions

# 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

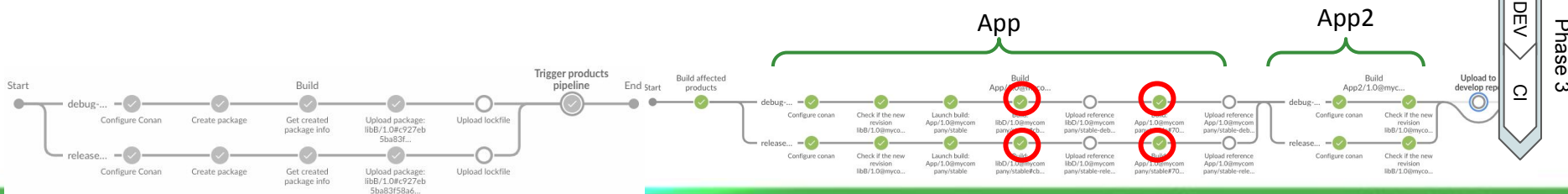
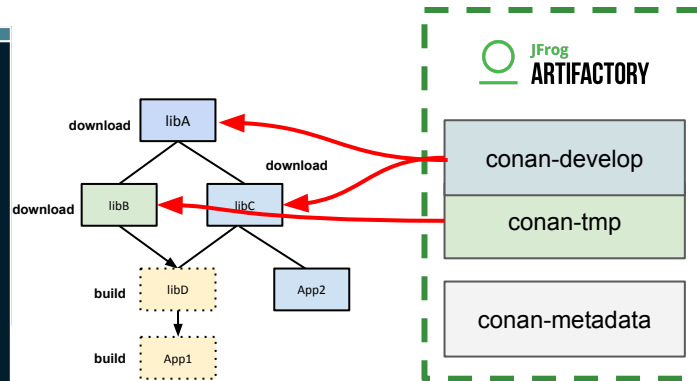
cat bo.json
```



[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`

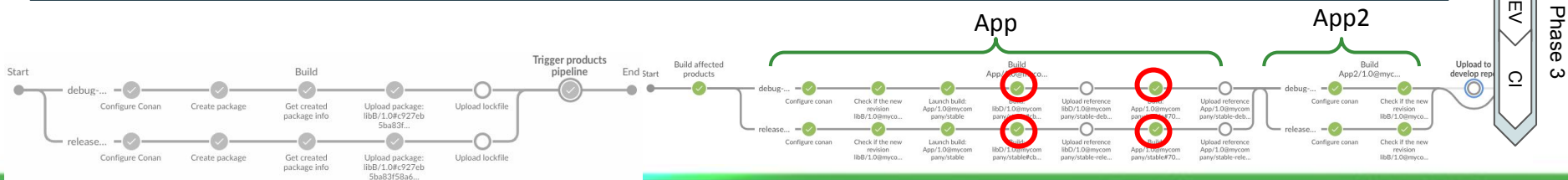




[Phase 2 - Products pipeline] [App/1.0 affected → Build libD, App]

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:

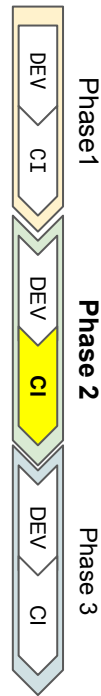
- Understand the process of building downstream packages using a lockfiles and build order

Task:

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

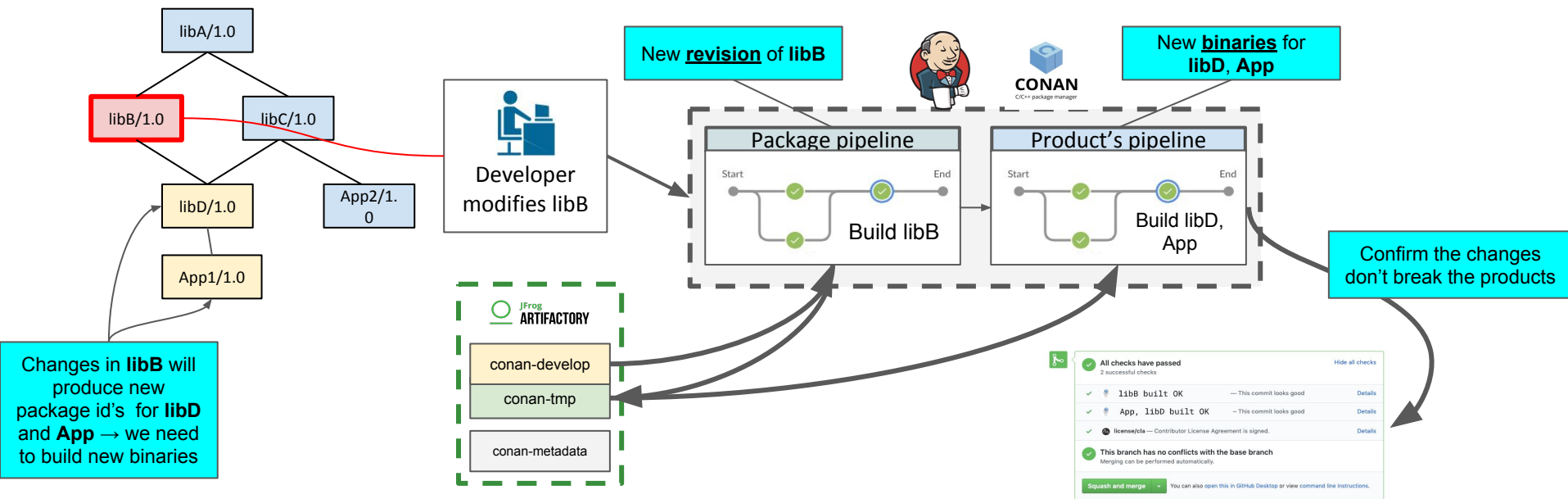
Success:

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



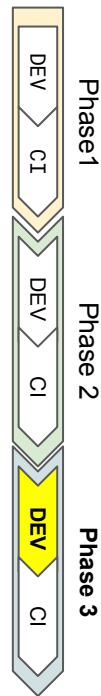


[Phase 2 - Summary]



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
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[Lab 5] The PR is merged to develop

Goal:

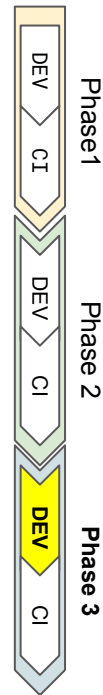
- Have a look at the set of operations that are going to be triggered in the CI when the PR-01 is merged to develop and the changes are pushed

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





2:00



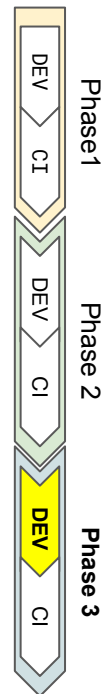
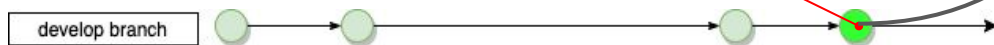
[Lab 5] The PR is merged to develop

```
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



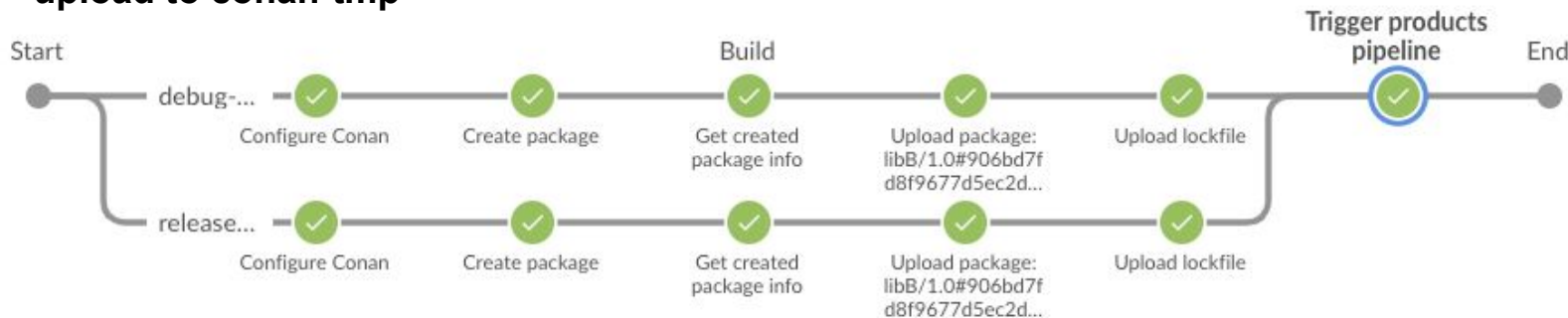


2:00

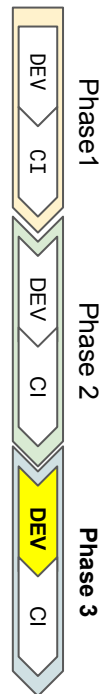
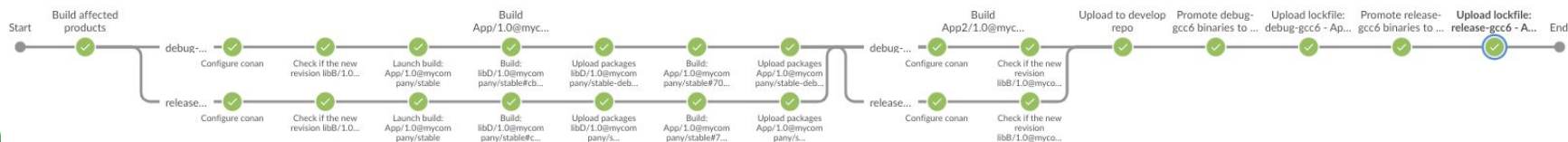


[Lab 5][Result] Check the stages run in the pipelines

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

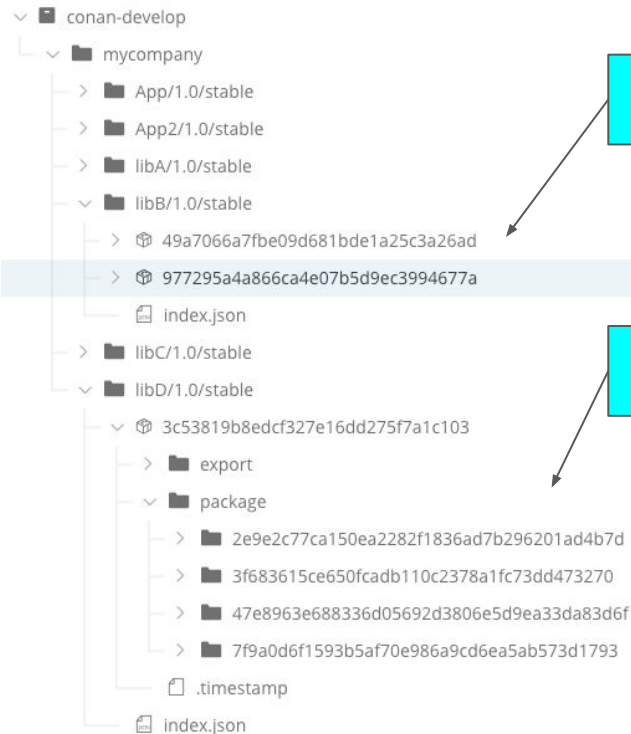




2:00



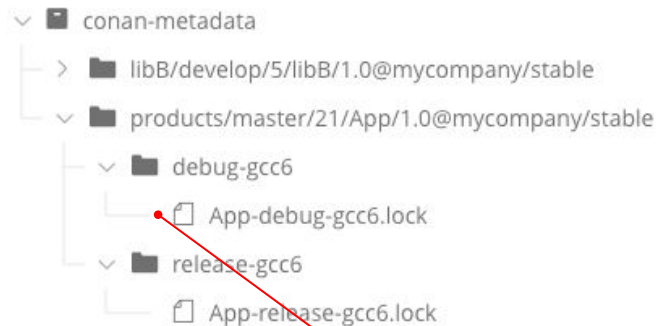
[Lab 5][Result] Check conan-develop and conan-metadata



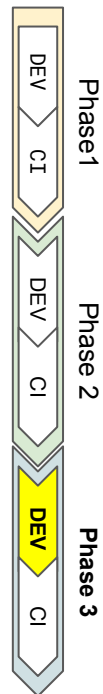
New revision of libB

New binaries for libD and App

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

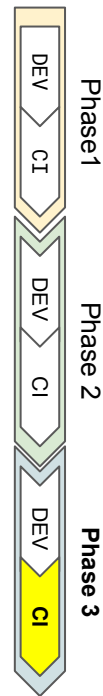


Property	Value(s)
profile	debug-gcc6
name	App
build.name	products/master
build.number	21
version	1.0



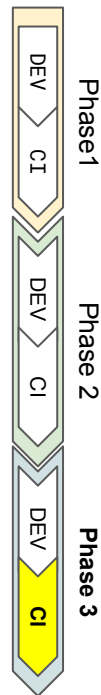
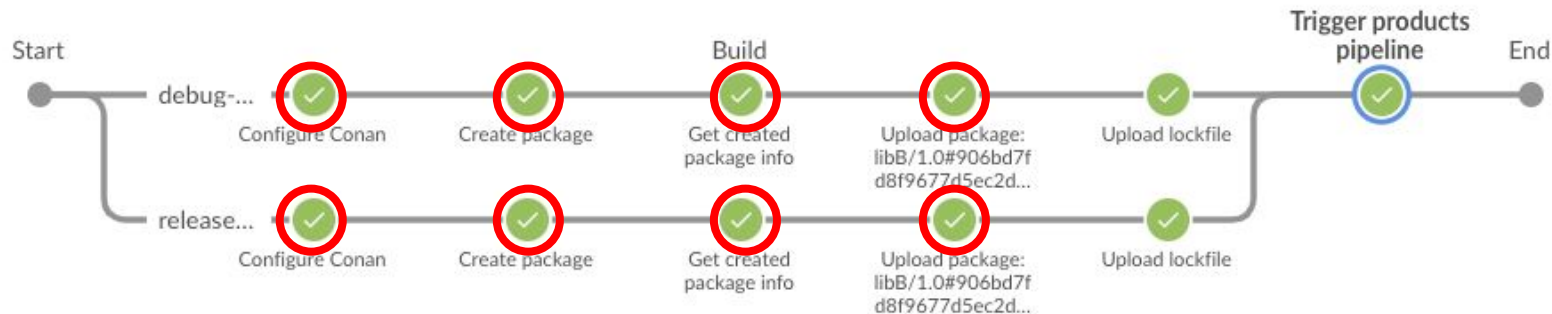
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[Phase 3 - Package pipeline] Stages in common with Phase 2

- 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

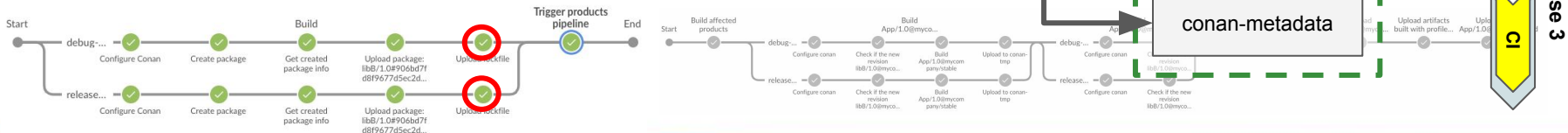
curl -u conan:conan2020 -X PUT
http://<artifactory_url>/conan-metadata/<path>/ -T conan.lock

# you can also assign properties to the uploaded files

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

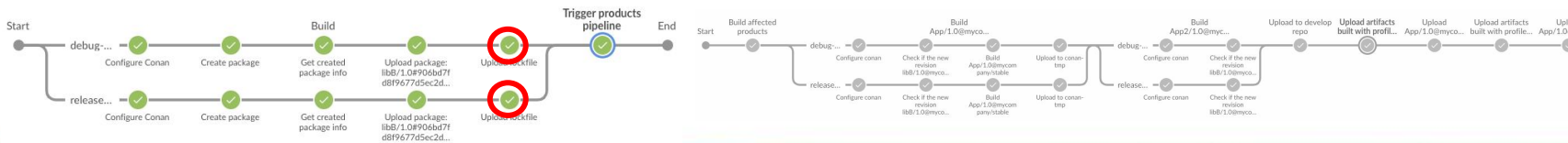
```
libB.lock

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





```
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

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
--------	-------	-----

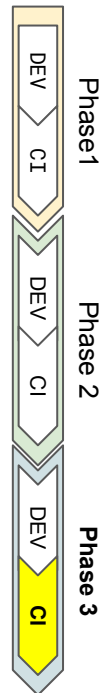
☐ Recursive ?

5 Properties

Filter by Property

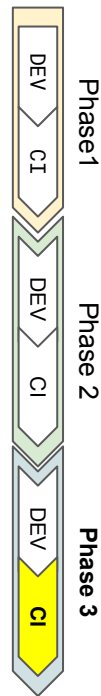
Delete

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



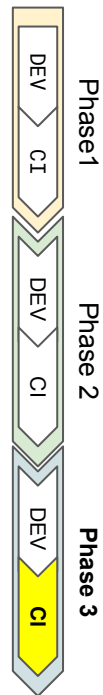
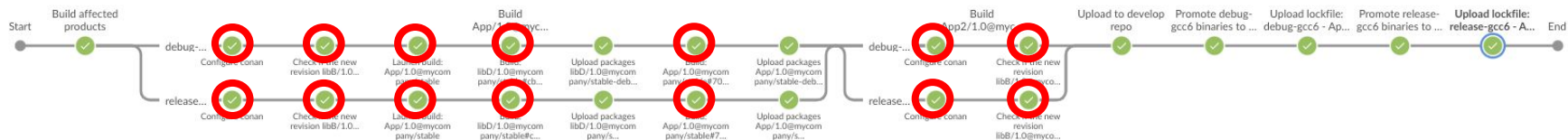
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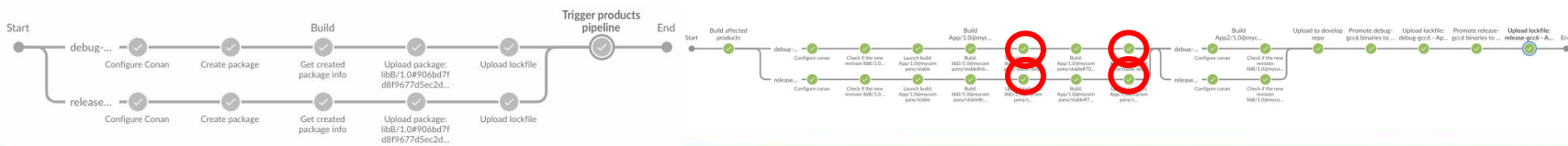
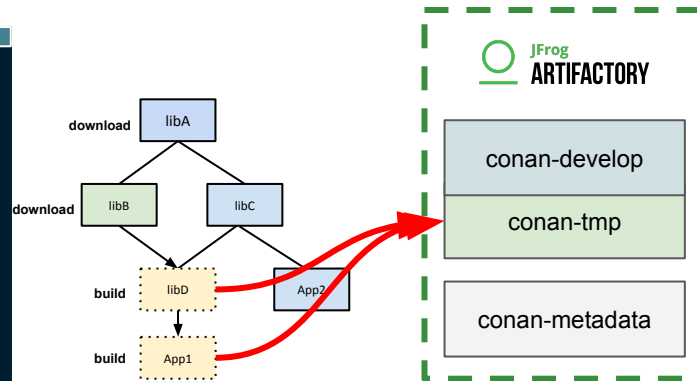
[Phase 3 - Products pipeline] Stages in common with Phase 2

- 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]

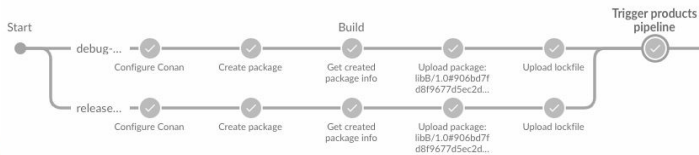
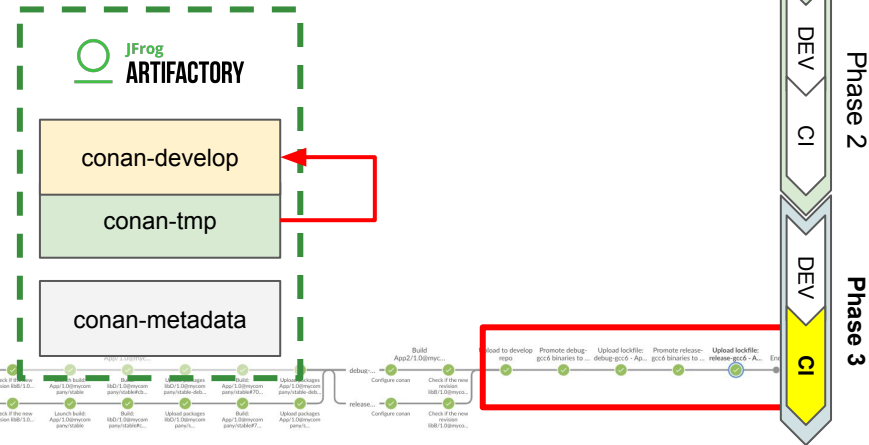
The information for all the built packages is stored in the lockfile we have used for building. We'll need code which does the following:

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 }
}
```



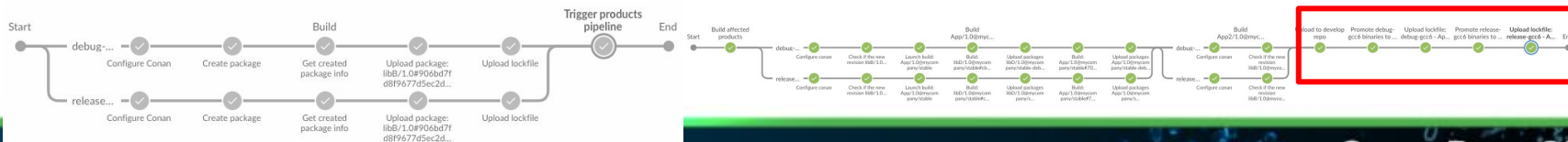


[Phase 3 - Products pipeline] [Copy built packages from tmp to develop repo]

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 additional (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=...
```

conan.lock

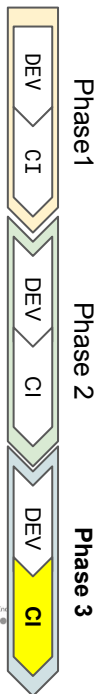
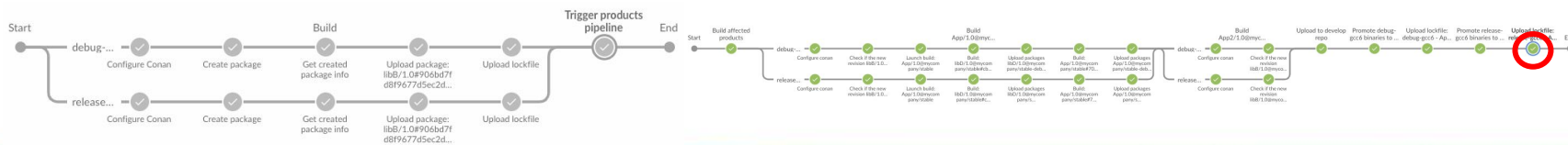
```
{
  profile="gcc6-release"
  nodes= {
    "0": { libB/1.0#rev:pkgid#prev, "built" }
    "1": { App/1.0#rev:pkgid#prev, "built" }
    "2": { libB/1.0#rev:pkgid#prev }
  }
}
```

JFrog
ARTIFACTORY

conan-develop

conan-tmp

conan-metadata



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

Artifact Repository Browser

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

General Properties Builds

Add: Property | Property Set

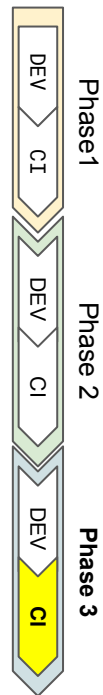
Name * Value Add

☐ Recursive ?

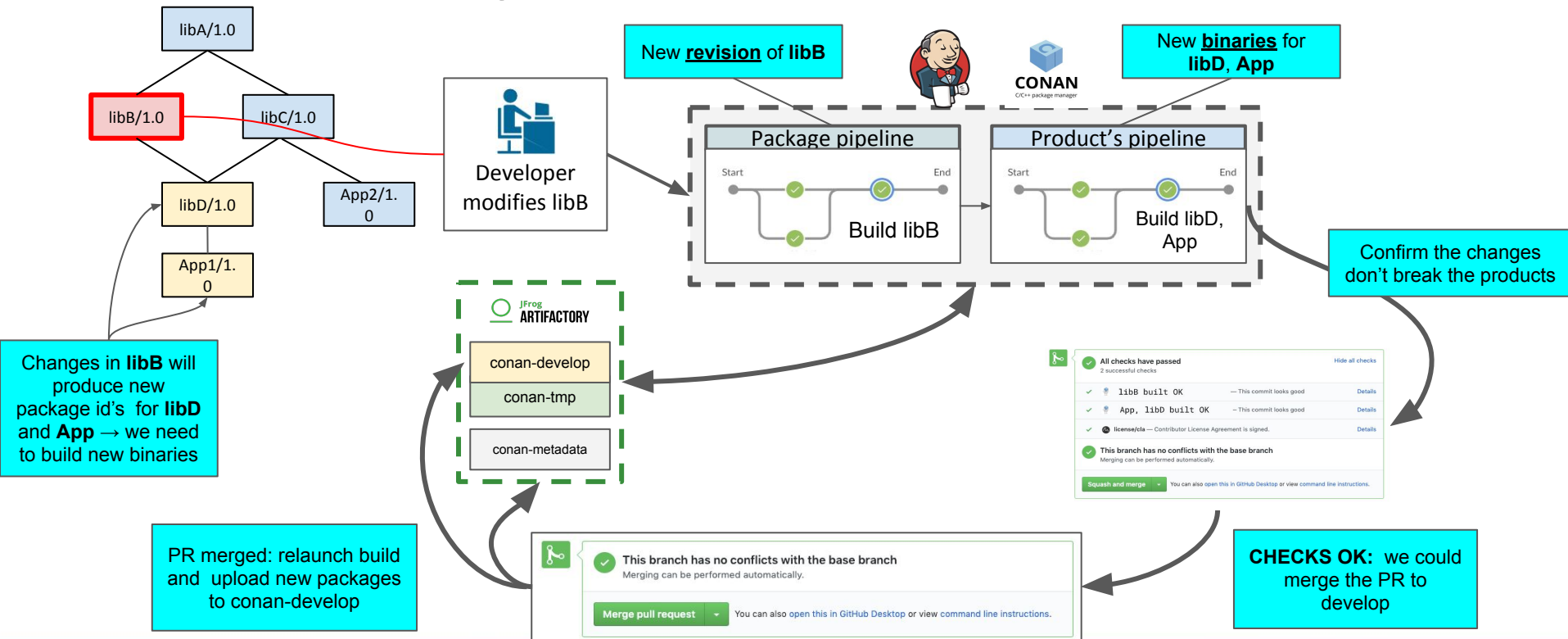
5 Properties

Filter by Property

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

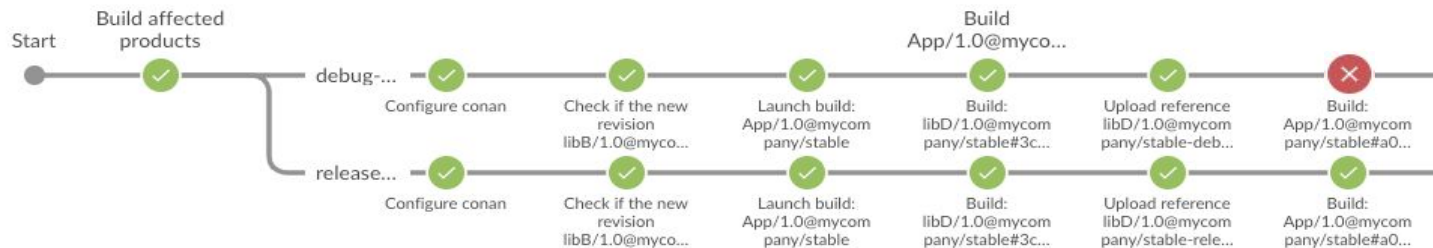


[Phase 3 - Summary]



But... what if libB breaks App?

- Until now we have been automatically integrating libB's changes without bumping versions, just using revisions
- If libB is introducing breaking changes then we should consider bumping the version of libB
- For the products pipeline the bump will not affect until App uses the new VERSION of libB



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

- Bill Of Material (JSON file):
 - List of generated binaries
 - Includes all consumed dependencies
 - You can use it to promote artifacts between repositories
- Can be published by CI plugins and JFrog CLI
- Conan can handle build info files (`conan_build_info --v2`)
 - Generate build info from a lockfile
 - Merge several build infos from different lockfiles
 - Publish generated build infos to Artifactory

Build Info - WARNING

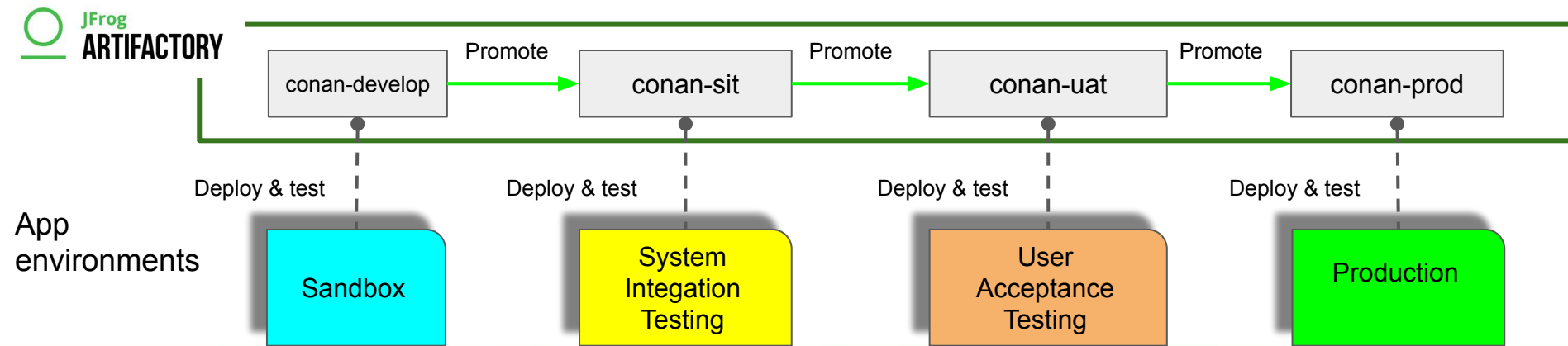
- Initially covering Java use case
- Doesn't FULLY support some use cases including **Conan**
 - **We don't recommend to use it for Conan for now**
 - See Appendix for :
 - How to create a Conan Build Info
 - Build Info limitation
- It's possible to create a custom Build Info where result of a build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

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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 dependencies

Promotion process of App/1.0

- Configure the JFrog CLI
- Locate the lockfile we used to build the App we want to promote
 - Download the artifacts of the App using the lockfile
- Create a debian package for the App
- Create a build info for the debian package
- Promote the debian package from SIT to UAT using the build info

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:

- Configure the JFrog CLI and search the repo content

Success:

- Test connection by listing the conan-metadata content



[Lab 6] Configure the JFrog CLI

```
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

Success:

- App is deployed to the local folder and run it successfully

* Artifactory Query Language : see Appendix for more details



[Lab 7] Download App based on properties

```
# 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

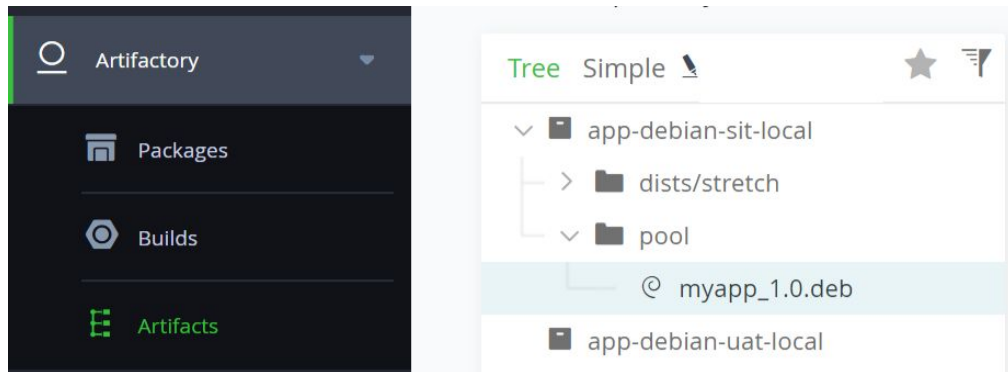


2:00



[Lab 8] Create and upload a debian package

```
./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 : lockfile for the App
- Publish the Build Info

Success:

- Check the Build Info in Artifactory



[Lab 9] Create a custom Build info

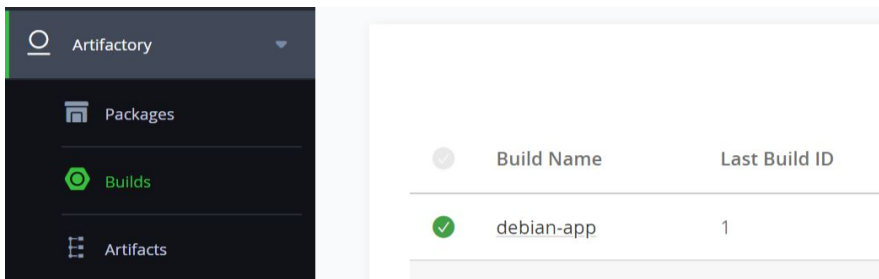
```
# define "artifact section" in build info
# won't be re-uploaded as the JFrog CLI is checksum aware => output "status":"success"
jfrog rt u debian_gen/myapp_1.0.deb app-debian-sit-local/pool/ --build-name=debian-app
--build-number=1

# 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

1 Artifact

Filter by Artifact Name

Artifact Name ^	Type ⓘ	Repo Path
myapp_1.0.deb	deb	app-debian-sit-local/pool/myapp_1.0.deb

1 Dependency

Filter by Dependency ID

Dependency ID ^	Scope ⓘ	Type ⓘ	Repo Path
App-release-gcc6.lock			conan-metadata/products/master/21/App/1.0@mycompany/stable/release-gcc6/App-release



[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

```
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



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[Last Lab] Homework :)

Have a look at the different Jenkinsfiles in this github organization:

<https://github.com/conan-ci-cd-training>

- Package pipeline:
<https://github.com/conan-ci-cd-training/libB/blob/develop/Jenkinsfile>
- Products pipeline:
<https://github.com/conan-ci-cd-training/products/blob/master/Jenkinsfile>
- Debian package 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
 - Use them to promote packages between repos
- 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 your 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 !

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Conan features

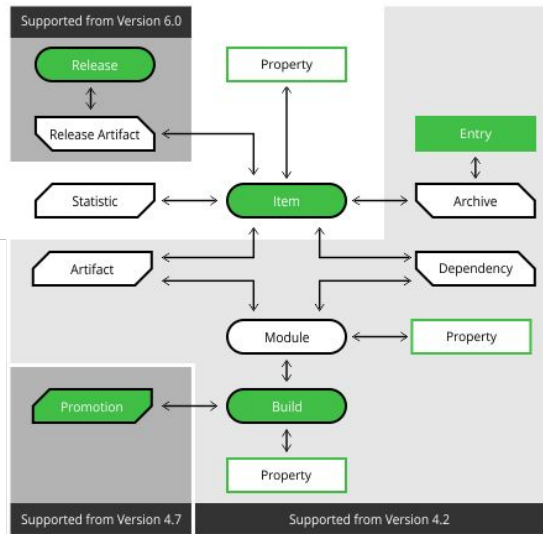
- Revisions
 - <https://docs.conan.io/en/latest/versioning/revisions.html>
- Package ID mode
 - https://docs.conan.io/en/latest/creating_packages/define_abi_compatibility.html#versioning-schema
- Custom Package ID
 - https://docs.conan.io/en/latest/creating_packages/define_abi_compatibility.html
- Lockfiles
 - <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

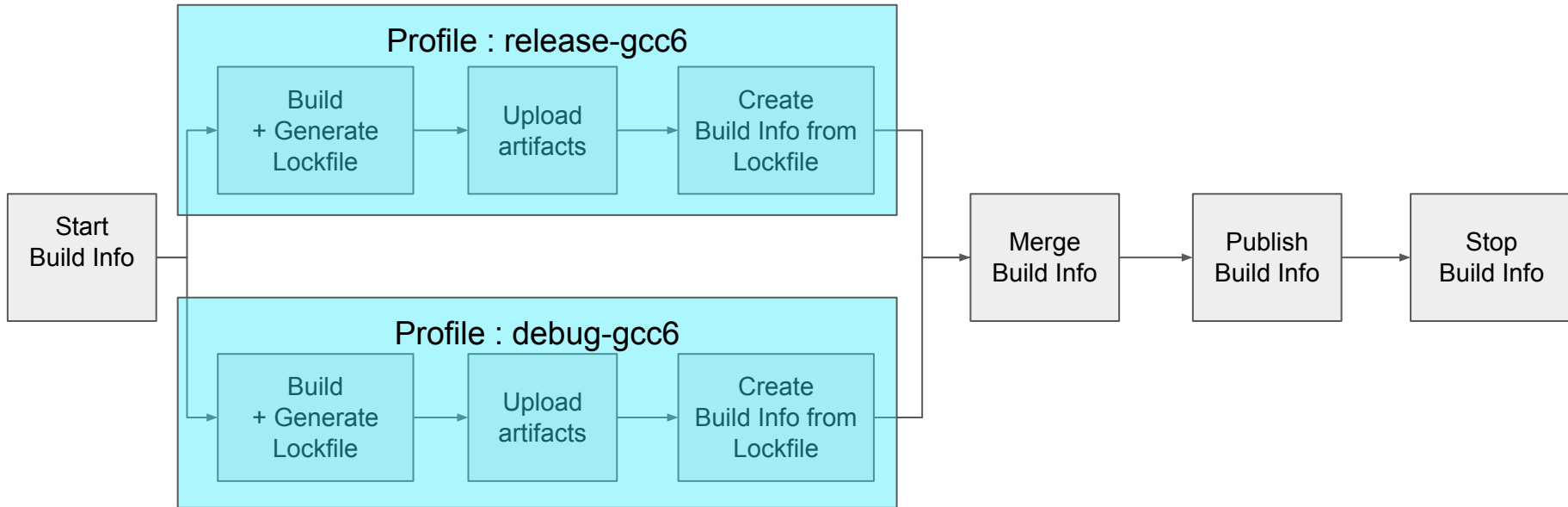
```
{
  "files": [{
    "aql": {
      "items.find": {
        "repo": "conan-metadata",
        "name": { "$match": "*.lock" },
        "$and": [
          { "@build.name": "conan-app" }, { "@build.number": "1" }
        ]
      }
    }
  }]
}
```

```
# 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 !