Version Control System

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(Adapted from Software Configuration Management Material)

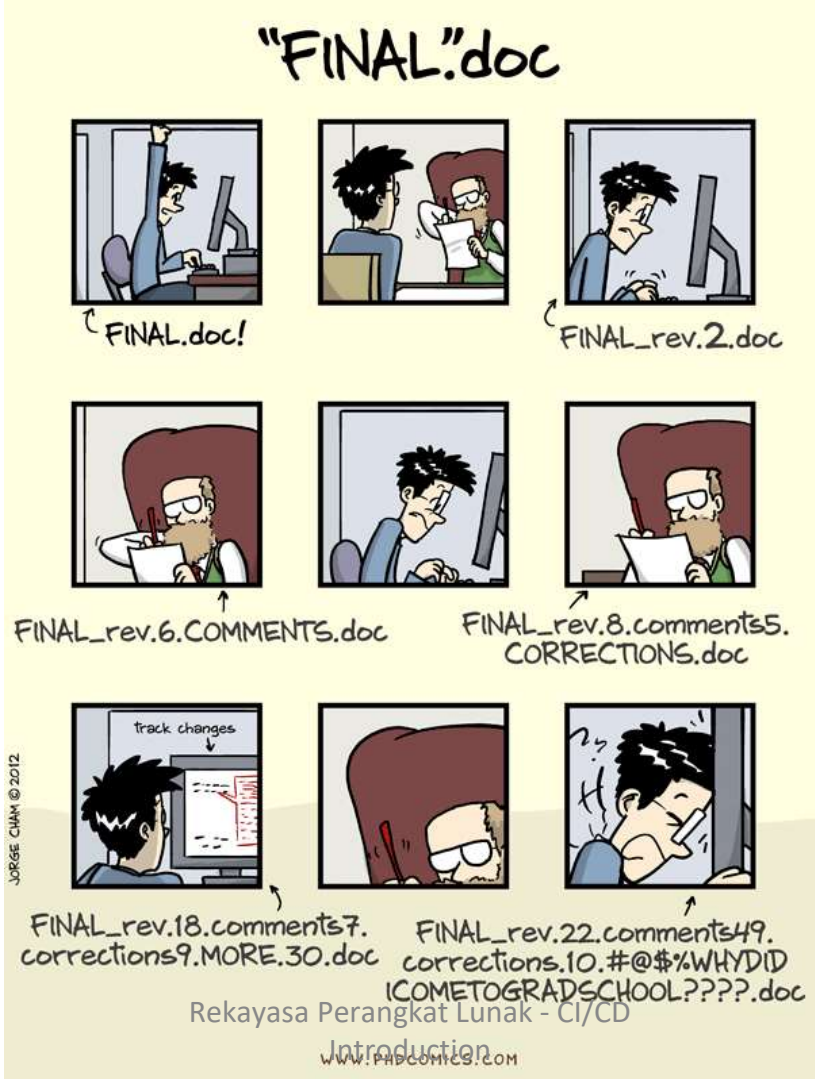
Introduction

- DevOps Engineer @ Kiteworks
- AWS Community Builders 2022 #DevOps
- https://aryya.id
- YT: “DevOps & Cloud with Aryya”

The Question

How to make software development more effective and efficient?

VERSION CONTROL


"FINAL".doc
FINAL.doc!
FINAL_rev.2.doc
FINAL_rev.6.COMMENTS.doc
FINAL_rev.8.comments5.
CORRECTIONS.doc
track changes
FINAL_rev.18.comments7.
corrections9.MORE.30.doc
FINAL_rev.22.comments49.
corrections.10.#@$%WHYDID
ICOMETOGRADSCHOOL????.doc
JORGE CHAM © 2012
WWW.PHDCOMICS.COM

Why version control?

- Scenario 1:
  - Your program is working
  - You change “just one thing”
  - Your program breaks
  - You change it back
  - Your program is still broken--*why?*
- Has this ever happened to you?

Why version control? (part 2)

- Your program worked well enough yesterday
- You made a lot of improvements last night...
  - ...but you haven't gotten them to work yet
- You need to turn in your program *now*

- Has this ever happened to you?

Version control for teams

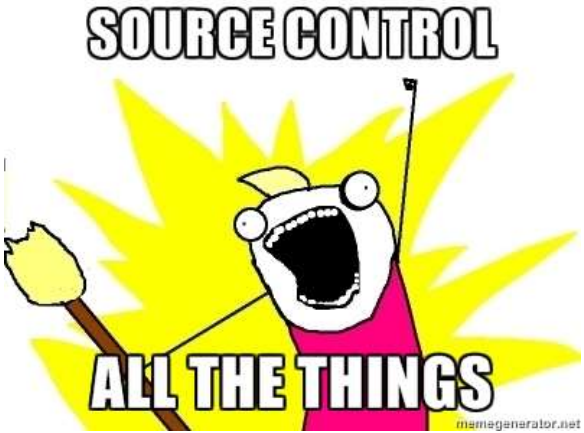
- Scenario:
  - You change one part of a program--it works
  - Your co-worker changes another part--it works
  - You put them together--it doesn't work
  - Some change in one part must have broken something in the other part
  - What were all the changes?

Teams (part 2)

- Scenario:
  - You make a number of improvements to a class
  - Your co-worker makes a number of *different* improvements to the *same* class
- How can you merge these changes?

Not just code!

- A *Code Base* does not just mean code!
- Also includes:
  - Documentation
  - Build Tools (Makefiles etc)
  - Configuration files
- But NOT a certain type of file



Version control systems

- A version control system (often called a source code control system or configuration management) does these things:
  - Keeps multiple (older and newer) versions of everything (not just source code)
  - Requests comments regarding every change
  - Allows “check in” and “check out” of files so you know which files someone else is working on
  - Displays differences between versions
  - Archive your development files
  - Serve as a single point of entry/exit when adding or updating development files

Essential Feature of VCS

- Locking (not common in DVCS)
- Merging
- Labelling
- Branching

Check Outs

- If you want to make a change the file needs to be *checked out* from the repository
- Usually done a file at a time.
- Some VCSs will lock checked out files so only one person may edit at a time.

Locking

- Only one person can work on a file at once
- Works fairly well if developers work on different areas of the project and don’t conflict often
- Problem:
  - People forget to unlock files when they are done
  - People work around locking by editing a private copy and checking in when the file is finally unlocked - easy to goof and lose changes

Check-In

- When changes are completed the new code is *checked-in*.
- A *commit* consists of a set of checked in files and the diff between the new and parent versions of each file.
- Each check-in is accompanied by a user name and other meta data.
- Check-ins can be exported from the Version Control system the form of a *patch.*

Merging

- There are occasions when multiple versions of a file need to be collapsed into a single version.
  - E.g. A feature from one branch is required in another
- Before committing changes, each user merges their copy with the latest co the database
- Difficult and dangerous to do in CVS
- Easy and cheap to do it git
- This is normally done automatically by the system and usually works, but you should not blindly accept the result of the merge

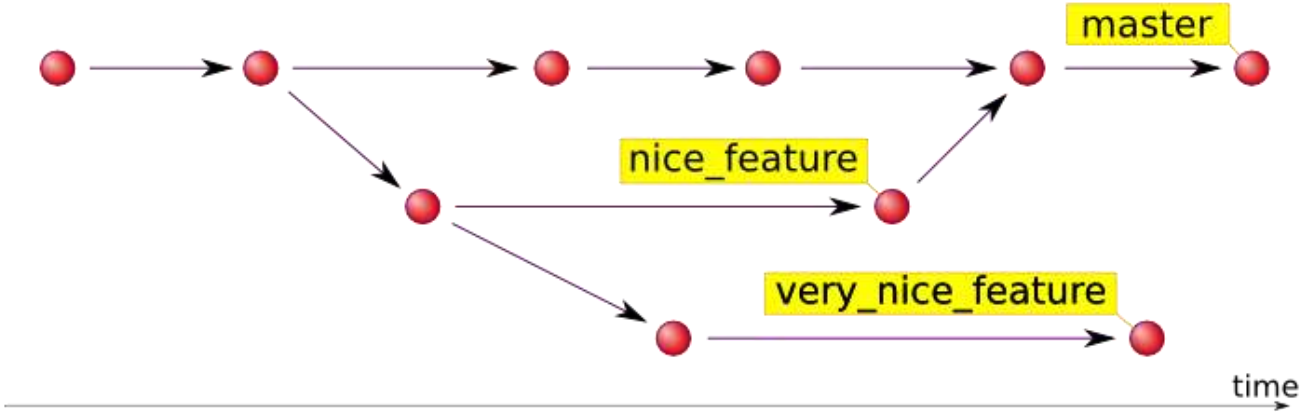
Labelling

- Label all the files in the source base that make up a product at each milestone
- Just before and just after a major change (eg. changing several interfaces)
- When a new version ships

Branching

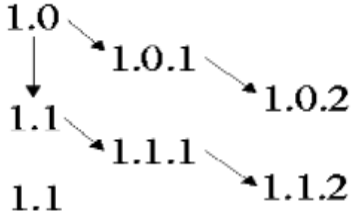
- When a new version ships, typically create a branch in the version tree for maintenance
- Double update: fix a defect in the latest version and then merge the changes (often by hand) into the maintenance version
- Also create personal versions so you can make a change against a stable source base and then merge in the latest version later
- Different versions can easily be maintained

Branching



Version Trees

- Each file in the database has a version tree
- Can branch off the version tree to allow separate development paths
- Typically a main path (trunk) for the next major version and branches off of shipped versions for maintenance

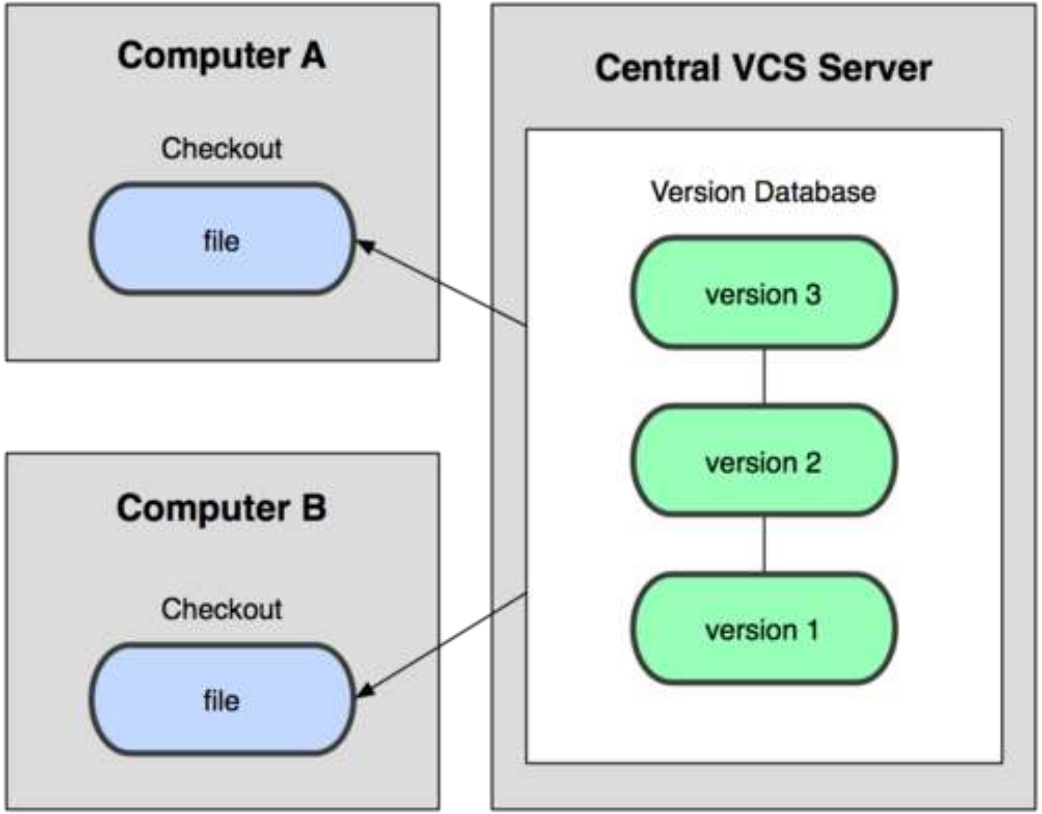


Centralised Version Control

- A single server holds the code base
- Clients access the server by means of check-in/check-outs
- Examples include CVS, Subversion, Visual Source Safe.

  Advantages: Easier to maintain a single server.

  Disadvantages: Single point of failure.


Computer A
Checkout
file
Computer B
Checkout
file
Central VCS Server
Version Database
version 3
version 2
version 1

Centralized Version Control

- Traditional version control system
  - Server with database
  - Clients have a working version
- Examples
  - CVS
  - Subversion
  - Visual Source Safe
- Challenges
  - Multi-developer conflicts
  - Client/server communication

Distributed Version Control

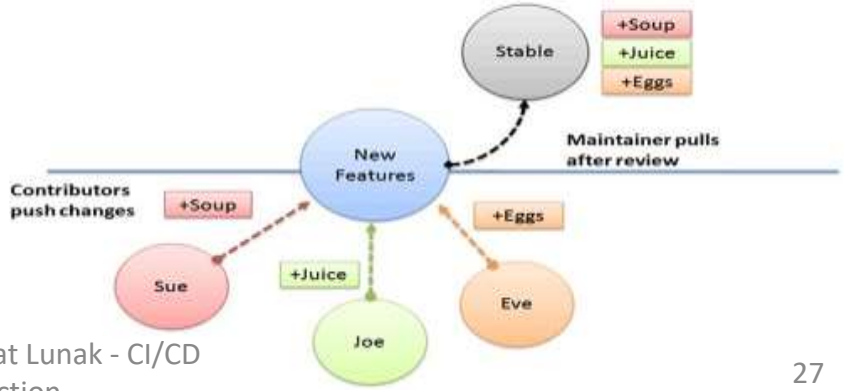
- Authoritative server by convention only
- Every working checkout is a repository
- Get version control even when detached
- Backups are trivial

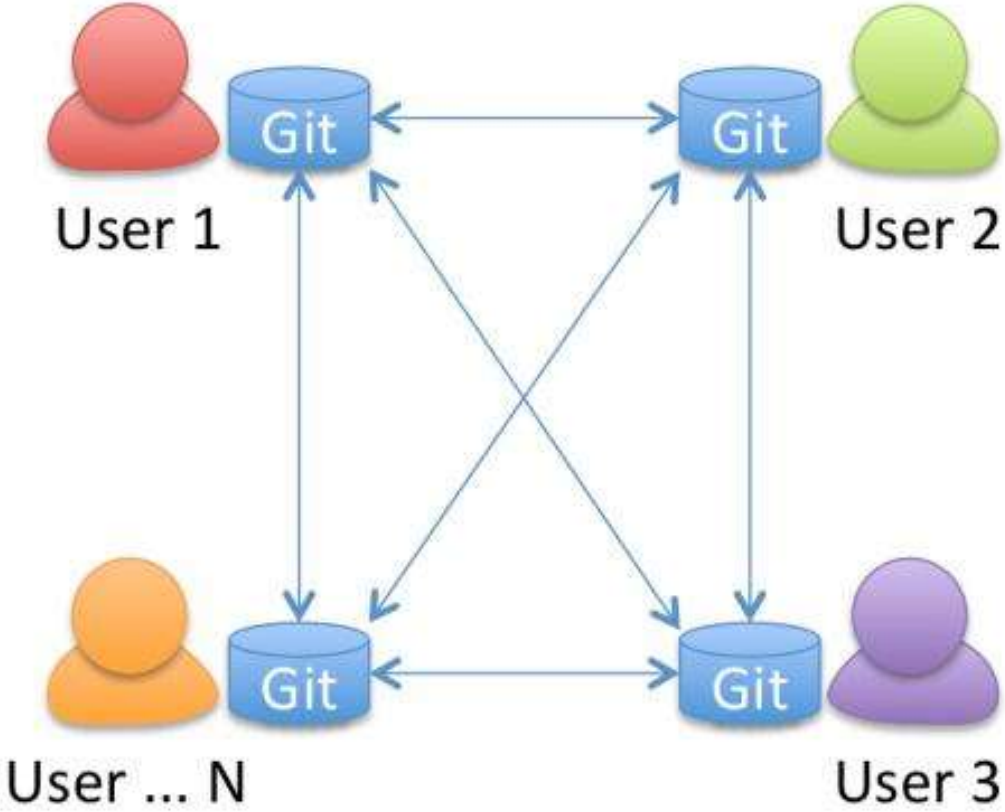
- Other distributed systems include
  - Mercurial
  - BitKeeper
  - Darcs
  - Bazaar

Distributed Version Control

- Allows multiple repositories
  - each one is a copy of the main repository (usually)
- All repositories can be synchronized
  - **clone:** creates a local copy of the main repo
  - **add** and **commit**: add and commit files in local repo
  - **push** the changes from the local repository to the main repo
  - **pull** the changes from the main repo to the local one

- Code is shared between clients by push/pulls
  - Advantages: Many operations cheaper. No single point of failure




Git
Git
User 1
User 2
Git
Git
User ... N
User 3

More Uses of Version Control

- Version control is not just useful for collaborative working, essential for quality source code development
- Often want to undo changes to a file
  - start work, realize it's the wrong approach, want to get back to starting point
  - like "undo" in an editor…
  - keep the whole history of every file and a *changelog*
- Also want to be able to see who changed what, when
  - The best way to find out how something works is often to ask the person who wrote it

Version Control is Not

- A substitute for project management
- A replacement for developer communication

To Do

- Learn about GIT and how people use it
- Learn about Github

GIT AND GITHUB

A Brief History of Git

- Linus uses BitKeeper to manage Linux code
- Ran into BitKeeper licensing issue
  - Liked functionality
  - Looked at CVS as how not to do things
- April 5, 2005 - Linus sends out email showing first version
- June 15, 2005 - Git used for Linux version control
- open source
- fast and efficient
- most used

Git Advantages

- Resilience
  - No one repository has more data than any other
- Speed
  - Very fast operations compared to other VCS (I'm looking at you CVS and Subversion)
- Space
  - Compression can be done across repository not just per file
  - Minimizes local size as well as push/pull data transfers
- Simplicity
  - Object model is very simple
- Large userbase with robust tools

Some GIT Disadvantages

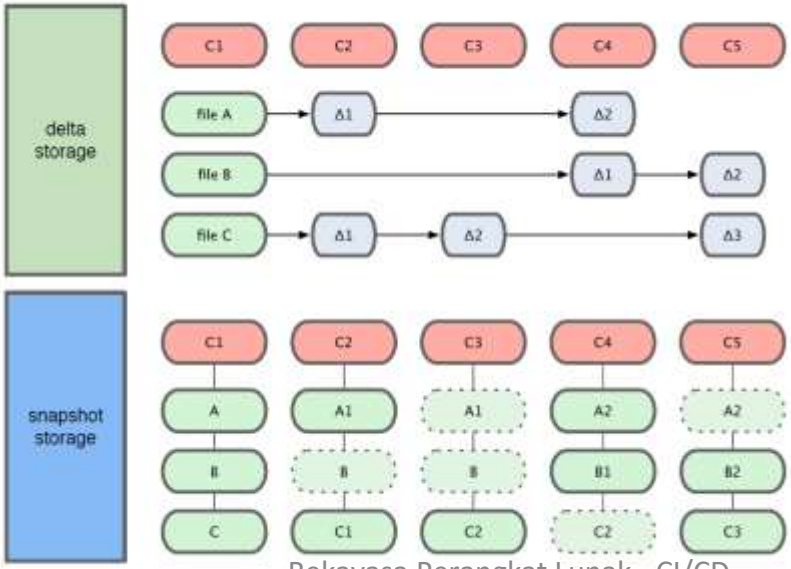
- Definite learning curve, especially for those used to centralized systems
  - Can sometimes seem overwhelming to learn
    - Conceptual difference
    - Huge amount of commands

Common Git Commands

- Git init
- Git clone
- Git pull
- Git push
- Git rebase
- Git cherry-pick
- Git merge
- Git checkout

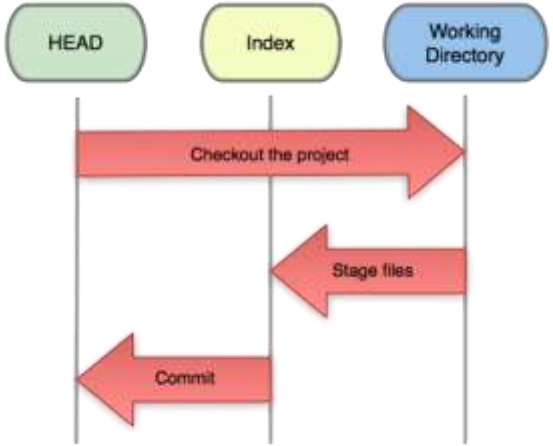
Getting Started

- Git use snapshot storage



Getting Started

- Three trees of Git
  - The HEAD
    - last commit snapshot, next parent
  - Index
    - Proposed next commit snapshot
  - Working directory
    - Sandbox



Getting Started

- A basic workflow
  1. (Possible init or clone) Init a repo
  2. Edit files
  3. Stage the changes
  4. Review your changes
  5. Commit the changes

Getting Started

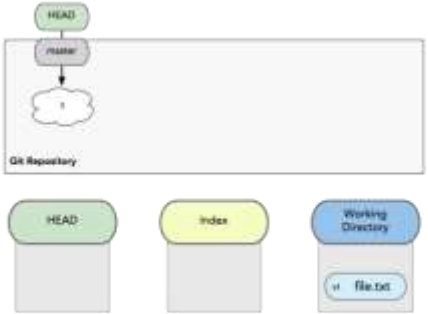
- Init a repository
- Git init

```
zachary@zachary-desktop:~/code/gitdemo$ git init
Initialized empty Git repository in /home/zachary/code/gitdemo/.git/
```

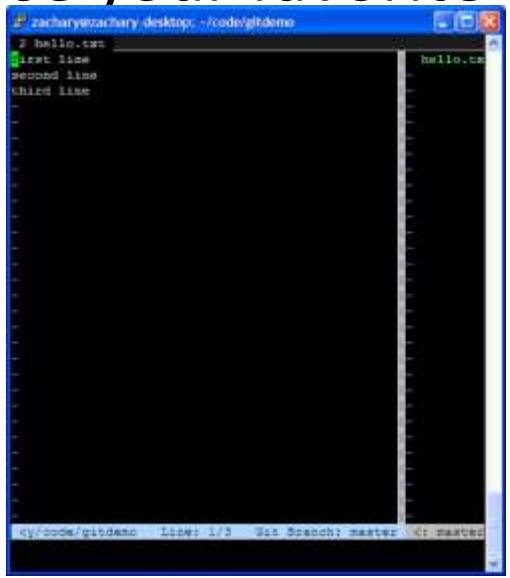
```
zachary@zachary-desktop:~/code/gitdemo$ ls -l .git/
total 32
drwxr-xr-x 2 zachary zachary 4096 2011-08-28 14:51 branches
-rw-r--r-- 1 zachary zachary   92 2011-08-28 14:51 config
-rw-r--r-- 1 zachary zachary   73 2011-08-28 14:51 description
-rw-r--r-- 1 zachary zachary   23 2011-08-28 14:51 HEAD
drwxr-xr-x 2 zachary zachary 4096 2011-08-28 14:51 hooks
drwxr-xr-x 2 zachary zachary 4096 2011-08-28 14:51 info
drwxr-xr-x 4 zachary zachary 4096 2011-08-28 14:51 objects
drwxr-xr-x 4 zachary zachary 4096 2011-08-28 14:51 refs
```

Getting Started

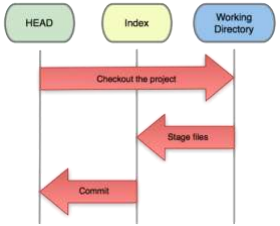
- A basic workflow
  - Edit files
  - Stage the changes
  - Review your changes
  - Commit the changes



- Use your favorite editor

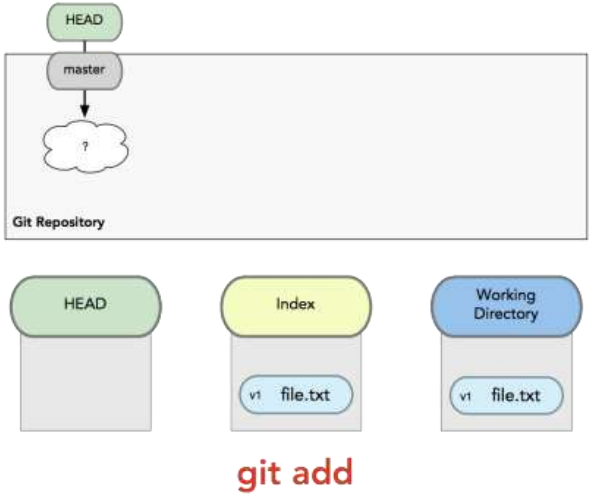


Getting Started



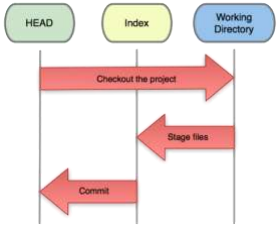
- A basic workflow
  - Edit files
  - Stage the changes
  - Review your changes
  - Commit the changes

- Git add filename




```
zachary@zachary-desktop:~/code/gitdemo$ git status
# On branch master
# Changes not staged for commit:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#       modified:   hello.txt
#
no changes added to commit (use "git add" and/or "git commit -a")
```

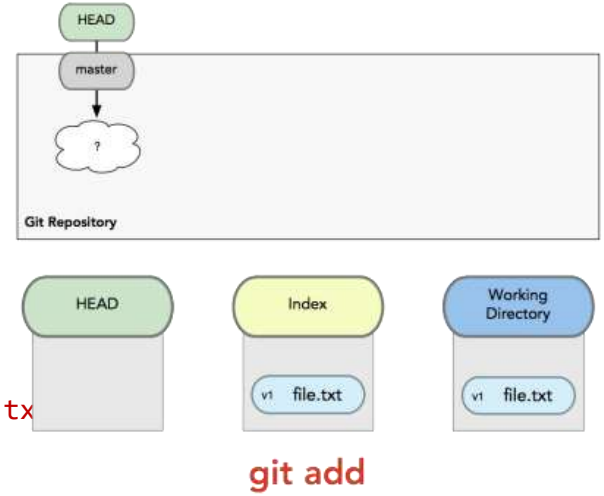
Getting Started



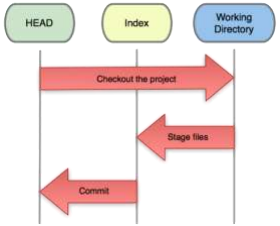
- A basic workflow
  - Edit files
  - Stage the changes
  - Review your changes
  - Commit the changes

```
zachary@zachary-desktop:~/code/gitdemo$ git add hello.tx
zachary@zachary-desktop:~/code/gitdemo$ git status
# On branch master
# Changes to be committed:
#   (use "git reset HEAD <file>..." to unstage)
#
#       modified:   hello.txt
#
```

- Git status

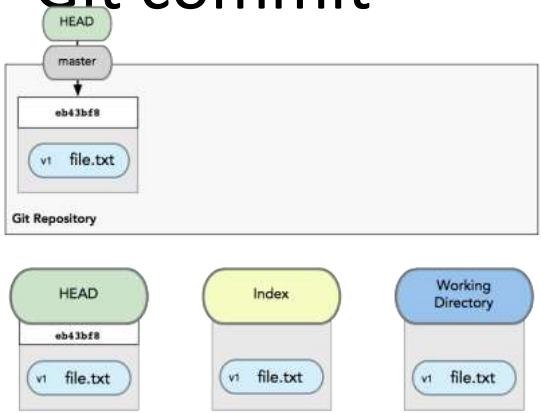


Getting Started



- A basic workflow
  - Edit files
  - Stage the changes
  - Review your changes
  - Commit the changes

- Git commit

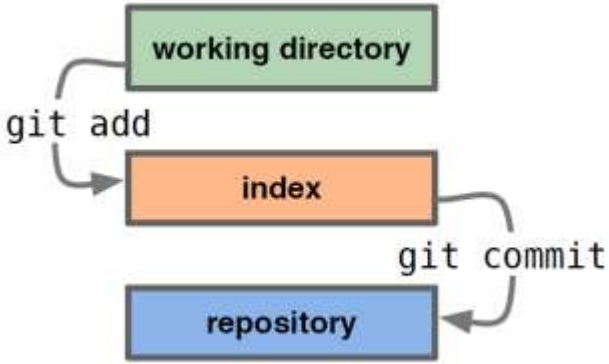


git commit

```
# Please enter the commit message for your changes. Lines starting
# with '#' will be ignored, and an empty message aborts the commit.
# On branch master
# Changes to be committed:
#   (use "git reset HEAD <file>..." to unstage)
#
#   modified:   hello.txt
#
```

Getting Started

- A basic workflow
  - Edit files
  - Stage the changes
  - Review your changes
  - Commit the changes



Getting Started

- View changes
- Git diff
  - Show the difference between working directory and staged
- Git diff --cached
  - Show the difference between staged and the HEAD

- View history
- Git log

```
zachary@zachary-desktop:~/code/gitdemo$ git log
commit efb3aeae66029474e28273536a8f52969d705d04
Author: Zachary Ling <zacling@gmail.com>
Date:   Sun Aug 28 15:02:08 2011 +0800

    Add second line

commit 453914143eae3fc5a57b9504343e2595365a7357
Author: Zachary Ling <zacling@gmail.com>
Date:   Sun Aug 28 14:59:13 2011 +0800

    Initial commit
```

Getting Started

- Revert changes (Get back to a previous version) ⍰ git checkout commit_hash

```
zachary@zachary-desktop:~/code/gitdemo$ git checkout 4539
Note: checking out '4539'.

You are in 'detached HEAD' state. You can look around, make experimental
changes and commit them, and you can discard any commits you make in this
state without impacting any branches by performing another checkout.

If you want to create a new branch to retain commits you create, you may
do so (now or later) by using -b with the checkout command again. Example:

  git checkout -b new_branch_name

HEAD is now at 4539141... Initial commit
```

Branching and Merging

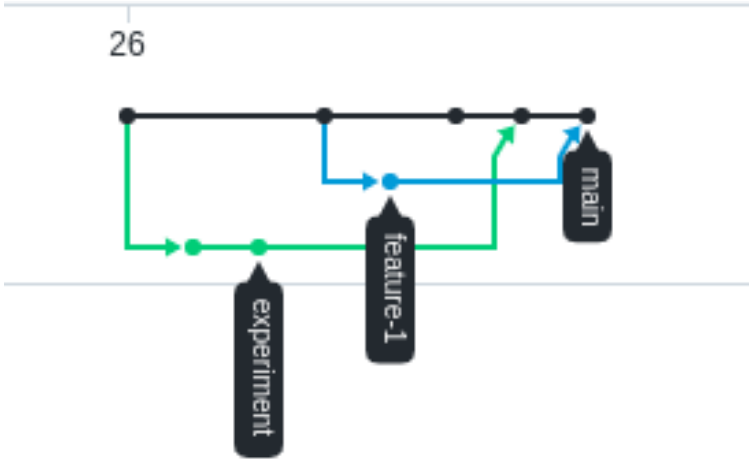
- Why this is cool? git branch & git merge {branch}
  - Non-linear development

```
clone the code that is in production
create a branch for issue #53 (iss53)
work for 10 minutes
someone asks for a hotfix for issue #102
checkout ‘production’
create a branch (iss102)
fix the issue
checkout ‘production’, merge ‘iss102’
push ‘production’
checkout ‘iss53’ and keep working
```

Exercise 1

Buat sebuah repository di github, dan push code kalian sehingga visualisasinya seperti ini.
Tampilan ini bisa dilihat di **Repository > Insight > Network**

Reference: **https://github.com/aryyaid/RPL-2023**



Cara add ssh-key:

1. Buka git bash
2. Generate ssh key dengan:
   ssh-keygen -t rsa -b 4096 -C "email_github"
3. account > settings > keys > new ssh keys

Form link:

K1: https://s.id/1EexU

K2: https://s.id/1Eey6

K3: https://s.id/1Eeyo

Undo Action

Let assume you commit and push credential file to repository in second commit. What would you do?

Rebase

Git rebase is used to replay commit to some branch. By using this feature, you can replay or remove commit.

```
commit d40116e38dbc9b20cce54caac0b9358ea664337d (HEAD -> main, origin/main)
Merge: 72a6cc9 02fd092
Author: aryyaid <128958399+aryyaid@users.noreply.github.com>
Date:   Sun Mar 26 14:22:37 2023 +0700

    Merge pull request #2 from aryyaid/feature-1

    add feature-1 first file

commit 72a6cc9acc433e0d86f483ada5ceaf0cbc89a3fb
Merge: 1a2e7a5 f9e3cf1
Author: aryyaid <128958399+aryyaid@users.noreply.github.com>
Date:   Sun Mar 26 14:22:16 2023 +0700

    Merge pull request #1 from aryyaid/experiment

    Experiment

commit 1a2e7a58ba6e174a1295b1e0d056862e4b016744
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:14:29 2023 +0700

    add third file in main branch

commit 02fd0922b3be214ad4074e09bbd5773a2d9bbdd1 (origin/feature-1, feature-1)
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:12:35 2023 +0700

    add feature-1 first file

commit ac0c252ca28aed5635ff2ef2fb5ad8e51302dc59
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:11:16 2023 +0700

    add second file in main branch
```

```
commit 72a6cc9acc433e0d86f483ada5ceaf0cbc89a3fb (HEAD -> main)
Merge: 1a2e7a5 f9e3cf1
Author: aryyaid <128958399+aryyaid@users.noreply.github.com>
Date:   Sun Mar 26 14:22:16 2023 +0700

    Merge pull request #1 from aryyaid/experiment

    Experiment

commit 1a2e7a58ba6e174a1295b1e0d056862e4b016744
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:14:29 2023 +0700

    add third file in main branch

commit ac0c252ca28aed5635ff2ef2fb5ad8e51302dc59
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:11:16 2023 +0700

    add second file in main branch

commit f9e3cf112515743552d40fdabd1911a994b3273d (origin/experiment, experiment)
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:10:34 2023 +0700

    add second file in experiment branch

commit 65c401cc478f9d983250e4e012a77409d8e03a79
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:09:37 2023 +0700

    Add first file in experiment branch
```

Rebase: Squash

What if some commits are supposed to be single commit?

```
commit 2823bf68305e17fab2e1ed673ef18d5cc67e6d21 (HEAD -> main)
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:11:16 2023 +0700

    add second and third file in main branch

commit e6a1b1187fb51a2458aa8acdf3511761a88f2eeb
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 13:53:22 2023 +0700

    initial commit
```

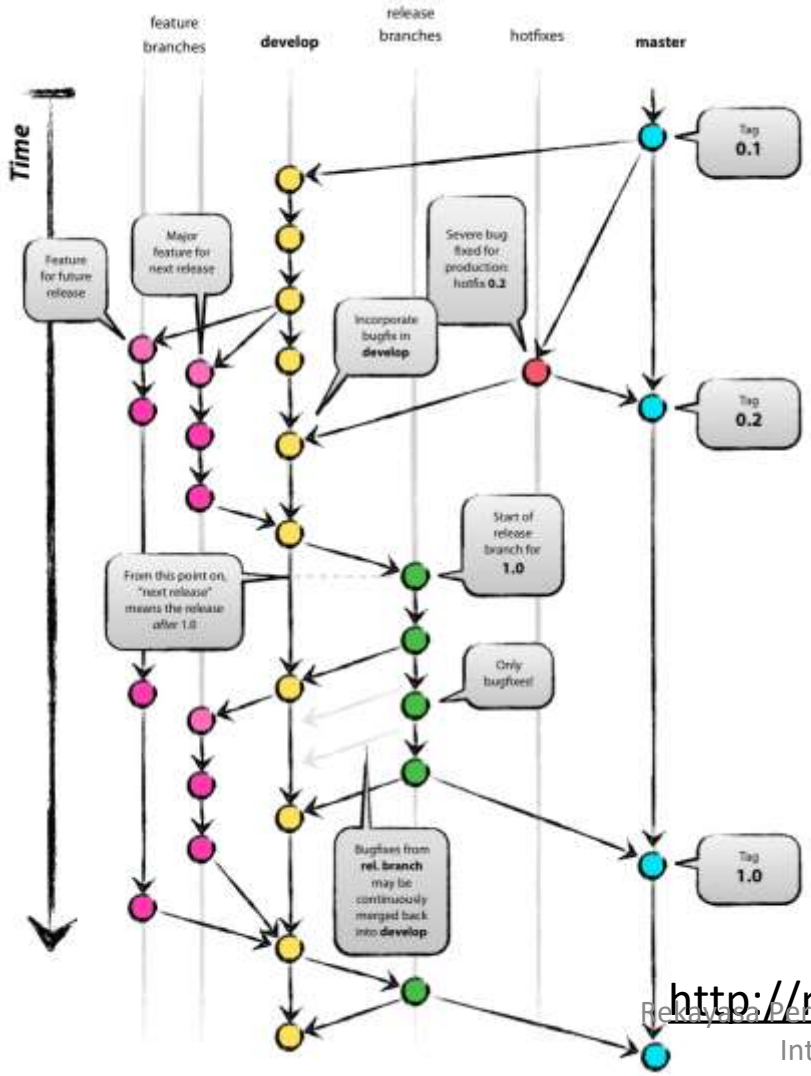
Cherry-Pick

Assume you have worked on another branch and only need to apply specific commit, not all commit in the branch

```
commit 2823bf68305e17fab2e1ed673ef18d5cc67e6d21 (HEAD -> main)
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:11:16 2023 +0700

    add second and third file in main branch

commit e6a1b1187fb51a2458aa8acdf3511761a88f2eeb
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 13:53:22 2023 +0700

    initial commit
```

```
commit 8b2fedd8039b3d4c1d99f11d36ae5cc1ce50dcc7 (HEAD -> main)
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 15:08:14 2023 +0700

    Add forth file

commit 2823bf68305e17fab2e1ed673ef18d5cc67e6d21
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 14:11:16 2023 +0700

    add second and third file in main branch

commit e6a1b1187fb51a2458aa8acdf3511761a88f2eeb
Author: Aryya W <aryya.widigdha@yahoo.com>
Date:   Sun Mar 26 13:53:22 2023 +0700

    initial commit
```

Successful Git Branch



http://nvie.com/posts/a-successful-git-branching-model/

Working with remote

- Use git clone to replicate repository
- Get changes with
  - git fetch
  - git pull (fetches and merges)
- Propagate changes with
  - git push
- Protocols
  - Local filesystem (file://)
  - SSH (ssh://)
  - **HTTP (http:// https://)**
  - Git protocol (git://)

Working with remote Local filesystem

- Pros
  - Simple
  - Support existing access control
  - NFS enabled
- Cons
  - Public share is difficult to set up
  - Slow on top of NFS

Working with remote SSH

- Pros
  - Support authenticated write access
  - Easy to set up as most system provide ssh toolsets
  - Fast
    - Compression before transfer
- Cons
  - No anonymous access
    - Not even for read access

Working with remote GIT

- Pros
  - Fastest protocol
  - Allow public anonymous access
- Cons
  - Lack of authentication
  - Difficult to set up
  - Use port 9418
    - Not standard port
    - Can be blocked

Working with remote HTTP/HTTPS

- Pros
  - Very easy to set up
  - Unlikely to be blocked
    - Using standard port
- Cons
  - Inefficient

Working with remote

- One person project
  - Local repo is enough
  - No need to bother with remote
- Small team project
  - SSH write access for a few core developers
  - GIT public read access

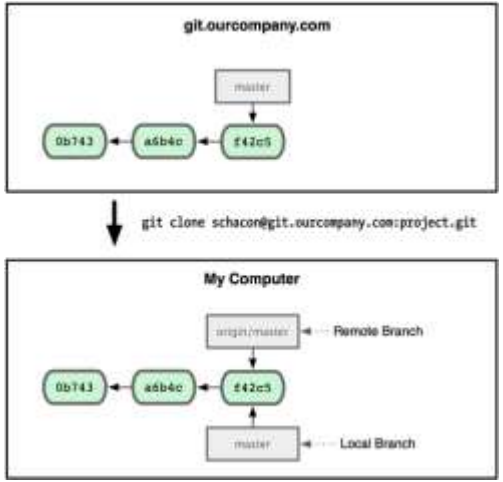
Working with remote

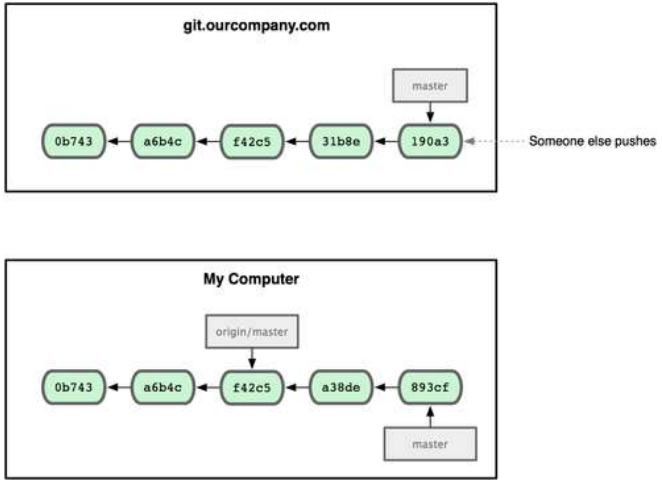
- Use git remote add to add an remote repository


```
Git remote add origin git@github.com:FreezingGod/vimcfg.git
zachary@zachary-desktop:~/.vim_runtime$ git remote
origin
```

Working with remote

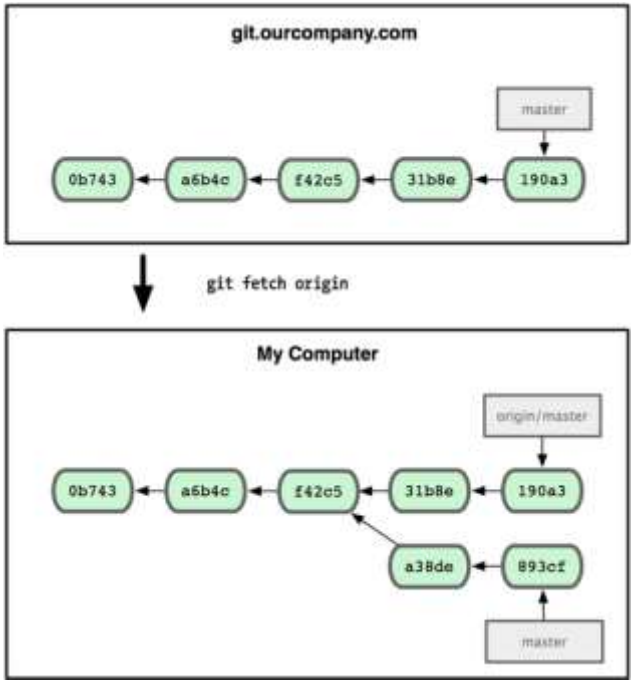
- Remote branching
  - Branch on remote are different from local branch





Working with remote

- Remote branching
  - Branch on remote are different from local branch
  - Git fetch origin to get remote changes
  - Git pull origin try to fetch remote changes and merge it onto current branch



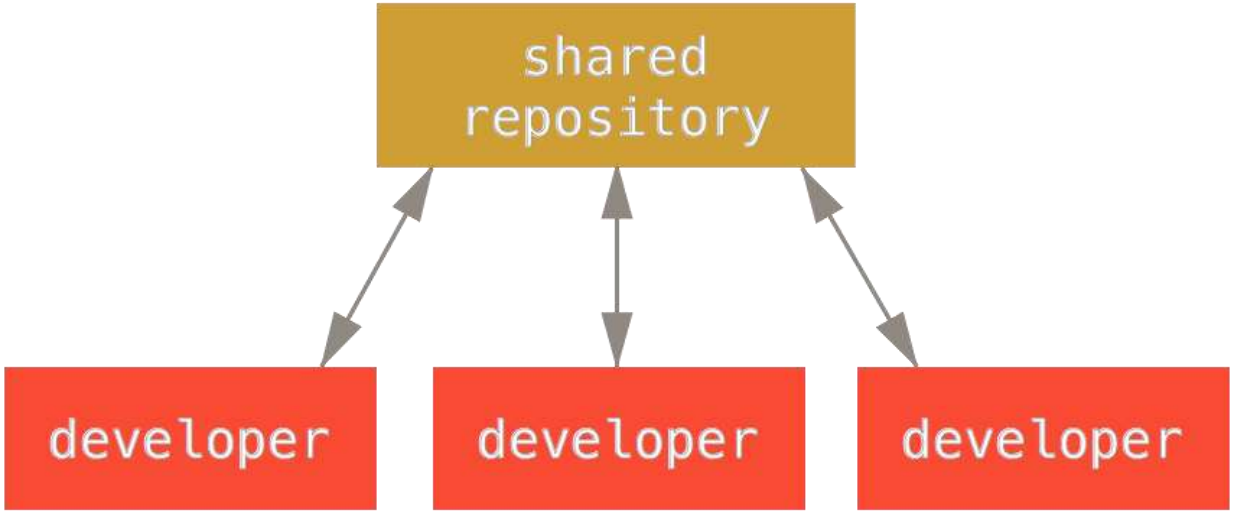
Working with remote

- Git push remote_name branch_name
  - Share your work done on branch_name to remote remote_name

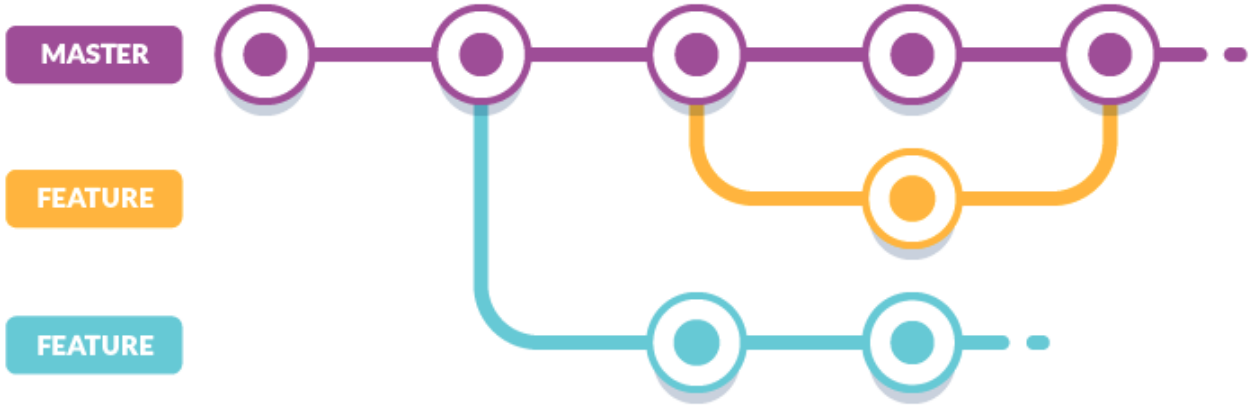
Various Git Workflows

- Centralized Workflow
- Feature Branch Workflow
- Gitflow Workflow
- Forking Workflow
- Integration-Manager Workflow

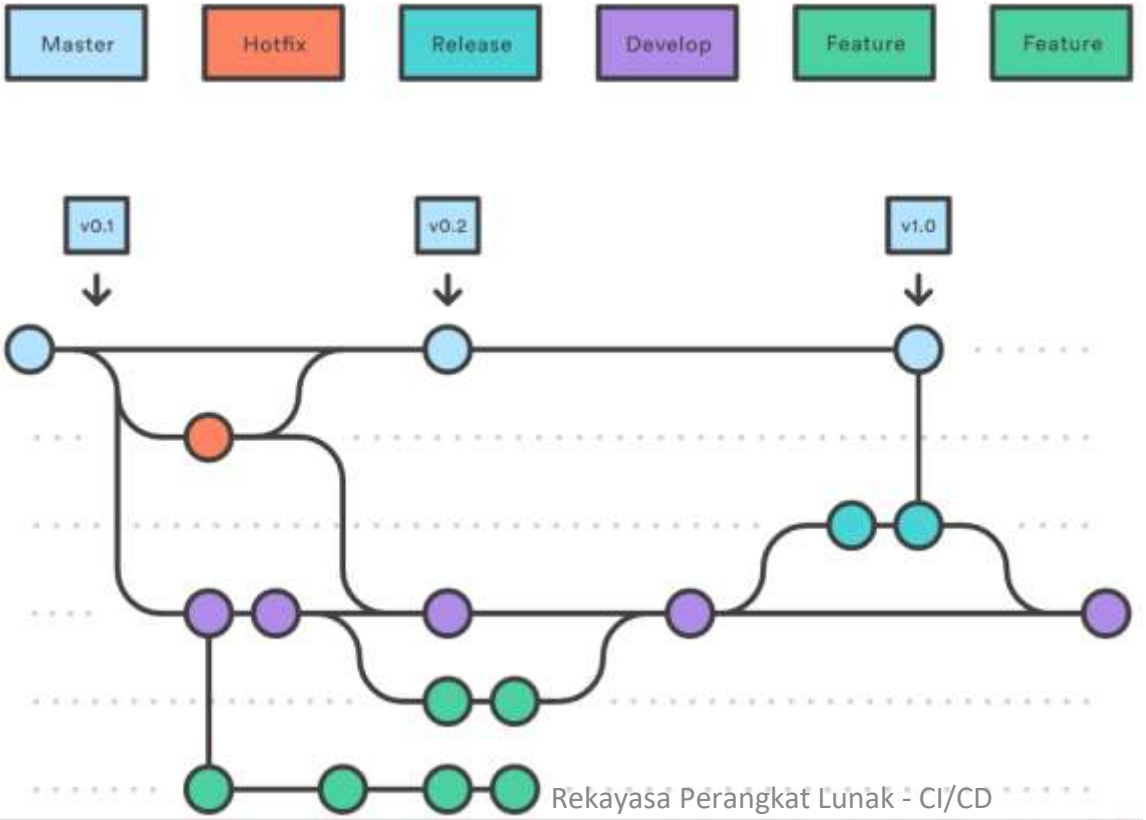
Centralized Workflows



Feature Branch Workflow



Gitflow Workflow



Best Practices on Git

- a label for a commit
- automatically follows on new commit (git commit)
- Always commit before merging
  - commit is cheap, easy and local
  - you never lose anything when merging
- Use of “sha1” or branch-name (e.g. brrrr)

Best Practices on Git

- commit early and often
- always commit before merge (or pull)
- use meaningful commit messages
- avoid committing
  - binary files that change often (NB: word/excel/... are binary)
  - generated files (that can be regenerated in a reasonable time)
  - temporary files
- keep your git status clean
- don't put git repositories inside git repositories

Github

- is
  - a web-based platform for version control and collaboration
  - allows developers to store and manage their source code and other digital assets
  - launched in 2008 and has become one of the most popular code-hosting services in the world.
- GitHub offers version control plus:
  - collaboration and project management
  - including issue tracking
  - project boards
  - wikis
  - pull requests

More on Github

- Forking
  - take a repository on Github
  - make a “personal” copy of this repository
- Pull Request
  - ask for another repo to integrate changes from your fork
- Issues (Tracking)
  - bug
  - questions
  - feature requests
- Github Actions
- Wikis
  - set of pages
  - (also accessible as a git repository)

Key Points

- Version control
  - keep track of what happened
  - store semantic snapshots/versions of your “code”
- Git
  - “distributed” version control: you have a complete repository
  - efficient and widely used
  - one repository per project
- Github
  - a place to share repositories (projects)
  - visualization of the repositories, wiki pages, issue tracker
  - available only via https or SSH

Extra Reading

- https://www.atlassian.com/git/tutorials/comparing-workflows
- http://nvie.com/posts/a-successful-git-branching-model/
- https://buddy.works/blog/5-types-of-git-workflows

Reference

- https://git-scm.com/book/en/v2
- http://www.cs.nott.ac.uk/~pszjg1/FSE12/FSE_8.ppt
- http://www.cs.cornell.edu/courses/cs501/2000FA/slides/Lecture8.ppt
- https://cecas.clemson.edu/~stb/ece417/spring2009/lecture03-cvs.ppt
- http://www.cse.cuhk.edu.hk/lyu/_media/groupmeeting/20110829_zacharyling_git.ppt