GIT ESSENTIALS

October 2011

This image is the Linux kernel as visualised by Gource

Why Distributed Version Control?

- Builds that never break
- Work that is always backed-up
- Safe local updating and merging
- Flexibility around adopted workflows
- No single point of failure
- Knows the 'fallacies of distributed computing‘

Branching as a process enabler

— You cannot have stable code without branches

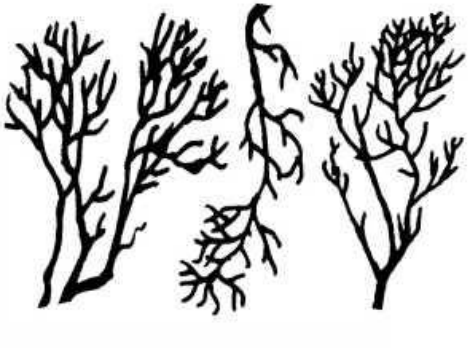
  stable lines must be isolated from development lines

— You cannot have code reviews without (some form of) branch

  otherwise you cannot continue to work while waiting for reviews to happen

— For a DVCS, branching is mandatory since every local commit is a branch that potentially needs merging

— A DVCS is designed to be good at branching and merging



Why GIT?

- Seems to be where the momentum is
- Already very stable and mature
- Beautifully simple semantic model
- Fast, especially under Linux
- Stable tools, e.g. Eclipse support
- Branch per task is practical

But...

— Git is harder to learn than a typical centralised VCS, it has more concepts and more commands

— Git is extremely flexible, but that demands disciplined processes and conventions

Git tracks content, not files

It stores three types of data separately:

— content is stored in blob objects

— history is stored in commit objects

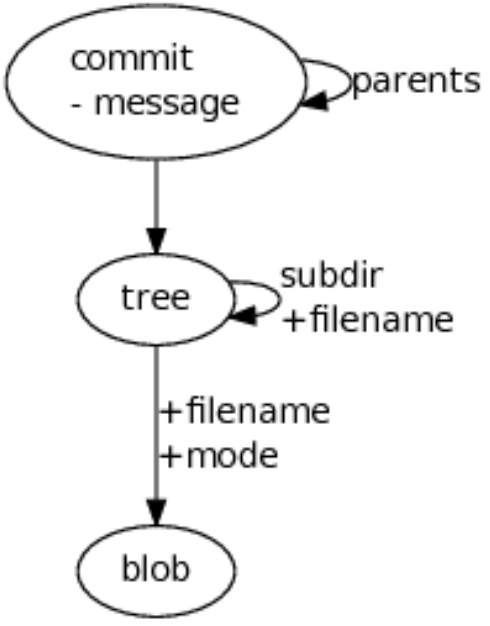
— folder structure is stored in tree objects

This allows:

— full merge accounting of non-linear histories

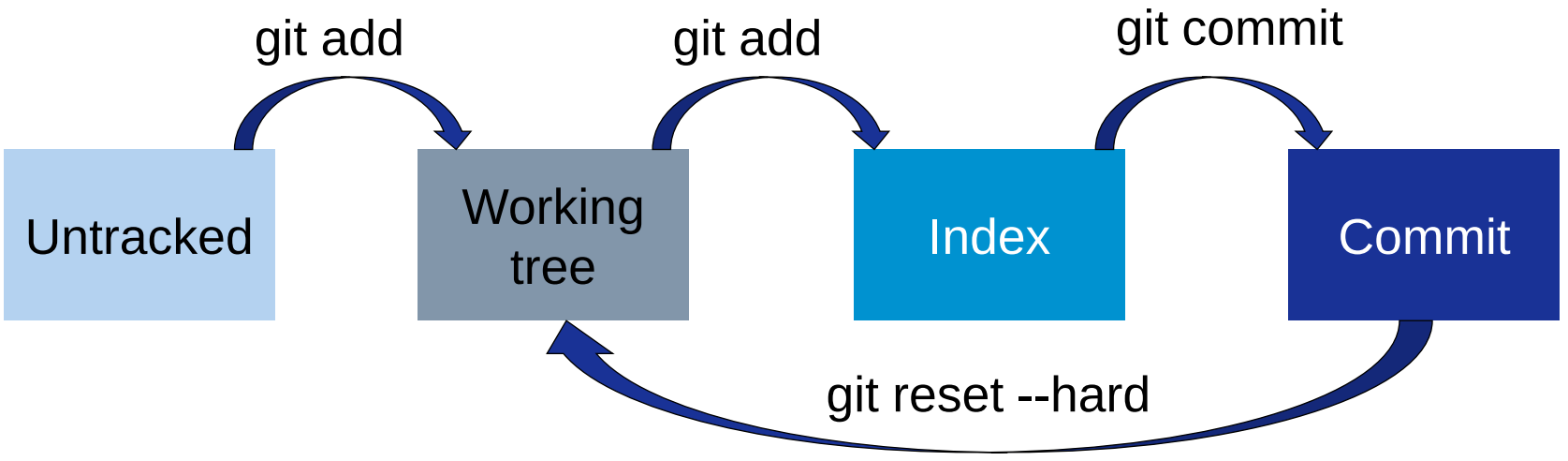
— tracking the history of code, which may pass through many files

— fast path-limited revision traversal



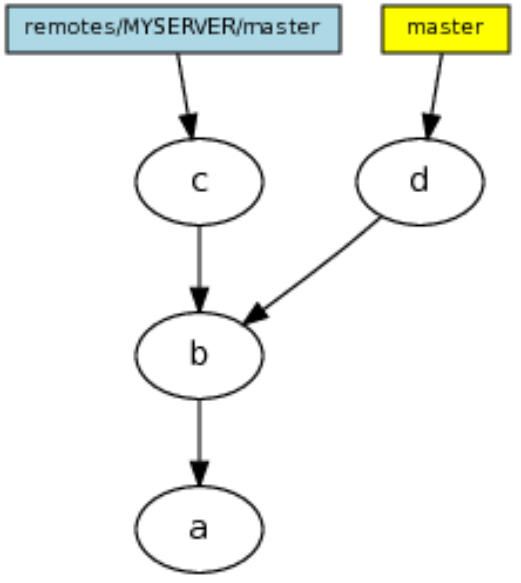
The Working Tree and Index

- Git commands such as “git add” and “git rm” work against the index, which is used to generate the next commit
- Changes to your working tree do not affect the index, changes are **staged** using the above commands
- Provides a place to store an unfinished merge, so you can try various strategies, including hand-editing, to finish it



Commits

- A single, atomic change-set with respect to the previous state
- Represents the entire repository, since we snapshot the index to create a new tree object representing the repository root
- Represents an entire line of development, since each commit points to its predecessor



- form a directed-acyclic graph, when we branch
- self-identifying and secure using SHA1 hashes

Branches

There are two types of branches in Git:

- Local branches
  represent **your** branches, use “git branch” to see them. They can be set to track remote-tracking branches
- Remote a.k.a. “remote-tracking” branches
  represent a snapshot of **someone else’s** branch, use “git branch -r” to see them and “git fetch” to update them

To create and checkout a local branch that tracks a remote:

```
git checkout --track -b experiment origin/experiment
```

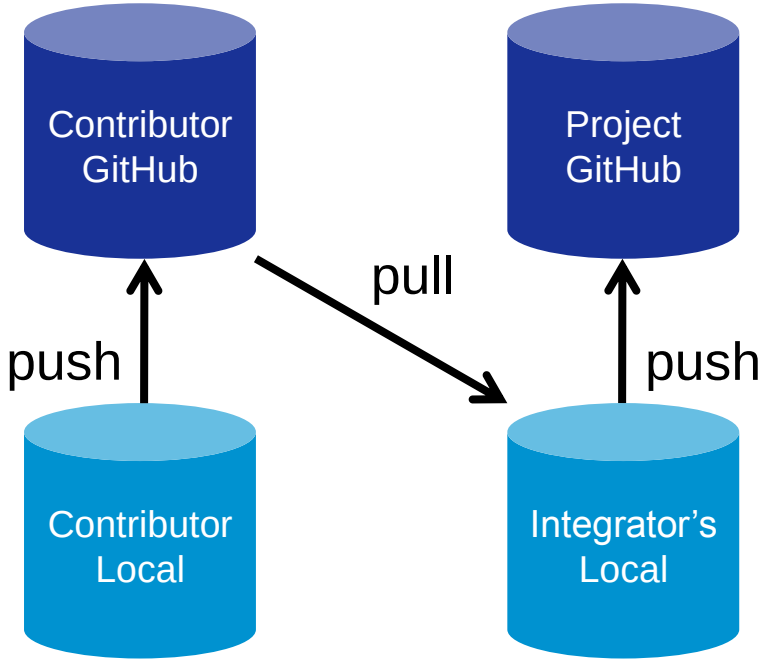
Remotes

— Git can have many peers

— these peers, called remotes, can thought of as simple aliases for long URLs

To add a new remote:

git remote add github <url>



Refs

- a ref is a SHA1 hash pointing to a git commit
- named refs are stored in .git/refs according to their fully qualified names
  For example .git/refs/remotes/origin/master contains the (last known) SHA1 commit of the origins master branch
- special refs exist, e.g. HEAD which means the latest commit on the current branch
- relative commits can be accessed using a tilda
  For example HEAD~2 references two commits before HEAD
- ranges can be specified using double dots
  For example HEAD..HEAD~2
- branches and tags are just named refs
  Note branch refs can move, tags cannot

Tags

- first class citizens in Git
- can be used to start new branches or simply mark milestones in the code's lifetime
- by default, “git tag” creates a simple named ref, essentially a branch that never moves
- better to create annotated tags using "git tag -a" or signed tags
- use “git describe --tags” to show how many commits you are past the last or supplied tag

Common commands

- Creating
  - git init
  - git clone
- Querying
  - git status
  - git show
  - git log
- Updating
  - git add
  - git commit
  - git fetch
  - git merge
  - git pull
- Undo
  - git reset
  - git clean
  - git revert
- Powertools
  - git rebase
  - git cherry-pick
  - git bisect
  - git stash
  - git blame

Subversion equivalents

Old world	New world
svn checkout <url>	git clone <url>
svn update	git pull
svn update -r <rev>	git checkout <rev>
svn revert	git checkout
svn add/rm/mv	git add/rm/mv
svn commit	git commit

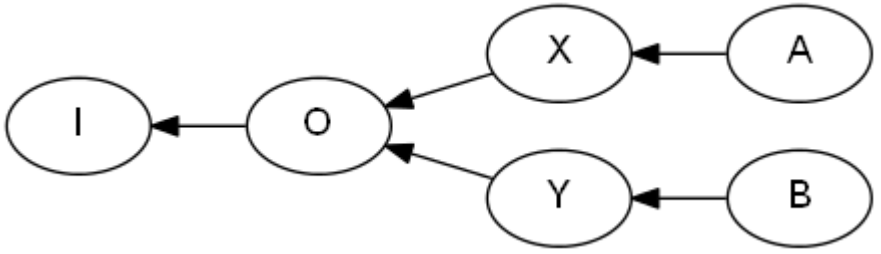
Merging

- Happens whenever we “git pull” or “git merge”
- No Conflicts:
  - Git creates a new merge commit, if the merge is non-trivial.
  - If the merge is trivial, ie. just an update, it **Fast-Forwards** the commits
- Conflicts:
  - changes alter the same line of the same file
  - must be resolved before a merge commit can be created

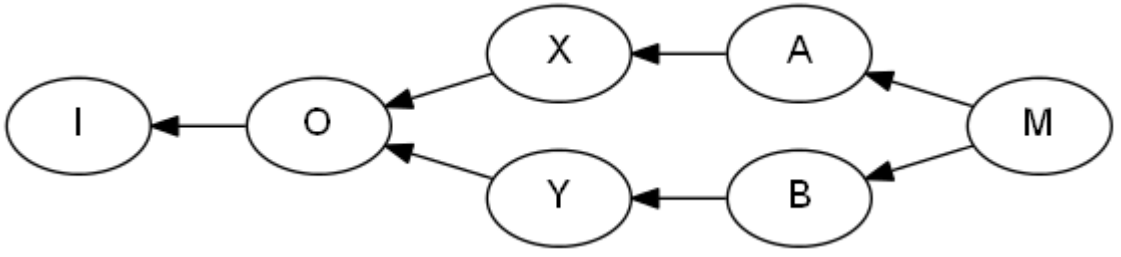
Merging

- Git has pluggable merge strategies and many to choose from
- By default Git uses the 'recursive' strategy to perform a basic three-way merge. It applies it to whole files, and then to lines within files.

To do a basic three-way merge, you need three versions of a file. The versions A and B you want to merge, and a common ancestor O.



We want the file O, plus all the changes made from O to A and from O to B.



Merging: common strategies

- **Fast-forward** (default trivial)
  - simply replays the commits onto a common parent
  - used, for example, to update a developer's remote copy
  - use "--no-ff" if you explicitly want the merge in your history when doing "git pull" or "git merge"
- **Recursive** (default non-trivial)
  - performs a basic three-way merge, unless there are multiple common ancestors, in which case it attempts to merge the ancestors and then use the result as a common base
- **Ours**
  - abandon any conflicting changes in the feature branch, but keep them in the history
- **Subtree**
  - for merging an independent project into a subdirectory of a superproject

Merging: Resolving conflicts

— a merge (via git pull or git merge) may result in a conflict

```
Auto-merging DemoServer/Java/pom.xml
CONFLICT (content): Merge conflict in DemoServer/Java/pom.xml
Auto-merging WebServer/Java/run.bat
CONFLICT (content): Merge conflict in WebServer/Java/run.bat
Auto-merging Bandwagon Examples.iws
CONFLICT (delete/modify): Bandwagon Examples.iws deleted in 682a683d05f763bb246a
439033e3e1e63ccff7b6 and modified in HEAD. Version HEAD of Bandwagon Examples.iw
s left in tree.
```

— while in a conflicted-merge state, the index holds three versions of each conflicted file: base, ours and theirs

— the conflicted files in the working tree also contain markers, showing the conflicted lines

  — “git status” will list all the modified files bought in by the non-conflicting commits. It will also list the conflicted files.

  — “git reset --hard” aborts the merge

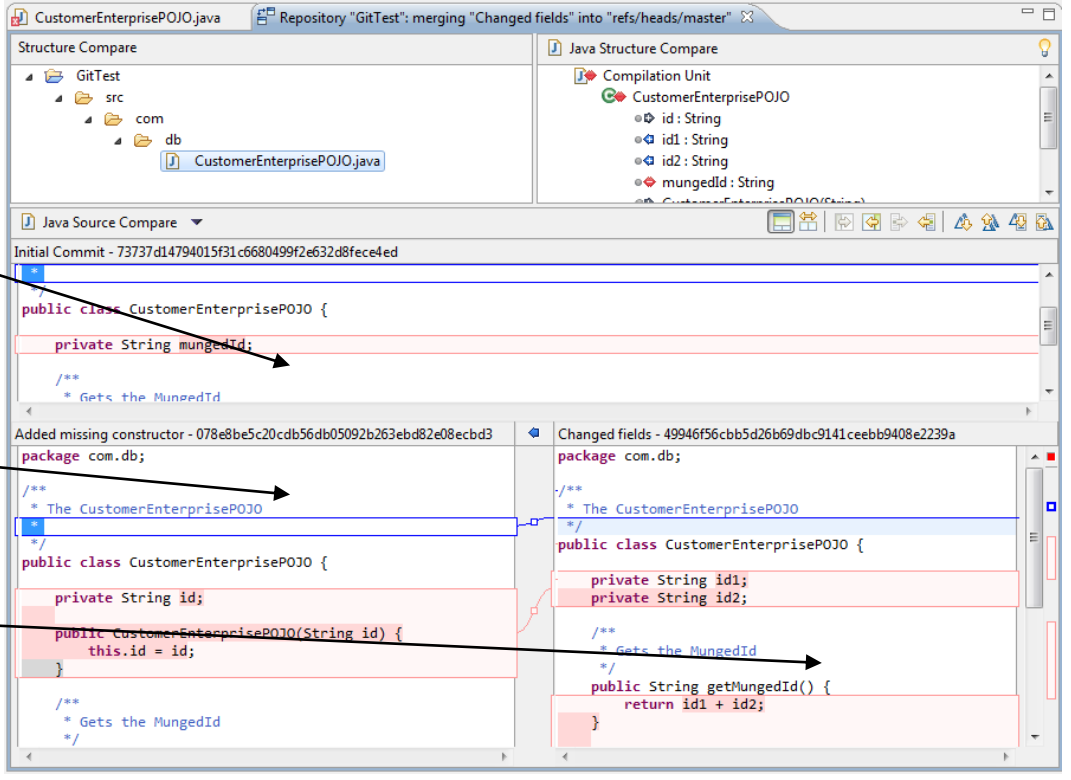
Merging: Eclipse and EGit

1. right click a conflicted file
2. select Team -> MergeTool
3. select the merge mode
   use HEAD (the last local version) of conflicting files" and click OK
4. the merge editor opens

Ancestor (base)

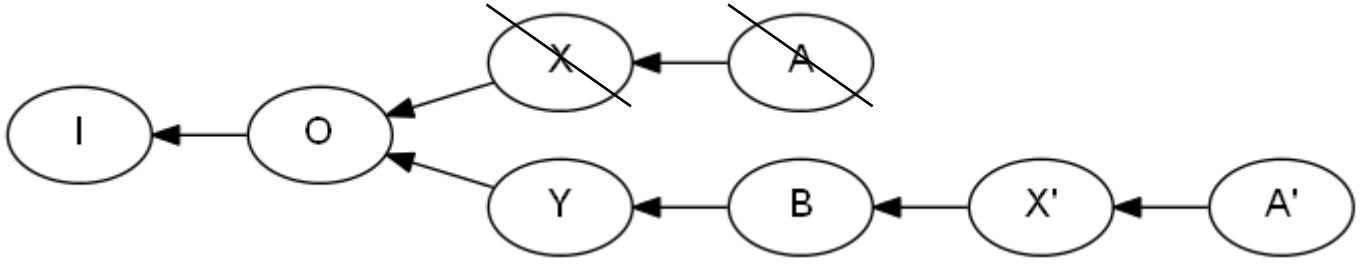
Working tree version

Version to be merged



Rebasing

- best thought of as re-writing history
- should not be done to commits already published!
- useful for cleaning up a noisy and confusing private history before publishing
  - especially if some bad intermediate commits may cause problems for tools such as “git bisect”
- the interactive rebase “git rebase -i” can be useful for squashing a series of recent commits into one bundle for publishing



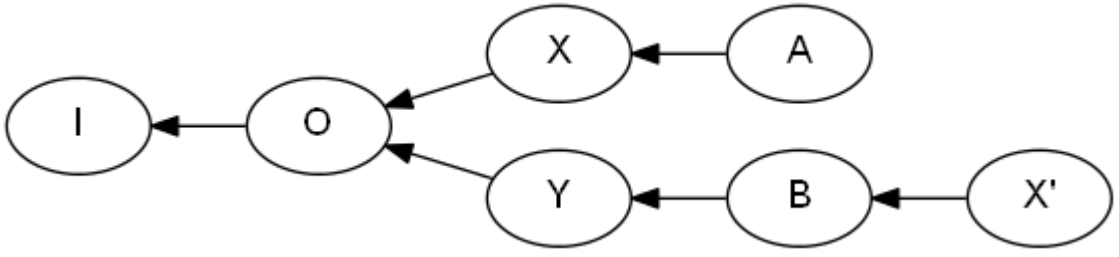
Cherry picking

— allows you to "cherry-pick" one or more commits from within an arbitrary development line

— creates a new commit on top of your current HEAD

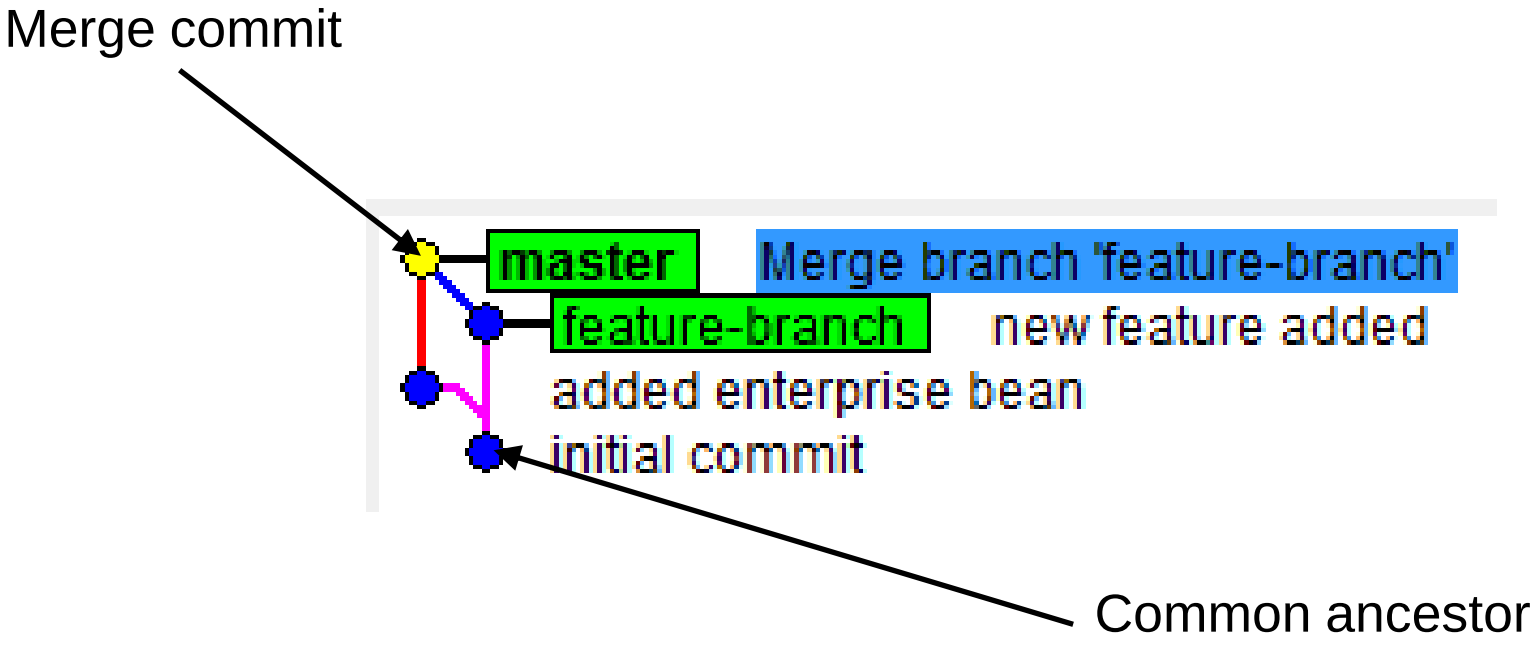
— if it cannot apply the change, conflicts are resolved similarly to “git merge”

— often an alternative to rebase, which can be thought of as a series of cherry-picks, followed by a branch reset



Visualisation

- gitk included with git
- Run using “gitk” or “gitk --all” for all branches
- Eclipse EGit offers similar graph views in the History view
  For example, Team -> Show in History



Renames

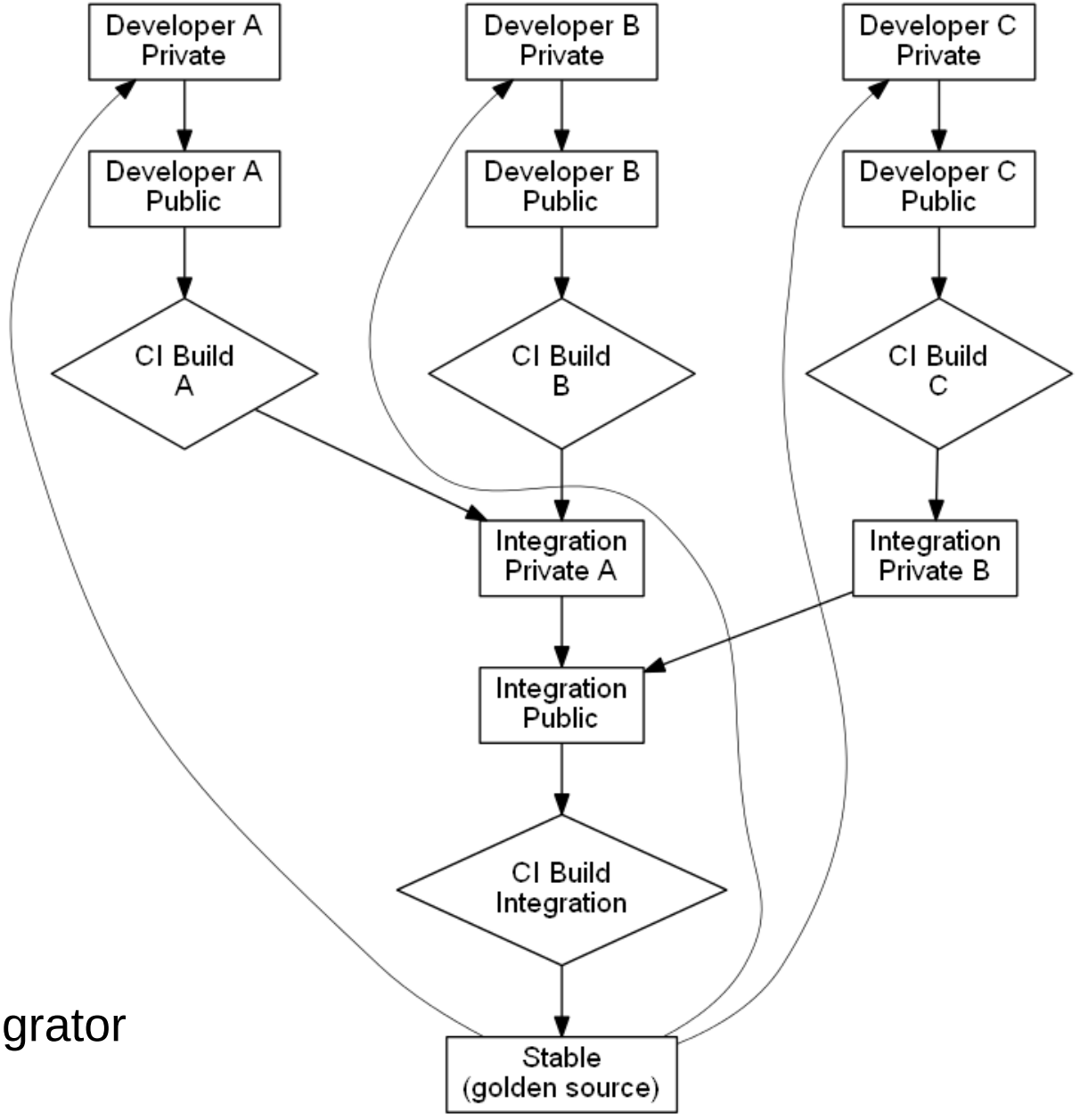
- Git doesn’t record any rename tracking information at commit time
- Renames are detected using heuristics. To make sure this works, always commit moves separately from content changes.
- Use “git log --follow <filename>” to view the history of a file across renames

Workflow

An ideal workflow for moderately sized teams would feature:

- **A stable "golden source" repository** that developers pull from and releases are cut from, that always builds
- **In-progress work is backed-up remotely**
  - this includes branches that may never make it into the golden source.
- **A Branch-per-task methodology**
  - made practical by Git's full merge accounting and scalable architecture.
- **First class code reviews**
  - using a collaboration platform like GitHub, code review is a trivial add-on.

Workflow



Roles:

- Developer
- Reviewer/integrator

Best practice

- all work should be done on ticket-linked branches
- commit and push regularly, especially after renames
- the person responsible for the pull request should resolve conflicts should their branch fall behind master
- work is not done and tickets are not closed, until code has at least made it to stable

Setting up

1. Set up your configuration:
   git config --global user.name "Tim Williams“
   git config --global user.email tim@timphilipwilliams.com
   - Three levels of config: system, global and local to the repository
   - You can view your configuration by doing "git config -l“
   - On Windows it is worth checking that "core.autocrlf" is set to false
2. Set up ssh keys:
   ssh-keygen -t rsa
   - add your keys here %HOME%\.ssh\id_rsa
   - private key should really have a password
3. Upload your public key to GitHub
   - taking care to avoid copy-paste errors!

Resources

- Details of various Git documents and books
  - http://git-scm.com/documentation
- Pro Git : the complete book
  - http://git-scm.com/book