CISL Computational & Information Systems Laboratory

Using Git for Centralized and Distributed Version Control Workflows - Day 3

1 April, 2016

Presenter:
Brian Vanderwende

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

NSF

Git jargon from last time...

- **Commit** - a project snapshot in a repository
- **Staging area** - where additions/modifications are gathered to be packaged into a commit
- **Clone** - a copy of an existing repository
- **HEAD** - the most recent commit of the currently checked out branch
- **Rebasing** - moving the starting point of a branch from an older to a new commit in the parent branch
- **Remote** - an outside repository that is linked to the current repository (can be local or on a server)
- **Push/pull** - send/receive commits to/from a remote

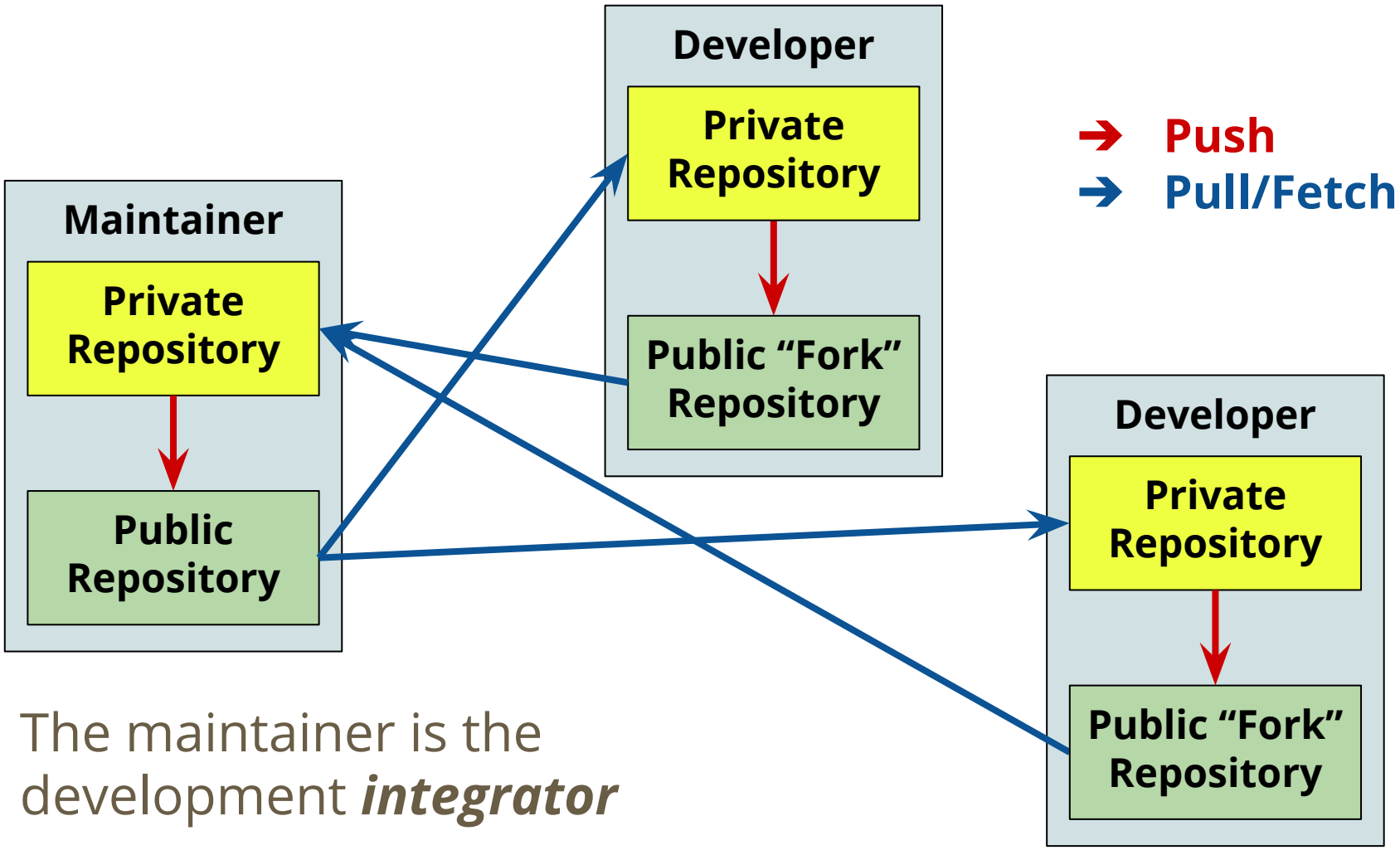
Day 3 - Workflows, Web Servers, and Submodules

1. Git workflows
    a. Distributed and centralized
2. Using a web-based remote repository - Github
3. Git submodules

While Git can be used for local collaboration, it was designed for large *distributed workflows*

- In a distributed workflow, devs can clone an “official” public repository to create private development repos.
- The developer then pushes their changes to their own public repository, from which the official project maintainer can pull to the “official” repo.
- This is also called the **integrator** workflow, because the official maintainer integrates features from developers
- Implicitly provides security and redundancy

Visualizing the distributed workflow

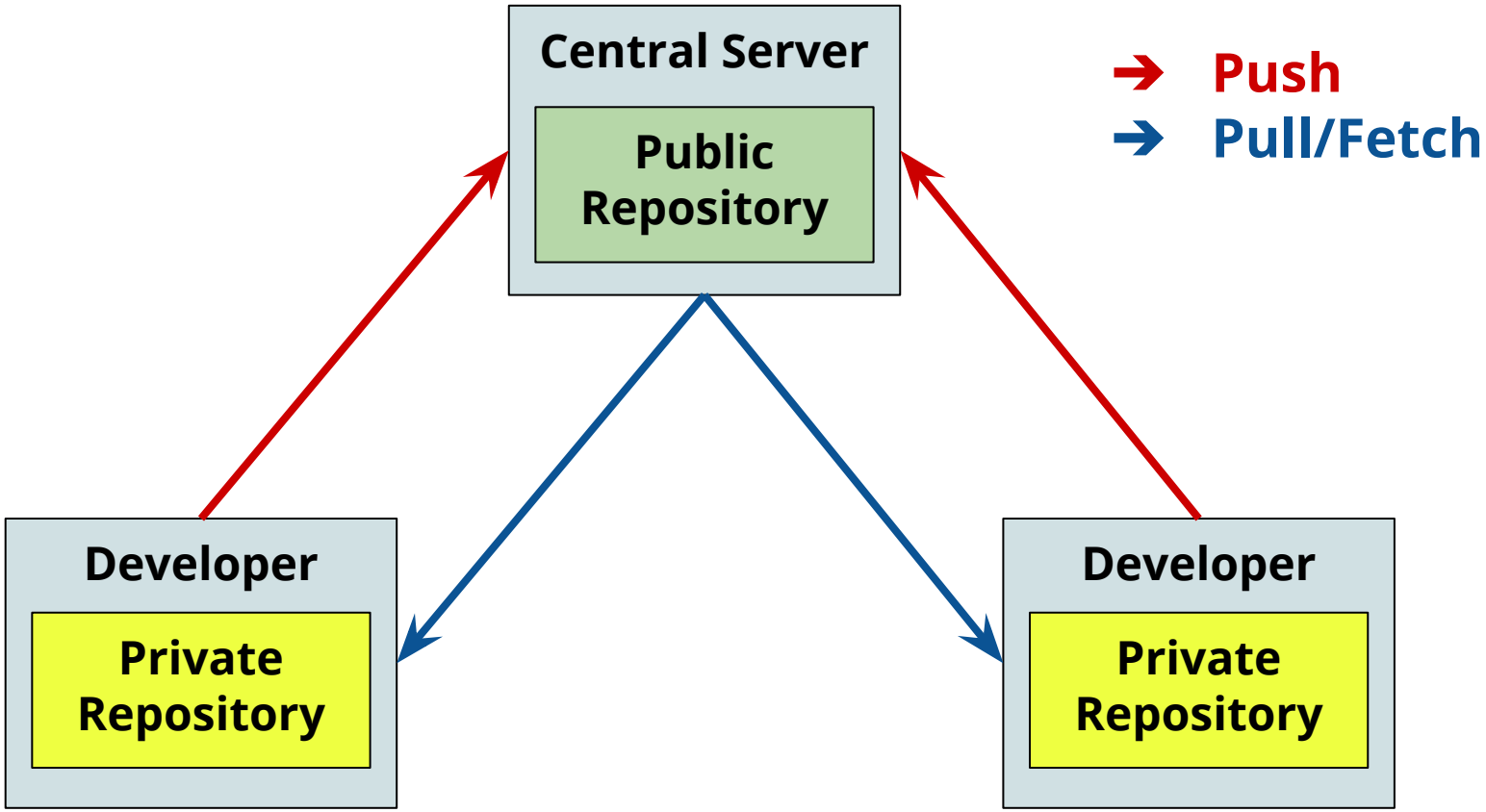


The maintainer is the development ***integrator***

Centralized workflows, involving a central repository, are also possible with Git

- In this model, all developers have a private repository, from which they can push features to a central (typically networked) repository
- Similar to the Subversion workflow
- All developers are responsible for resolving commit conflicts with other pushed changes
  - There is no **integrator** in this model

Visualizing the centralized workflow



Public repositories are typically created without a working directory for obvious (?) reasons

- Use the **bare** option to create a repository without a working directory:

  git init --bare <repo_name>.git

- Note the **.git** at the end of the repository name. This accepted convention is used when no working directory exists.

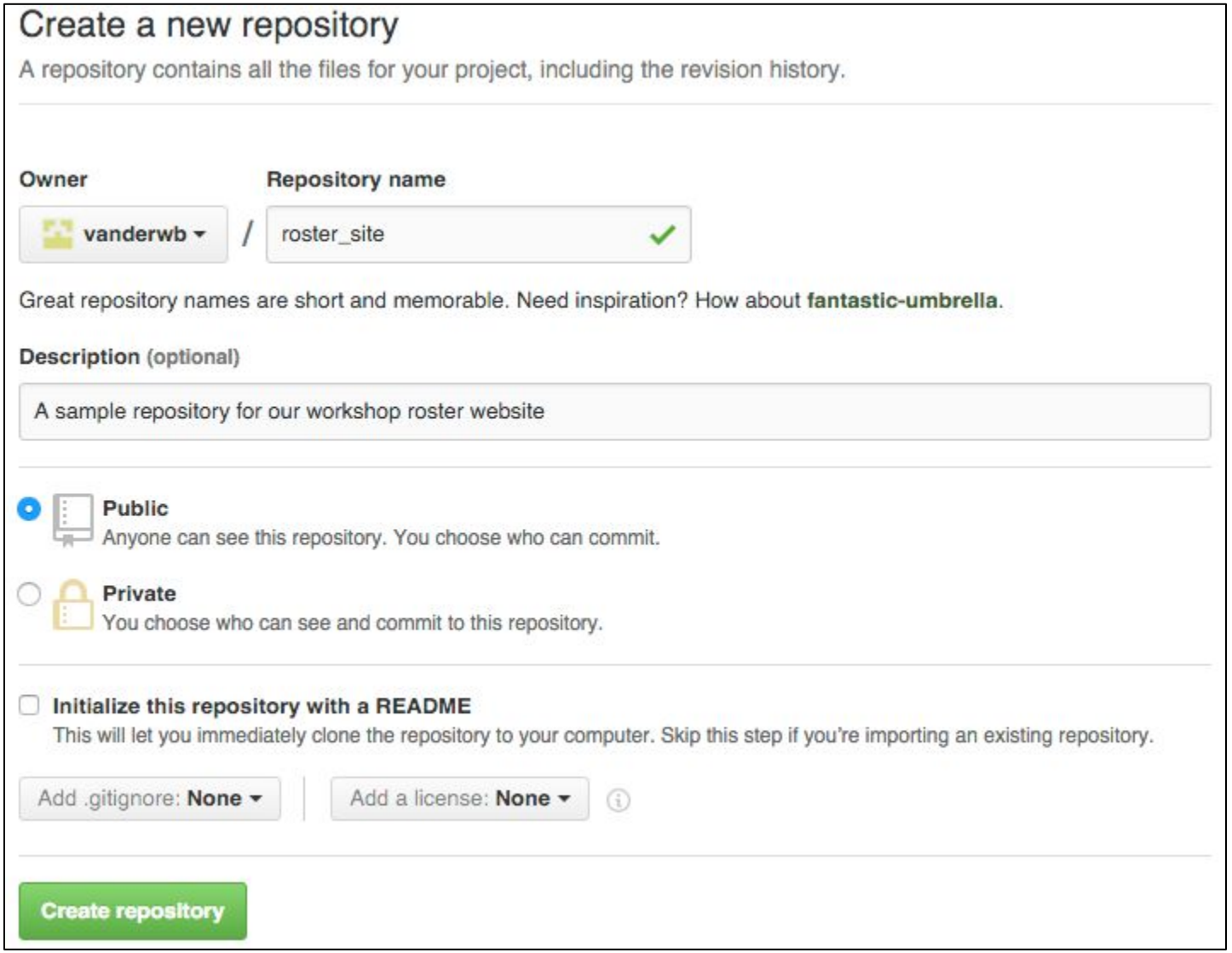
Of course, hybrid workflows with distributed groups accessing a central server are possible too!

Github and competitors simply provide web-hosting and tools for Git repositories

- Provide an easy method for cross-network collaboration as well as source distribution
- Add visual flair to the Git experience (web GUI)
- Can be incorporated into any workflow:
  - In centralized, the public repository is stored on web server, and all developers are given push access
  - In distributed, developers can store public repositories online (including the integrator and the “official” repository)

You may recall, I hosted the sample repository for this workshop on Github. Let's explore that process...

Earlier, I wanted to set up a public repository for my workshop roster website project on Github



Next, I needed to *push* my private repository to the public Github repository

- Git allows for HTTPS or SSH authentication. I find SSH to be more reliable, but you do need to set up an SSH key.

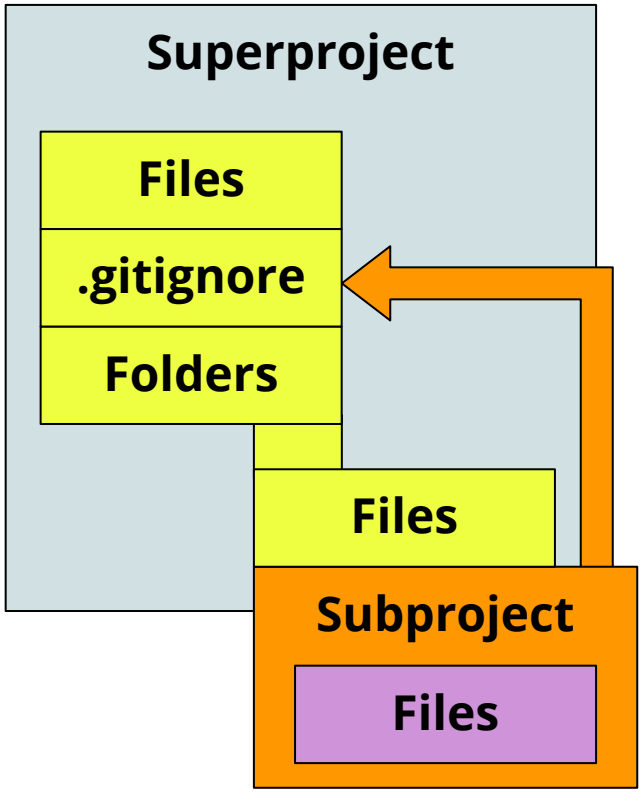
git remote add origin
git@github.com:vanderwb/roster_site.git
git push -u origin master

A quick note about Github permissions

- By default, public repositories are open access
- Anyone can view the repository (all users have *read*/pull access)
- Anyone can issue a pull-request to the repository
  - This enables and follows the **integrator workflow**
- The owner of the repository can add **collaborators**
  - These users have *write* access, meaning they can push commits to the repository
  - Collaborators enable the **centralized workflow**

What if I want to nest one Git repository within another?

The simplest approach is to nest the subproject within a directory, and add to .gitignore



- Easy to set up
- Repositories act independently
  - Must be pushed/pulled independently
- **Problem: if another user clones the superproject, subprojects are not cloned with it**

We need a way to link the subproject to the superproject without mixing their commits...

First, let's think about the Subversion solution to this problem: *externals*

- Creating an external in SVN is (relatively) easy
  - Create a directory for the embedded project
  - Set the directory to be an external by associating the repository URL
  - Commit the external to the superproject
- Now, whenever you update the superproject, the external will be updated as well
- If the external is in the same repository, any changes to it will be included in the commit list
  - If not, you have to commit changes separately

In Git, *submodules* provide some of the advantages of externals, with a few important differences

- A submodule is a copy of a single commit from the subproject repository, kept in a subdirectory of the superproject repository
- The directory structure of the superproject and URL of the subproject repository are maintained when cloning
- **However,** unlike SVN:externals, submodules are **locked** to a **single** commit at any one time, and **don't automatically track** the external project's HEAD

How do you add a submodule to a repository?

- A submodule is basically a special **remote** embedded in the superproject repository. So we add it:

  git submodule add [-b <branch>] <URL>

- By default, the submodule directory will have the same name as the source repository
- A new, version controlled, file called .gitmodules stores the mapping of the repository to the directory
- You can manually track a submodule branch using **-b**
  - If not set, the submodule will default to the master branch

Use recursive cloning when copying a repository with submodules

- To properly clone a repository with submodules, use:

  git clone --recursive <source-URL> <dest-URL>

- Otherwise, you will get an empty submodule folder. You can recover from that by running:

  git submodule init
  git submodule update

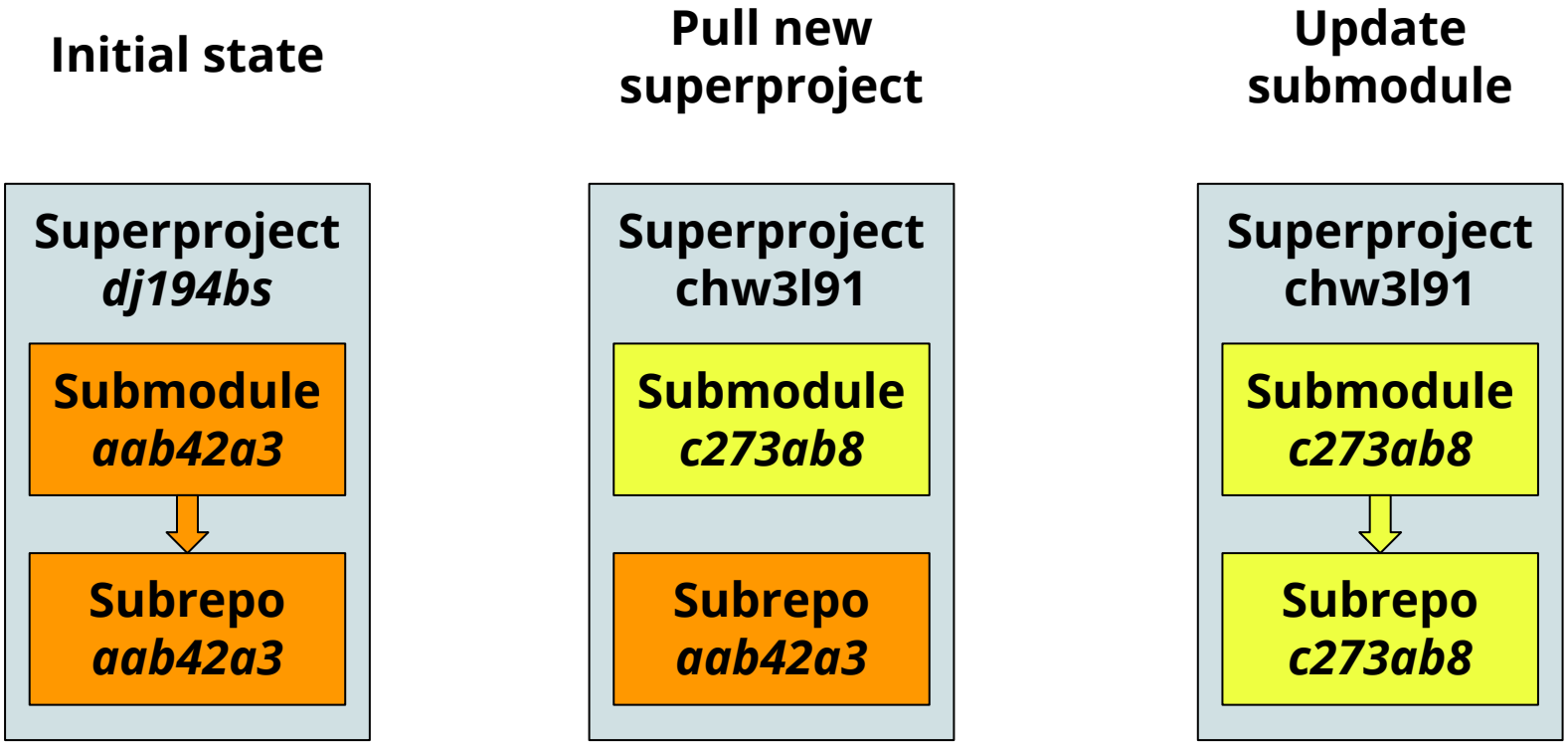
First way to update the submodule - pull the commit tracked by the *superproject*

- The **superproject** tracks a single commit for each **subproject/submodule**
- After pulling a superproject commit that points to a newer submodule commit, update the submodule contents using (i.e. load the commit):

git submodule update [--merge/--rebase]

- If your submodule diverges from the updates, a merge or rebase will be required

First way to update the submodule - pull the commit tracked by the *superproject*



Second way to update the submodule - pull the latest commit from the *subproject branch*

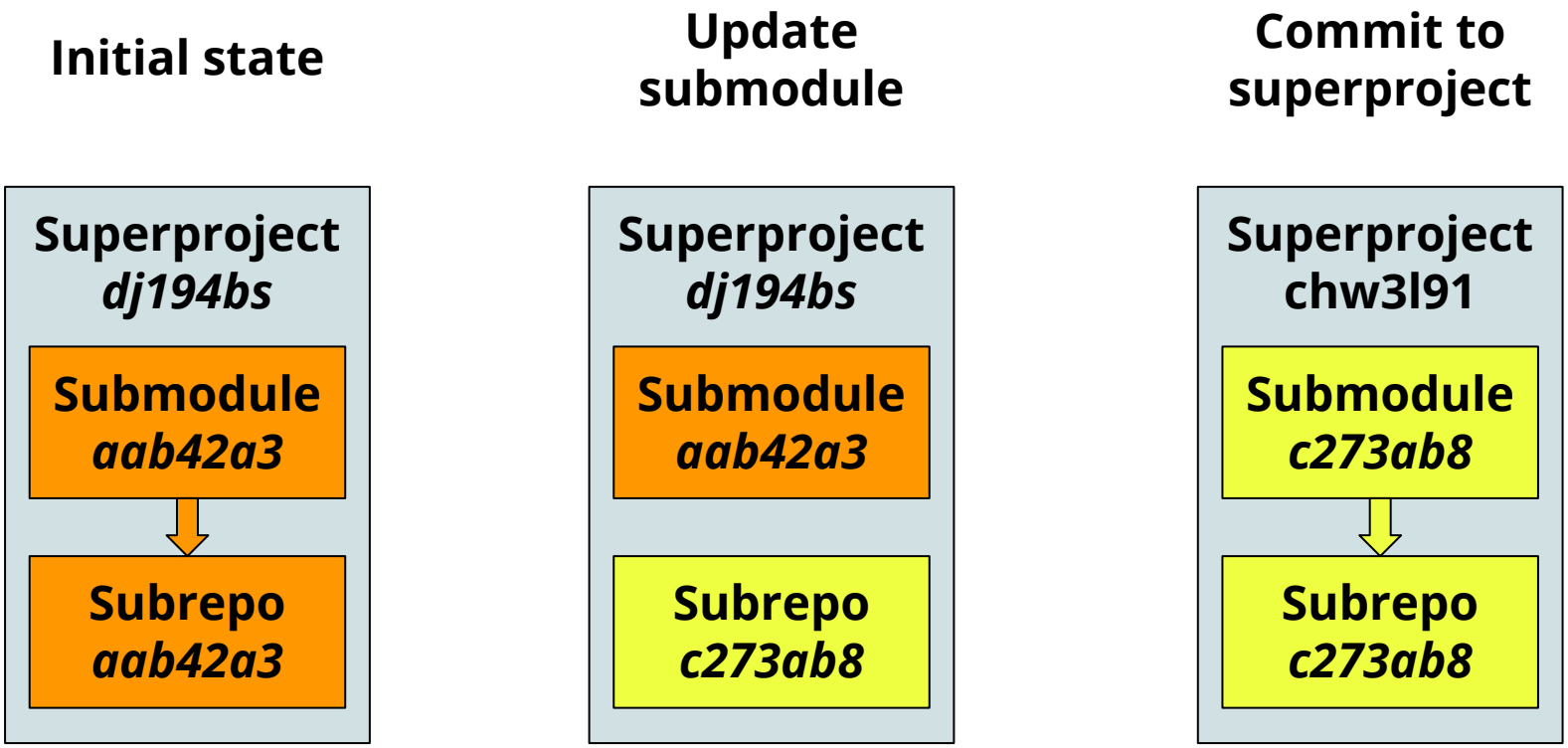
- The submodule is itself a remote repository
- You can pull the latest changes from the targeted branch of the subproject by doing a remote update

    git submodule update --remote

- The tracked branch can be changed as follows:

    git config -f .gitmodules
    submodule.<path>.branch <branch>

Second way to update the submodule - pull the latest commit from the *subproject branch*



Changes made in the submodule must be committed within the subproject AND superproject

- If you make modifications to the subproject, you must commit them, and then stage and commit the submodule itself within the superproject

```
subproject$ echo "TBD" > hello_gpu.f90
subproject$ git add hello_gpu.f90
subproject$ git commit -m "Added stub file for hello world GPU program"
subproject$ cd ..
superproject$ git diff
diff --git a/subproject b/subproject
index 208f4f8..3479225 160000
--- a/subproject
+++ b/subproject
@@ -1 +1 @@
-Subproject commit 208f4f884c99ff26f012dbe36b50e3a7411af9f8
+Subproject commit 3479225ec1636dae3f29902200a8980a589c270d
superproject$ git commit -am "Updated submodule"
superproject$ git diff
```

Submodule pushing can be done recursively from within the superproject

- Submodule changes **must** be pushed before superproject changes!
- If you want Git to simply check for submodule changes, and terminate the push if they are found:

    git push --recurse-submodules=check

- If you want Git to first push submodule changes:

    git push --recurse-submodules=on-demand

CAUTION: Git's heavy focus on branches can cause problems when submodules are introduced...

```
$ git checkout -b add_sub
$ git submodule add ../subproject
$ git commit -am "Added submodule"
$ git checkout master
warning: unable to rmdir subproject: Directory not empty
Switched to branch 'master'
$ git status
On branch master
Untracked files:

        subproject/

$ rm -rf subproject
$ git status
On branch master
nothing to commit, working directory clean
$ git checkout add_sub
$ ls subproject/
$ git submodule update
Submodule path 'subproject': checked out
'208f4f884c99ff26f012dbe36b50e3a7411af9f8'
$ ls subproject/
hello_mpi.f90  hello_serial.f90
```

Making life easier when using submodules

- Git aliases come in handy as many submodule commands are long and cumbersome:

  git config alias.spush 'push --recurse-submodules=on-demand'
  git config alias.supdate 'submodule update --remote --merge'

- The **foreach** command can be used to send any command to all submodules. For example:

  git submodule foreach 'git checkout -b <branch>'

Integrating a subversion repository into a Git project using submodules requires a Git clone

- If Git, SVN, and Alien::SVN are installed, can use git-svn to clone an SVN repository in Git. On Yellowstone:

  module load git
  module load git-svn
  git svn clone -s <SVN-URL> <clone-path>

- Then, in the Git superproject, make the clone a submodule using ***git submodule add <clone-path>***

Updating the SVN submodule is a clunky process

- Need to **resync** with upstream SVN repo, **pull** changes to the submodule, and **update** the superproject:

```
cd <clone_path>
git svn rebase
cd <superproject_path/subproject>
git checkout master
git pull
cd ..
git add <subproject>
git commit -m “Updated submodule to vX.X”
```

Github can make the Git/SVN transition easier, as both programs can interact with Github repositories

For more information, check out man pages and:

https://git-scm.com/doc

http://rypress.com/tutorials/git/index

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

https://www.atlassian.com/git/tutorials/

My contact information:

Brian Vanderwende
CISL Consulting Services Group
ML-55L (x2442)
vanderwb@ucar.edu