Git Tutorial Tour

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Git Tutorial Tour Outline

- Repository Management
  - Git Repository Concepts
  - Inter-Repository Data Flow
  - Branches
  - Merges
- Local Use Cases
  - Pull Updates
  - Generating Patches
  - Examples
- Supplemental Slides

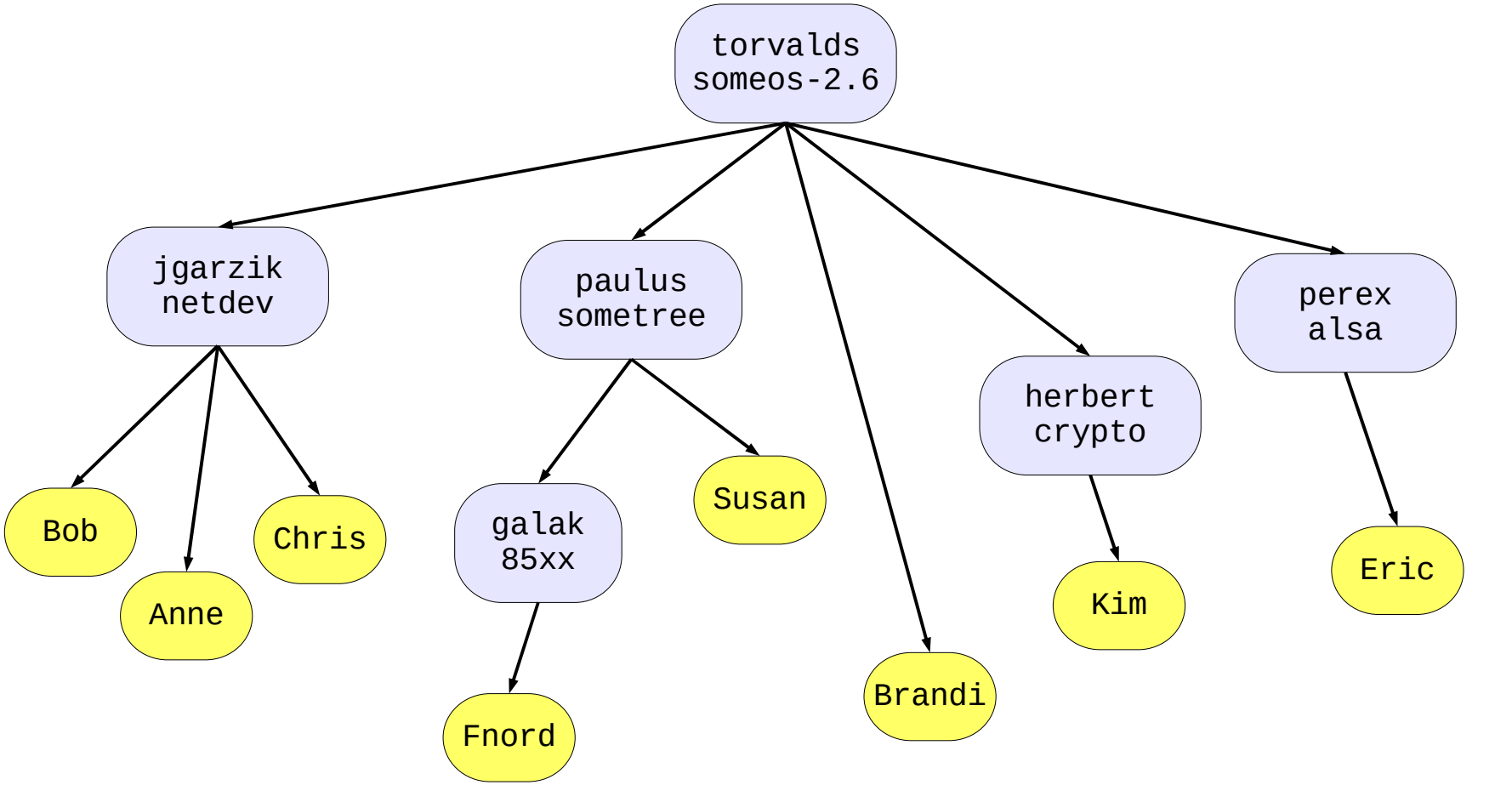
Git Concepts: Repositories

- Git repository is self-contained, local and complete
  - Doesn't require external content
  - No centralized repository
  - Includes complete history of every file and change log
- Git repository is not distributed
  - No: part here, part there, part over there...
- No git repository is inherently authoritative
  - Only authoritative by convention and agreement

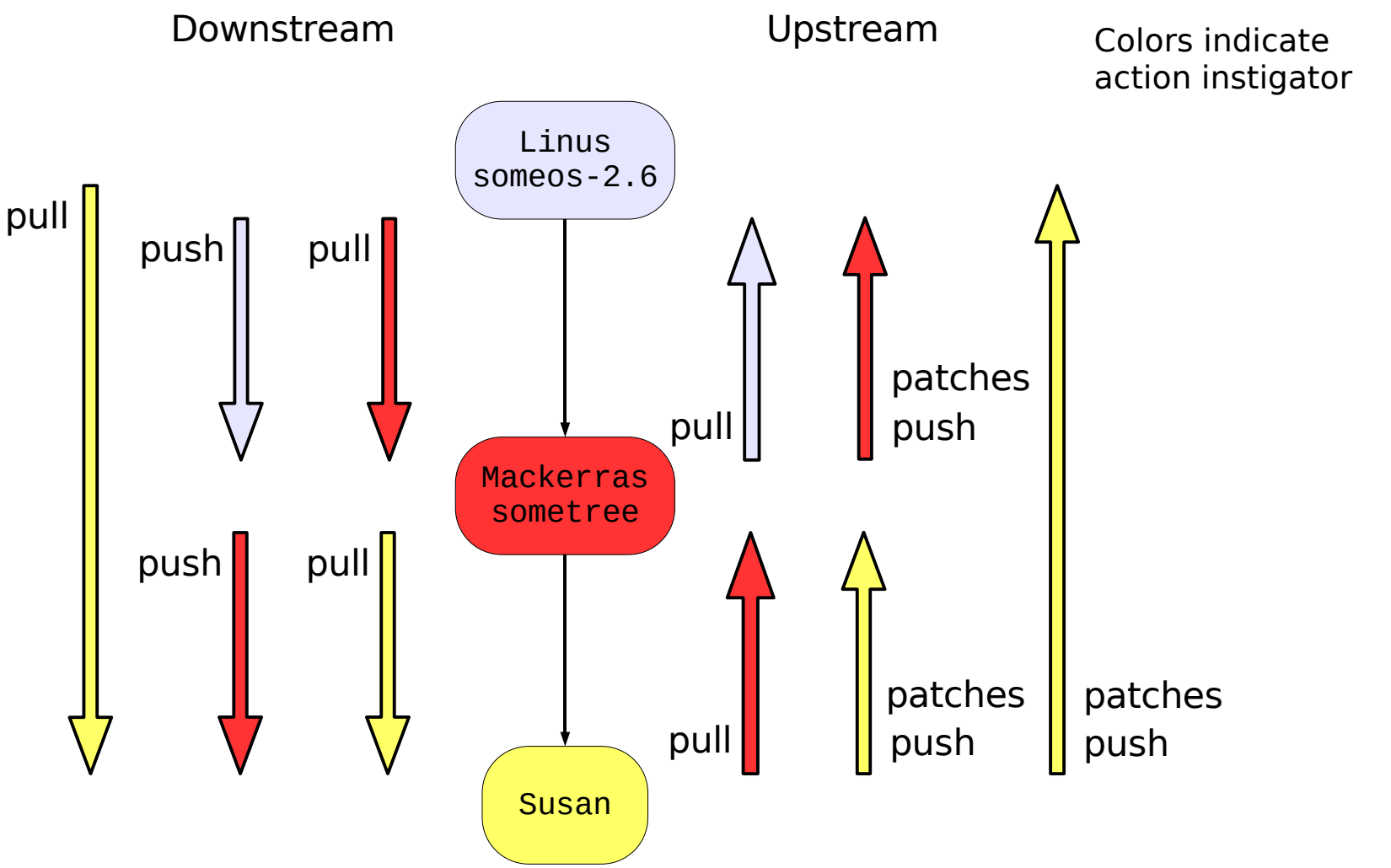
Git Concepts: Distributed Development

- Development can be distributed
  - Multiple repositories can create different histories and changes
    - Even if they originated from a common ancestor
  - Multiple repositories with different development can be combined
- Development can be shared
  - Multiple developers can use and update a common repository
    - No matter if the repository is local or remote
- Development can be private
  - Revision control your Address List at home

Repository Network



Repository Data Flow



Git Concepts: Branches in git

- Cheap, fast and easy
- Topic/Development Branches
  - Stable, development, bug-fix, testing branches
  - Small development lines, per-feature, per-developer, etc
  - Collect, reorder or organize changes
  - Cherry-pick particular patches
- Tracking Branches
  - Follow upstream changes in local repository
  - Don't commit to tracking branches
  - Identified as RHS of `Pull:` refspecs
- Branch names refer to the current branch HEAD revision
- Branches don't have a “beginning” per se

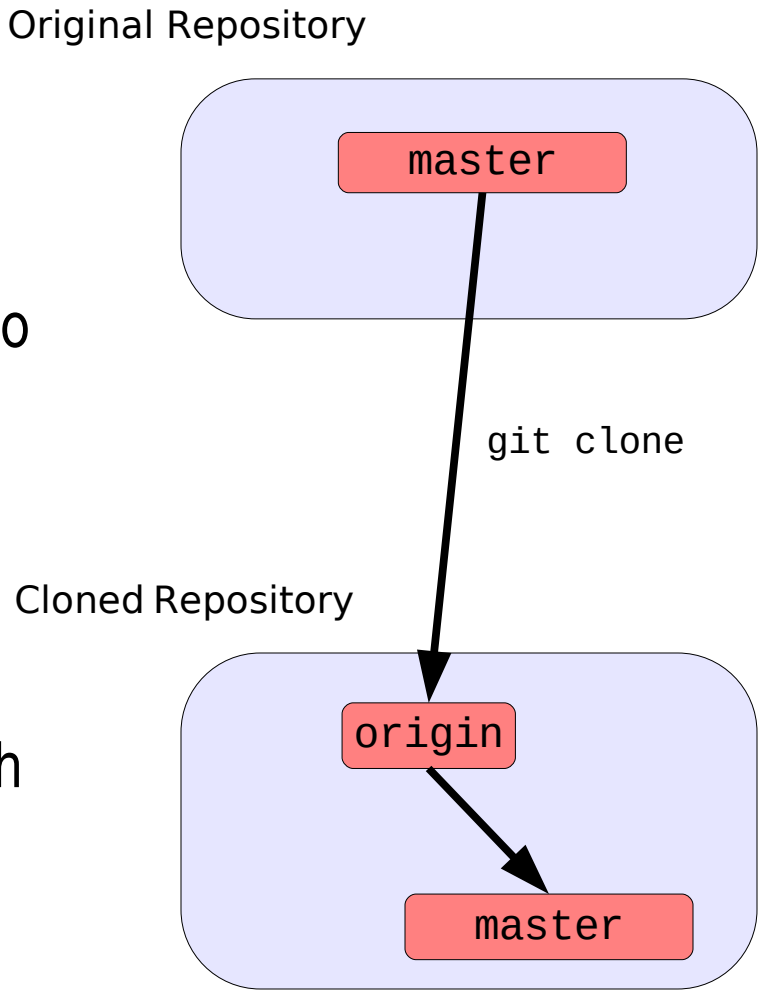
```
$ git merge-base <original-branch> <branch-name>
```

Branches: Cloning

- Clone from upstream URL

```
$ git clone
  git://www.jdl.com/software/dtc.git
```

- Copies complete upstream repository into a local repository
- Creates `origin` tracking branch
  - Tracks upstream `master` branch
- Introduces `master` development branch
  - Initially the same place as `origin`
  - For *your* development



Branches: Commit Onto Branches

- Master branch in your repo is for *your* development!

```
$ git checkout master
# Edit a file.
$ git commit -a -m "Add copyright.  Fix 80-column line."
```

- Introduce your own topic development branches too

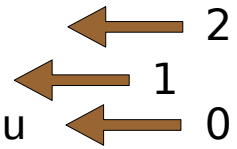
```
$ git checkout -b jdl
# Edit a file.
$ git commit -a -m "Remove dead code."
```

- Gotcha: Commits require an author!
  - Environment variables: `GIT_AUTHOR_NAME`, `GIT_AUTHOR_EMAIL`
  - Config file: `$ git repo-config user.name 'Eric S. Raymond'`
  - Gecos value: `/etc/passwd`

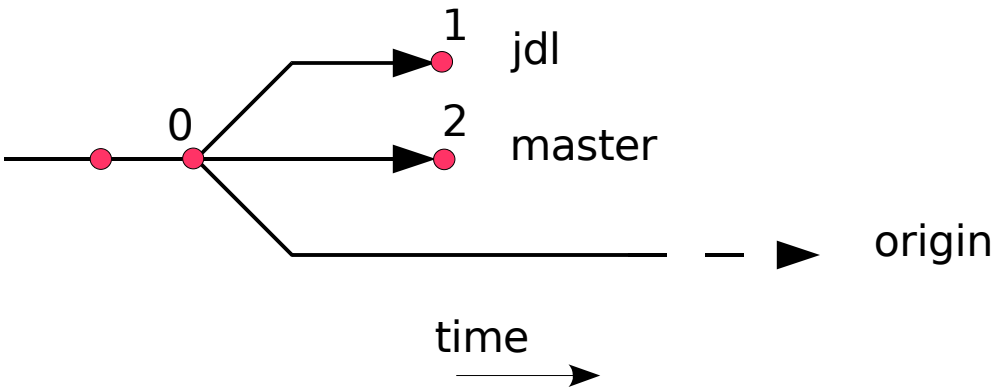
Branches: Visualizing Branches

```
$ git show-branch

! [jdl] Remove dead code.
 * [master] Add copyright.  Fix 80-column line.
  ! [origin] dtc: add setting of physical boot cpu
---
 *  [master] Add copyright.  Fix 80-column line.
+   [jdl] Remove dead code.
+*+ [origin] dtc: add setting of physical boot cpu
```



Branch Timeline



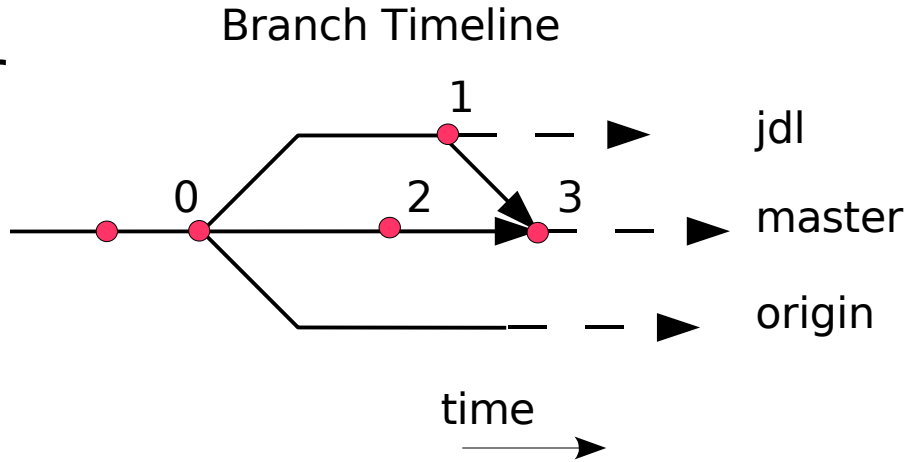
Git Concepts: Merges

- Merge: Combine directory and file contents from separate sources to yield one combined result.
  - Sources for merges are local branches
  - Merges always occur in the current, checked-out branch
  - A complete merge ends with a new commit
- Merge resolution is inherently ambiguous
  - Git uses several merge heuristics:
    - Several merge strategies: resolve, recursive, octopus, ours
    - Techniques: fast-forward, three-way
- Some merge conflicts may need to be resolved by the developer

Merge jdl branch To master

- Merge `jdl` branch into `master`

```
$ git checkout master
$ git pull . jdl
```



- Resulting Branch History

```
$ git show-branch

! [jdl] Remove dead code.
 * [master] Merge branch 'jdl'
  ! [origin] dtc: add setting of physical boot cpu
---
 -  [master] Merge branch 'jdl'
+*  [jdl] Remove dead code.
 *  [master^] Add copyright.  Fix 80-column line.
+*+ [origin] dtc: add setting of physical boot cpu
```

Outline: Use Cases

- Repository Management
- Local Use Cases
  - Pulling Updates
  - Making Patches
  - Finding a Commit
  - Cherry Picking
  - Reverting a Commit
  - Resolving Merges
  - Rebasing Local Changes
- Supplemental Slides

Pulling Updates

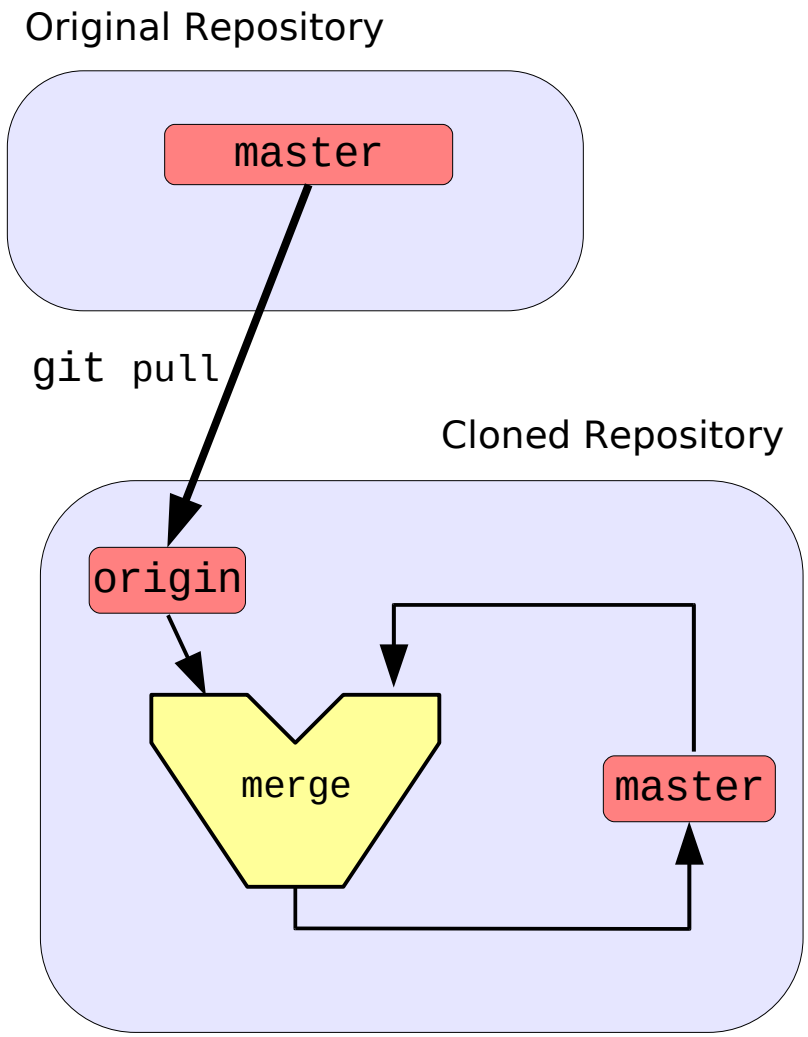
- The default origin “remotes” file

```
$ cat .git/remotes/origin
URL: git://www.jdl.com/software/dtc.git
Pull: refs/heads/master:refs/heads/origin
```

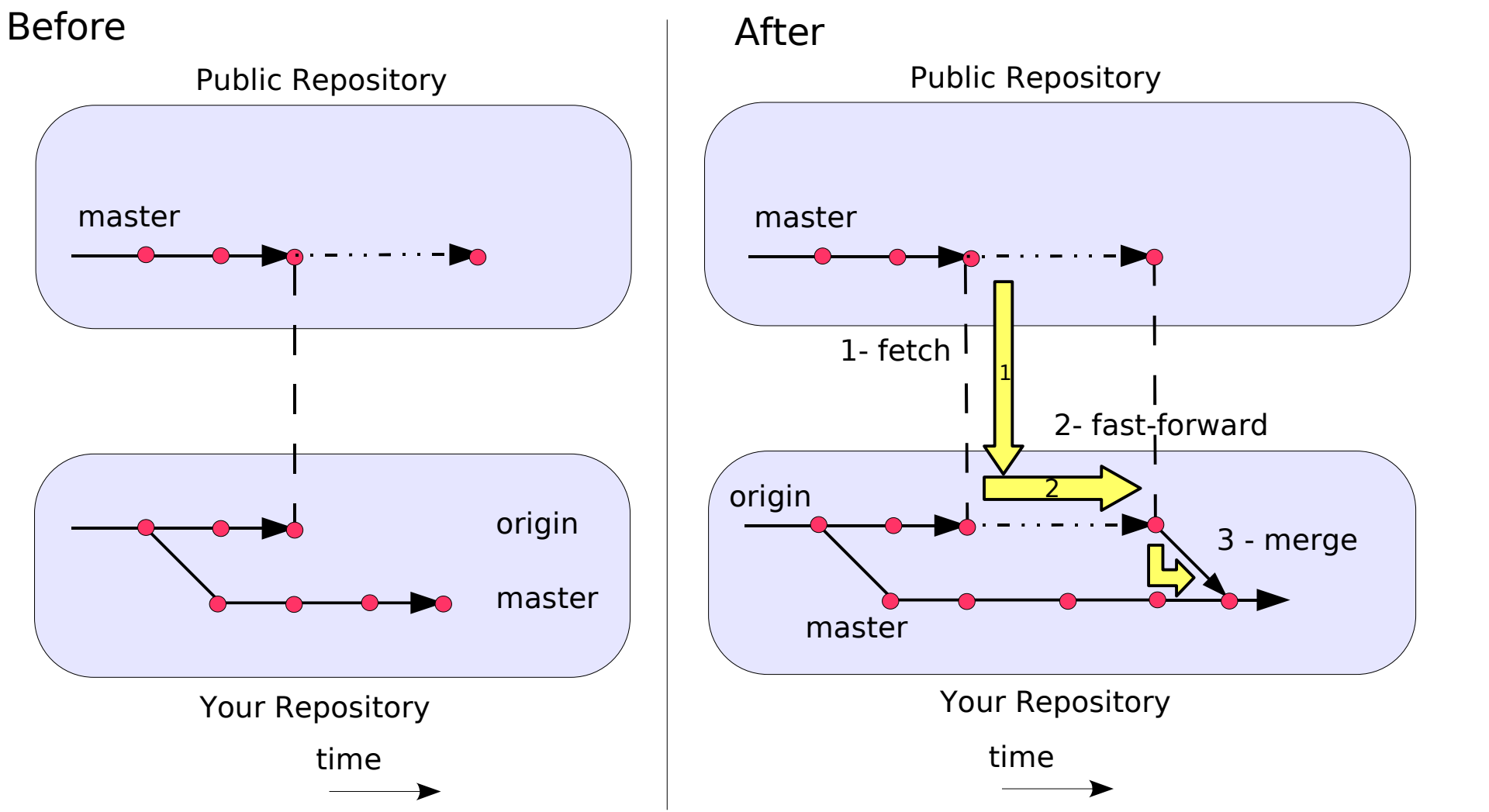
- Get updates from remote repository

```
$ git checkout master
$ git pull origin
```

- Pull is a fetch then merge
  - Places fetched updates in `ref/heads/origin`
  - Merges `origin` into the current, checked-out branch, `master`



Pull: Fetch and Merge Branch Timeline



Pull: What Else?

- Pull is a `fetch` followed by a `merge`
  - Merges should start with some common base, though
- Can fetch/pull any branch from any repository
  - Supply URL on command line directly
  - Maybe add new “remotes” file with URL and `Pull:` line
  - Even this repository: `git pull . <branch>`
- Could just `git fetch` an upstream branch too
  - Able to then `cherry-pick` commits rather than full merge
  - Able to use `git diff`, `git log`, etc.

Pull: When?

- When you want to!
- When it is convenient, stable, Wednesday...
- When the upstream tree is stable
- When your working directory is stable
  - ...and you have the right branch checked out
  - Your working directory should probably be clean
    - `git diff` or `git status` should be empty
  - Technically not necessary, but...

Sending Changes Upstream

- Generate and send patches via email
  - Most developers send patches to a maintainer or list
  - Highly visible public review of patches on mail list
- Maintainer pulls updates from a downstream developer
  - Maintainer can directly pull from your published repository
  - Initiated by upstream maintainer
- Developer pushes updates to an upstream maintainer
  - Some developers have write permissions on an upstream repository
  - Initiated by downstream developer

Patches: Generate a Patch

- Use `git format-patch` command

```
$ git format-patch --signoff origin..jdl

From: Jon Loeliger <jdl@jdl.com>
Date: Sat, 24 Jun 2006 15:42:51 -0500
Subject: [PATCH] Remove dead code.

Signed-off-by: Jon Loeliger <jdl@jdl.com>
---
 data.c |   18 ------------------
 1 files changed, 0 insertions(+), 18 deletions(-)

diff --git a/data.c b/data.c
index 911b271..d3b55f9 100644
--- a/data.c
+++ b/data.c
@@ -20,24 +20,6 @@
```

Patches: A Side Note

- Read the README
- Follow the coding standards
- Compile and test your code
- Fix the whitespace issues
- Know who the upstream maintainer is
- Understand any “sign-off” policy

Patches: Formatting and Sending Mail

- Send plain ASCII, not HTML
  - Send patches inline
  - Don't use attachments
- Send only your changes
- One line “commit summary” first
- Be careful of cut-n-paste solutions
  - Use file browse and insert if possible
- Maybe move pre-formatted patches to your MUA draft folder
- Send git-format-patch output directly

```
$ git send-email --to
  maintainer@example.com my.patch
```

Finding a Commit

- SHA-1 hash names are constant
- Symbolic commit names like `master~4` change over time!
  - They are relative to the current HEAD
- Ways to determine the name of a commit you want
  - `git show-branch` => `paul~38^2~10^2`
  - Paw around in `gitk` => `9ad494f62444ee37209e85173377c67612e66ef1`
  - Use `git log -- <some/file/path>`
  - Use `gitweb`
- Note:

```
$ git rev-parse paul~38^2~10^2
9ad494f62444ee37209e85173377c67612e66ef1
```

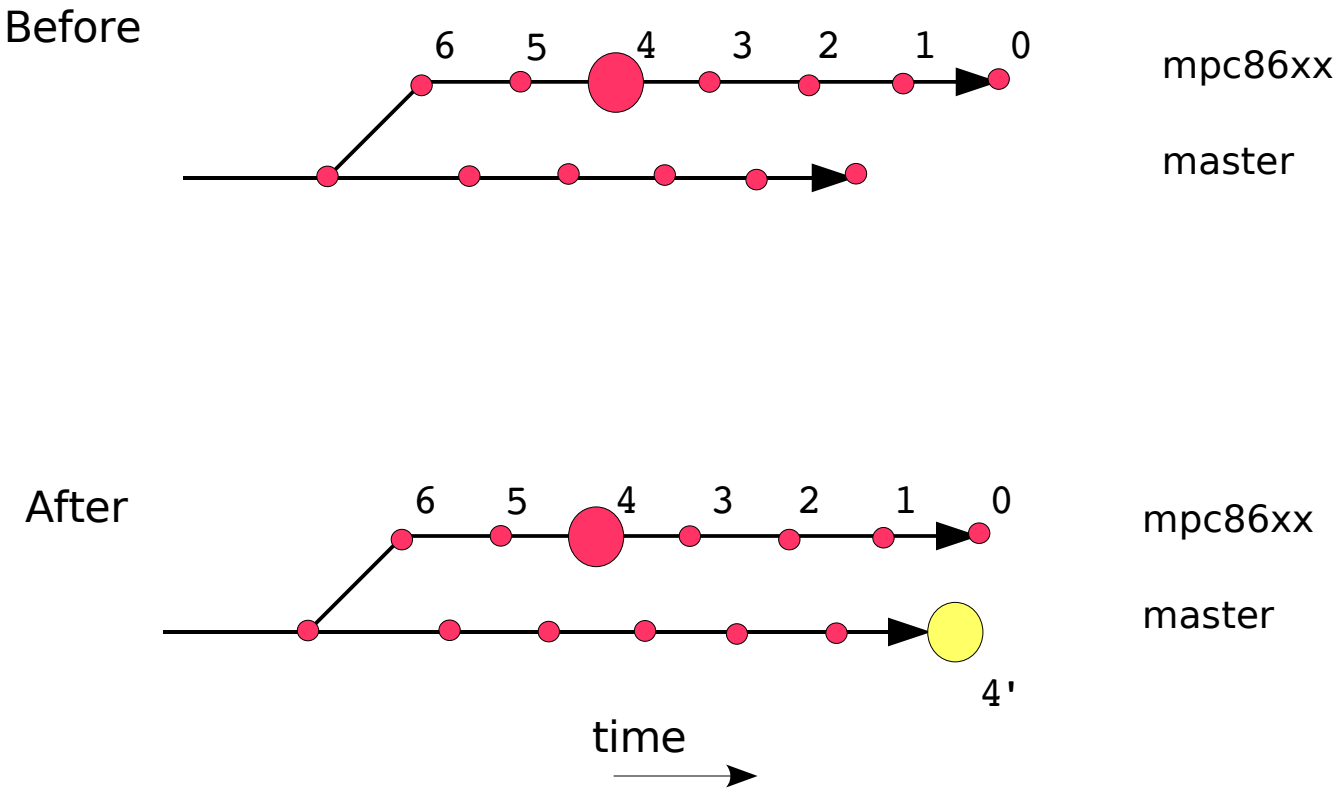
Cherry Picking Example

- You want one or more particular commits from some other branch applied to your current branch
  - Bug fix from some other branch
  - Transfer partial functionality from development branch
- Get that commit into your repository
  - Already present on a different branch
  - Perhaps using `git fetch` from another repository
- Cherry-pick it into appropriate branch

```
$ git checkout master
$ git cherry-pick 9ad494
```

Cherry Picking: Before and After

- Branch Timeline Picture
  - 4' is a different commit with the same content as 4



Revert Example

- Situation:
  - Some commit buried in the past needs to be undone
  - ... and it has already been `merged` to master too!

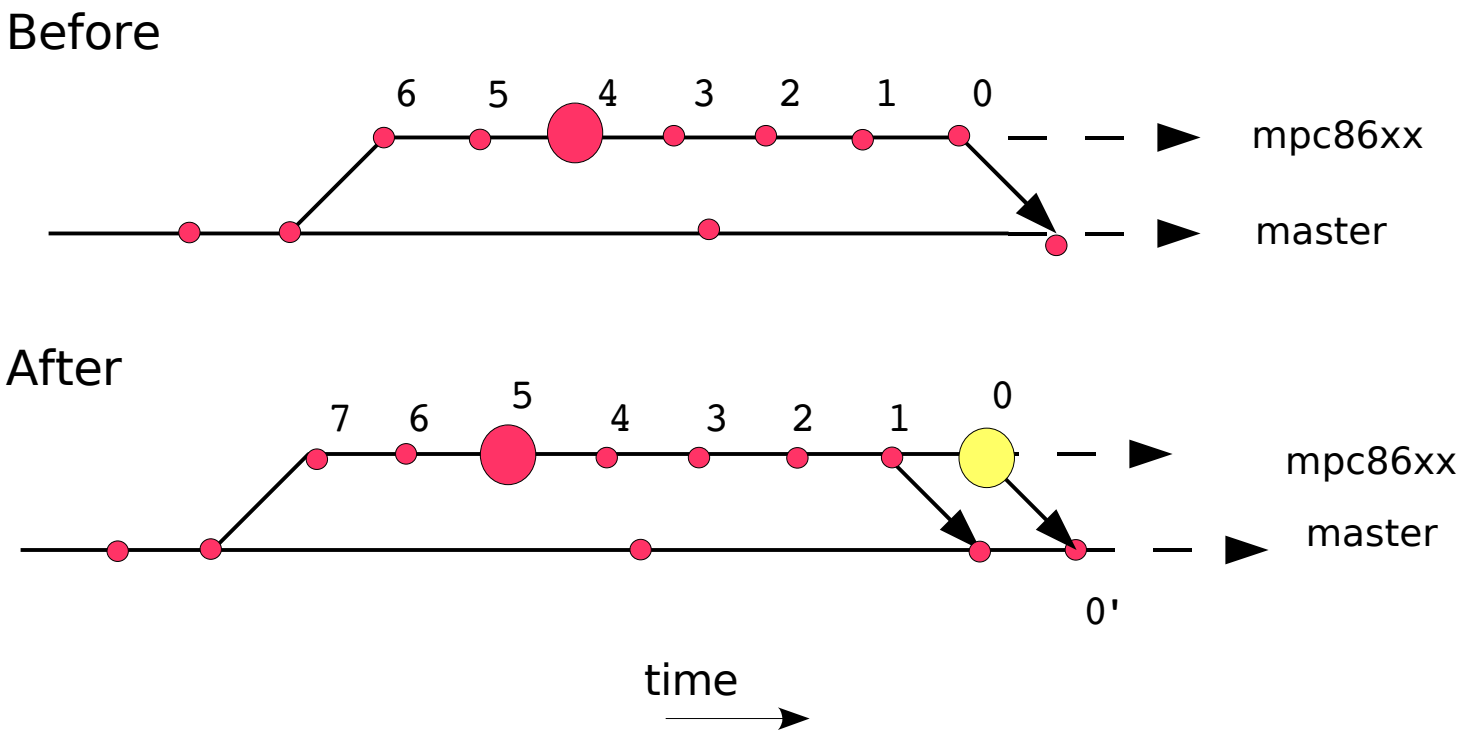
```
$ git show-branch --more=10 master mpc86xx

*  [master] Merge branch 'mpc86xx'
 ! [mpc86xx] Remove obsolete #include <someos/config.h>.
--
-   [master] Merge branch 'mpc86xx'
*+ [mpc86xx] Remove obsolete #include <someos/config.h>.
*+ [mpc86xx^] Remove redundant STD_MMU selection.
*+ [mpc86xx~2] Move I8259 selection under MPC8641HPCN board.
*+ [mpc86xx~3] Remove redundant PPC_86XX check.
*+ [mpc86xx~4] Reworked the IRQ mapping. Now reading IRQ and ... <====== ARGH!
*+ [mpc86xx~5] Make 86xx secondary CPU start be more generic.
*+ [mpc86xx~6] Updated 86xx defcnofig after merge with Paul
```

- This is a job for `git revert`

Revert: Before and After

- Commit 4 is reverted, creating commit 0 in yellow
- Commit 0 is merged to master as commit 0'



Revert: Commands

- Revert applies a new “inverse” patch for a given commit
- Revert works without rewriting the commit history
- Can revert multiple commits at the same time

- Revert commit on `mpc86xx` topic branch:

```
$ git checkout mpc86xx
$ git revert mpc86xx~4
```

- Reflect it onto `master` branch as well:

```
$ git checkout master
$ git pull . mpc86xx
```

Revert: Branch History After

```
$ git show-branch --more=10 master mpc86xx

*  [master] Merge branch 'mpc86xx'
 ! [mpc86xx] Revert "Reworked the IRQ mapping. Now reading IRQ and ..."
--
-   [master] Merge branch 'mpc86xx'
*+ [mpc86xx] Revert "Reworked the IRQ mapping. Now reading IRQ and ..."
*+ [mpc86xx^] Remove obsolete #include <someos/config.h>.
*+ [mpc86xx~2] Remove redundant STD_MMU selection.
*+ [mpc86xx~3] Move I8259 selection under MPC8641HPCN board.
*+ [mpc86xx~4] Remove redundant PPC_86XX check.
*+ [mpc86xx~5] Reworked the IRQ mapping. Now reading IRQ and ...
*+ [mpc86xx~6] Make 86xx secondary CPU start be more generic.
*+ [mpc86xx~7] Updated 86xx defcnofig after merge with Paul
```

Revert versus Reset versus Checkout

- Reset versus Revert: Trying to undo the last commit?
  - Ask: Does someone else have this version of the repository history?
  - → Yes: Use `git revert` and do not change history
  - → No : Could use `git reset` or `git commit --amend` perhaps

- Reset versus Checkout
  - Reset doesn't change your current branch
  - Checkout establishes your current branch
  - These can be similar unless naming a different branch:

```
git reset --hard topic   # still on original branch,
                         #   but it now looks like topic!
git checkout -f topic    # topic branch checked out now
```

Merge Resolution Hell ... er, Examples

- Pulling updates from upstream can go wrong for a number of reasons!
  - Conflicting file contents
  - New or modified files in your working tree
  - Different file modes
  - Possible for your upstream changes to come back differently
    - Altered upstream by maintainer?
    - Were they pulled or patched upstream?
    - Same file *content*, but different *commits*?
  - Merge is a heuristic!

Merge Resolution Strategies

- Before doing the pull or merge
  - Check out the correct “merge into” branch, likely `master`
  - Ensure a clean working directory first

```
git ls-files --others
git status
```

- After “failed” pull/merge request:

```
git ls-files -u   # Show unmerged files remaining
git diff          # Clean if it matches one of the variants!
```

- Make progress resolving conflicts:

```
git update-index  # Tell git when a conflict has been resolved
```

- Be done :
  - Fully resolved: `git commit`
  - Abandon merge: `git reset --hard ORIG_HEAD`

Failed Merge: Untracked Working Tree File

- Git says:

```
git-read-tree: fatal: Untracked working tree file
'Documentation/ABI/README' would be overwritten by merge.
```

- Huh? I don't have that file...
  - Maybe you *do* have that file and should check!
  - But maybe it is leftover from a previous merge effort?
  - Are you on the right branch?

```
git branch
git show-branch
```

Failed Merge: Untracked File Resolution

- Your key:

```
git ls-files --others   # Look for untracked files
git status              # Check for unexpected files
git clean -d            # Remove cruft
```

- Reset the working directory:
  - Maybe abandon this merge?
  - Look for other files
  - Clean out the old files
  - Do the merge again!

```
$ git reset --hard ORIG_HEAD
$ git ls-files --others
$ git clean -d
$ git status   # Ah! Nice-n-tidy
```

Failed Merge: CONFLICT Content

- Git message:

```
CONFLICT (content): Merge conflict in drivers/net/phy/Makefile
```

- Semi-traditional "<<<< ==== >>>>" style file content differences.

```
$ git diff drivers/net/phy/Makefile

@@@ -8,4 -8,5 +8,9 @@@
  obj-$(CONFIG_CICADA_PHY)      += cicada.o
  obj-$(CONFIG_LXT_PHY)         += lxt.o
  obj-$(CONFIG_QSEMI_PHY)       += qsemi.o
++<<<<<<< HEAD/drivers/net/phy/Makefile
 +obj-$(CONFIG_VITESSE_PHY)     += vitesse.o
++=======
+ obj-$(CONFIG_SMSC_PHY)        += smsc.o
+ obj-$(CONFIG_VITESSE_PHY)     += vitesse.o
++>>>>>>>
  501b7c77de3e90519e95fd99e923bf9a29cd120d/drivers/net/phy/Makefile
```

Failed Merge: Resolve Content Conflict

- Your key:

```
git diff
git ls-files -s arch/somearch/Kconfig    # Various stage versions
```

- Edit and fix
  - Use your favorite editor, emacs
- Make progress

```
git update-index arch/somearch/Kconfig
```

Failed Merge: CONFLICT add/add

- Git says either:

```
➔ Added file3 in both, but differently.  ERROR: Merge conflict in file3
➔ CONFLICT (add/add):
    File arch/somearch/platforms/86xx/mpc86xx_hpcn.c
    added non-identically in both branches.
        Adding as arch/somearch/platforms/86xx/mpc86xx_hpcn.c~HEAD
        and arch/somearch/platforms/86xx/mpc86xx_hpcn.c~501b7c instead.
```

- Two branches added the same file, but differently.
  - The version from my `master` HEAD is left with `~HEAD` suffix.
  - The version from incoming origin is left with `~501b7c` suffix.
- Resolution:
  - Pick the right one or merge them
  - Use `git add` to add it back with the right name (drop ~suffix)
  - Remove the other

Failed Merge: CONFLICT rename/add

- Git says:

```
CONFLICT (rename/add): Rename
arch/{mips/configs/ddb5476_defconfig =>
  somearch/configs/mpc8641_hpcn_defconfig} in 501b7c...
arch/somearch/configs/mpc8641_hpcn_defconfig added in HEAD
```

- Maybe it lies!
  - Rename detection isn't 100% precise. It is a heuristic!
    - `ddb5476_defconfig` just happens to be removed
    - `mpc8641_hpcn_defconfig` really added!

- Resolution:
  - Add it back! Holy cow!
  - Make sure index has correct, added file and either:

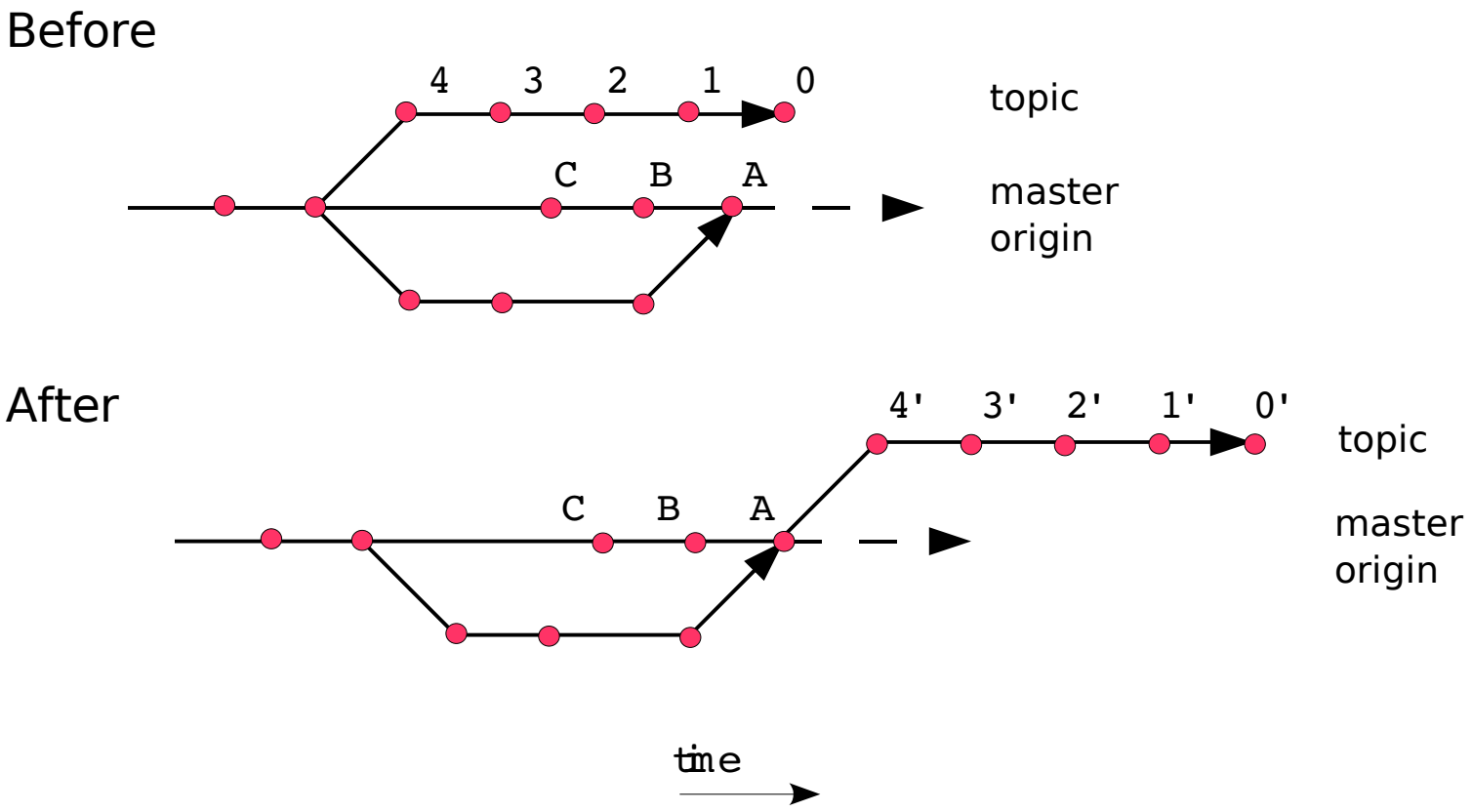
```
git update-index arch/somearch/configs/mpc8641_hpcn_defconfig
git add arch/somearch/configs/mpc8641_hpcn_defconfig
```

Rebase Local Changes Example

- Situation:
  - You have done development work on your topic branch
  - You pull in upstream `origin` and merge it to `master`
  - You don't want to merge `master` into your topic branch
  - You don't want to merge your topic into the `master` branch
  - No one else has cloned your topic branch!
    - Why? Don't rewrite history
  - But you want to send your topic branch patches upstream!
- This is a job for `git rebase`

Rebase: Before and After

- Rebase commits 0 – 4 of `topic` onto `master` branch at A as 0' – 4'



Rebase: Commands

- Rebase Commands

```
$ git checkout topic
$ git rebase master
```

- Creates a series of patches from `topic` to be applied to `master`
- May have to resolve conflicts at each step due to merge operation

```
git rebase --continue
git rebase --skip
git rebase --abort
```

Git Resources

- Sources and Documentation:
  - Git sources, documentation and many repositories: kernel.org/git
  - The Git Wiki: git.or.cz/gitwiki
- Front-ends and Viewers:
  - Cogito: kernel.org/pub/software/scm/cogito
  - Stacked Git: www.procode.org/stgit
  - Patchy Git: www.spearce.org/category/projects/scm/pg
  - QT Gui viewer: sourceforge.net/project/qgit
- Mail List: git @ vger.kernel.org
- IRC: freenode.net #git

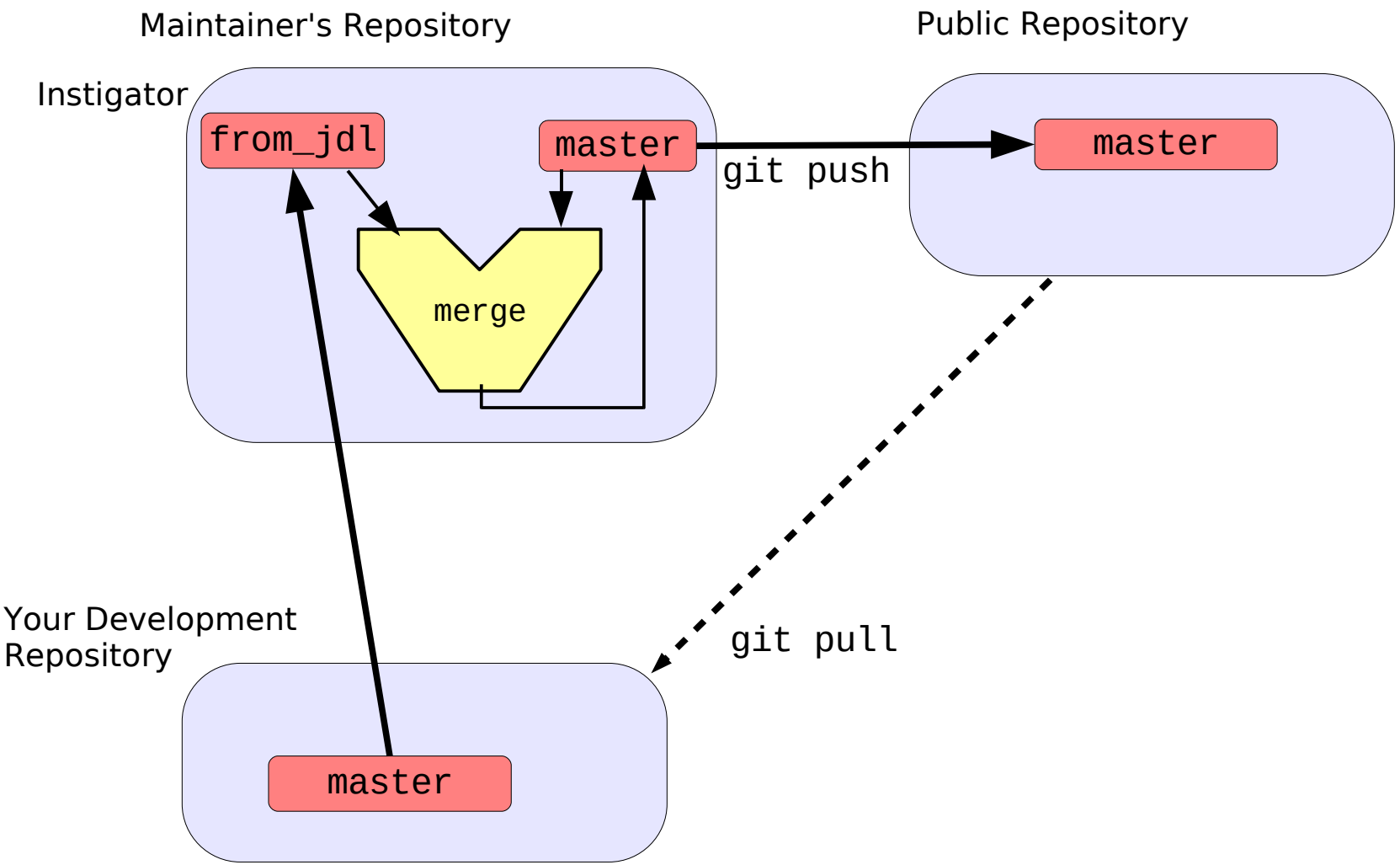
Outline: Supplemental

- Repository Management
- Local Use Cases
- Supplemental Slides
  - Sending Changes Upstream Using Pull and Push
  - Screen Capture of gitk

Send Changes Upstream Using git pull

- Upstream maintainer trusts you and your work
- You have the ability to publish a public repository
- You have a lot of changes, more than a few patches
- Advertise your repository and branch
- Wait for upstream maintainer to pull it
  - `$ git pull git://www.your-site.org/path/to/repo.git`
- Profit.

Using Pull: Data Flow Picture



Sending Changes Upstream Using git push

- Direct push into remote repository
  - Sends objects, packs, branches to remote repository
- Push to a repository from which you have fetched
  - Can only push to a branch that is a proper subset
  - Should result in a "fast-forward" on the remote end
  - Technically you can push elsewhere, but...
- Requires write access on the remote end
  - Likely via ssh

Using Push: Setup Remotes File

- Create a “remotes” file
  - State upstream repository URL
  - State branches to be pushed upstream
- Can push multiple branches, as needed
  - Just add a `Push:` refspec line for each branch
- Can push to different remote branch names

```
Push: master:incoming
```

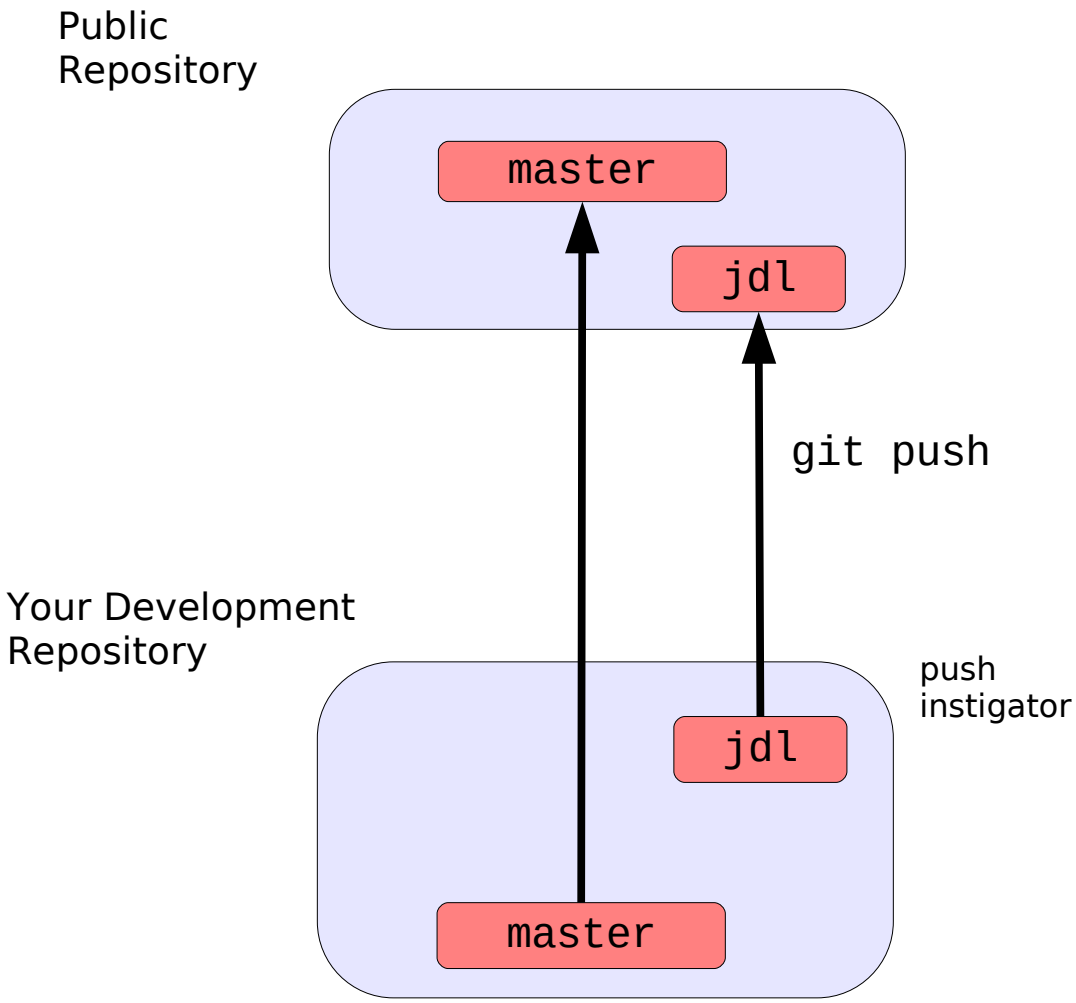
```
$ cat .git/remotes/publish
URL: ssh://www.jdl.com/software/dtc.git
Push: master:master
Push: jdl:jdl
```

Using Push: git push

```
$ git push publish

Password:
updating 'refs/heads/master'
  from 38e8f8fd88dae07ef8ada9d6baa41b06a4d9ac9f
  to   a73b7d43d4f60e76d82018fb9a4d137b089a1325
Generating pack...
Done counting 11 objects.
Result has 8 objects.
Deltifying 8 objects.
 100% (8/8) done
Total 8, written 8 (delta 5), reused 0 (delta 0)
Unpacking 8 objects
refs/heads/master: 38e8f8 -> a73b7d
```

Using Push: Data Flow Picture



gitk Example