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# git and its History

# Once upon a time there was diff

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## **The Unix world (GNU, Linux) was heavily based on text files**

- Text is always readable (it's friendly to men)
- Text is accessible for impaired people (it's friendly to all men)
- A simple editor can change any text file (it's friendly to machines)
- ASCII text is portable (it's friendly to all machines)

## **History, at last, is validating our views:**

- All successful network protocols are text protocols
- HTML is a text format
- XML (depicted as the solution to all sins) is text
- ODF is text (though embodied in a zip file)

**With every task, with every data, people need to know  
what changes they accumulated while working**

## **One of the first Unix programs was "diff"**

- Diff assumes that text files are line-oriented
- The program reports to stdout the differences between two files
- Differences are shown as a textual printout

# Diff generated patch

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**Baby diff could return commands for "ed", the editor:**

- `diff -e <oldfile> <newfile>`

**In his youth, he learnt to show context around differences  
to be more pleasant for men:**

- `diff -c <oldfile> <newfile>`

**Once grown up, he learnt to be terse**

**to be more pleasant for machines and networks:**

- `diff -u <oldfile> <newfile>`

**The "patch" command, initially written by Larry Wall, uses  
diff's output to change <oldfile> into <newfile>**

- It's used to "patch" a wrong file into a correct one
- Patch files are just diff's output saved to file

# And SCCS came. He made RCS, CVS, SVN

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## **SCCS and his children keep track of versions and revisions**

- They save all the revisions, by storing diffs
- The new ideas of "checkout" and "commit" appear
- Programmers can use symbolic names («tags»)
- The tools automatically generate version numbers (e.g.: 1.432)
- Every commit is augmented by a log message

## **CVS, quite widespread, is mainly just RCS over the network**

- Its own files live in a centralized repository
- Several users can concurrently access the repository to read or write
- The network protocol is simple
- Conflicts are handled, though with some limitation

## **What's wrong with CVS:**

- Revisions are only maintained within each individual file
- If you rename a file you lose its history
- If you split or merge files, you lose their history
- Committing several files is not an atomic operation

# Hash, CRC, MD5, SHA1, rsync, PowerPC

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## **The idea of hashing predates diff and patch**

- Theoretically, a hash is an injective, non-invertible, math function
- In practice, it's something that represents a file with a number
- It's a basic concept people study (and forget) in the first CS course

## **CRC32: polynomial algorithm run on a bit sequence**

- The CRC in the "cksum" command is a Posix standard

## **MD5: message digest, by Dan Rivest**

- Hash algorithm returning 128 bits, decently secure

## **SHA1: secure hash algorithm (one)**

- Hash algorithm returning 160 bits, more secure

## **rsync is a remarkable application of the hash idea**

- It allows synchronization of files or file trees
- It only exchanges the differences, limiting network traffic

## **Even PowerPC virtual memory is based on a hash table**

- Page tables are just one level (on x86 it was 2 levels, now 3)
- Memory size, and thus conflict rate, is configurable

# Then Torvalds came, and Stallman got upset

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## **Linus used to refuse SCM tools, for three reasons:**

- CVS is crap
- CVS is real crap
- SVN ("cvs made the right way") can't be but sweeter crap

## **Larry McVoy, a previous kernel/scm hacker in Sun, offers help**

- He would write BitKeeper according to Linus' needs
- He would allow free software to use BitKeeper
- He would sell Bk with proprietary license terms

## **One year or so later Bk is ready, and the kernel starts using it**

- Centralized repository on bkbites.net
- Restrictive license, repeatedly modified over time
- RMS and many of his area shout out in disgust
- Some core hackers refuse to use Bk
- Linus is overall satisfied

## **But, as renown, power (of license) makes men greedy**

- An "arch" developer was immediately revoked his Bk license
- Over time the license turned more and more restrictive, until...

# Linus made git in his own resemblance

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## **Git is a distributed version control system**

- There is no centralized repository
- Each programmer gets hold of the whole history, locally
- If everyone pulls from Torvalds, it's just because he has the best bits

## **Git manages the whole project as a unit**

- It doesn't keep separate history for each file
- It supports renaming, copying, merging, splitting

## **Each version is blessed with its own SHA1 hash**

- There are no more sequential numbers that are hard to remember

## **Git has its own tools to share information over the network**

- It has its own client/server network protocol to exchange data
- It can leverage on email as primary exchange channel

# A different approach to file history

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## Git handles 4 different types of objects

- Files (called «blobs»)
- Directories (called «trees»)
- Commits («commits»)
- Tags («tags»)

## All objects are immutable

- Each object is identified by its own hash
- Git stores objects in a directory «objects», according to their hashes
- An object may include hashes that link other objects

## The status and complete history of a file-set is identified by the final commit in such history

- Every commit is represented by its SHA1 hash
- If two users own the same commit they automatically own the same files
  - ♦ To authenticate a file-set and history you just sign the hash



# Branch management, merging, conflicts

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## **A "branch" is one of several histories of the project**

- Each programmer works on her own branch
- In a single directory a programmer usually hosts many branches
- No branch makes any reference to other branches

## **Branches are only compared when needed**

- Every branch is independent, but when merging

## **There is no such thing as a main branch, like in SVN**

- Actually, the concept of trunk is not applicable at all

## **Git only merges local branches or external patches**

- Everything must be already committed
- No conflict can ever lead to information loss

## **We have tools to move branches or change past history**

- `git rebase`
- `git rebase -i`
- `git commit --amend`

# They reconciled and lived happily ever after

## **Git is released as free software**

- GNU GPL License

## **Most software projects are now relying on git for their own development:**

- Xorg
- LibreOffice
- busybox
- perl
- qt, gnome
- fedora
- ffmpeg
- buildroot
- ...

## **And most "centralized" sites are not actually centralized.**

- I rarely login into github, gitlab, bitbucket, ...

# Notes about git "advanced" use (1/2)

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## Some useful features of git that are rarely used

- **"git describe [--dirty]" to know where you are**
- **"git remote" to have local references to other repositories**
  - ◆ You can fetch all branches from a remote to a safe place
  - ◆ You can manually specify how to fetch and push to a remote
- **"git cherry-pick" to take an individual commit from a local branch**
  - ◆ This is especially useful if you commit by file
  - ◆ Note that upstream wants commits by feature
- **"git show <commit>:pathname"**
- **"git show <hash>"**
  - ◆ You can recover any file from any commit or any diff
- **"git diff <commit> <pathname>"**
  - ◆ You can diff an individual file
- **"git diff <hash> <hash>"**
  - ◆ You can diff releases or files

# Notes about git "advanced" use (2/2)

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## Other advanced commands that are very useful at times

- **git blame**
  - ♦ Show the guilty guy for each line of code
- **git bisect**
  - ♦ Find the faulty commit for a regression
- **git merge-base <rev> <rev>**
  - ♦ Find the last common commit of two branches
- **git filter-branch**
  - ♦ Rewrite stuff keeping history
- **git rebase -i**
  - ♦ Change history at will
- **git add -p**
  - ♦ Select individual patches to be committed
- **git commit --amend**
  - ♦ Modify an existing commit
- **git commit -C <rev>**
  - ♦ Reuse a commit message

# Useful Utilities

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- **git archive**
  - ♦ **Make a tar/zip file**
- **git grep**
  - ♦ **Faster alternative to grep -r**
- **git log**
  - ♦ **All kinds of logging information**
- **git revert**
  - ♦ **Revert a commit (then you may "rebase -i")**
- **git stash**
  - ♦ **Park/unpark local modifications**
- **git describe**
  - ♦ **Print a human-readable name for the current status**
- **git fetch**
  - ♦ **I prefer "fetch" and "rebase" over "pull": it's safer**
- **git format-patch**
- **git am**
  - ♦ **Generate patch files (email msgs) and apply them**
- **git submodule**
  - ♦ **Import another project as a checkout in a subdir**