

Inf2: SEPP

Lecture 15: Construction II:  
version control and system building

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# Last lectures

- ▶ Construction: high quality code

# This lecture

## Construction: version control and system building

- ▶ The problem of systems changing
- ▶ Software Configuration Management
- ▶ Version control
  - ▶ How file updates can be lost
  - ▶ Lock-Modify-Unlock model (RCS)
  - ▶ Copy-Modify-Merge model (CVS and SVN) and its three-way merge
  - ▶ Distributed version control (Git, Mercurial, Bazaar)
  - ▶ More on branches
- ▶ Build tools: Make, Ant, Maven, Gradle

# The problem of systems changing

- ▶ Systems are constantly changing through development and use
  - ▶ Requirements change and systems evolve to match
  - ▶ bugs found and fixed
  - ▶ new hardware and software environments are targeted
- ▶ Multiple versions might have to be maintained at each point in time
- ▶ Easy to lose track of which changes realised in which version
- ▶ Help is needed in managing versions and the processes that produce them.

# Software Configuration Management to the rescue

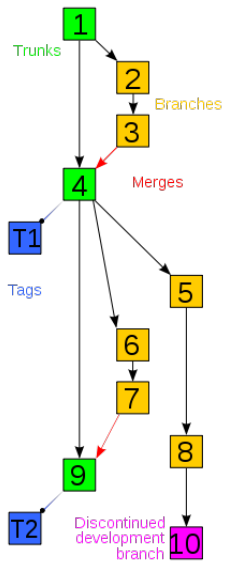
CM is all about providing such help.

Common CM activities:

- ▶ **Version control**
  - ▶ tracking multiple versions,
  - ▶ ensuring changes by multiple developers don't interfere
- ▶ **System building**
  - ▶ assembling program components, data and libraries,
  - ▶ compiling and linking to create executables
  - ▶ can also be used to automatically package binary code, run tests
- ▶ **Change management**
  - ▶ tracking change requests,
  - ▶ estimating change difficulty and priority
  - ▶ scheduling changes
- ▶ **Release management**
  - ▶ preparing software for external release
  - ▶ tracking released versions

Focus on first two today

# Version control



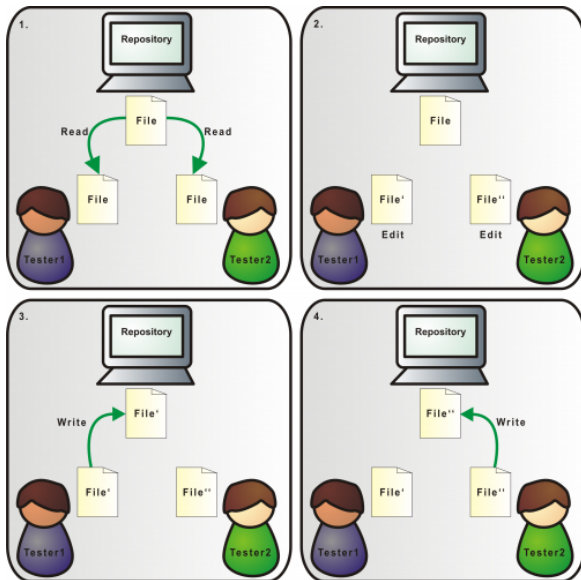
# Version control

The core of configuration management.

The idea:

- ▶ keep copies of every version (every edit?) of files
- ▶ provide change logs
- ▶ somehow manage situation where several people want to edit the same file
- ▶ provide *diffs/deltas* between versions

# How file updates can be lost

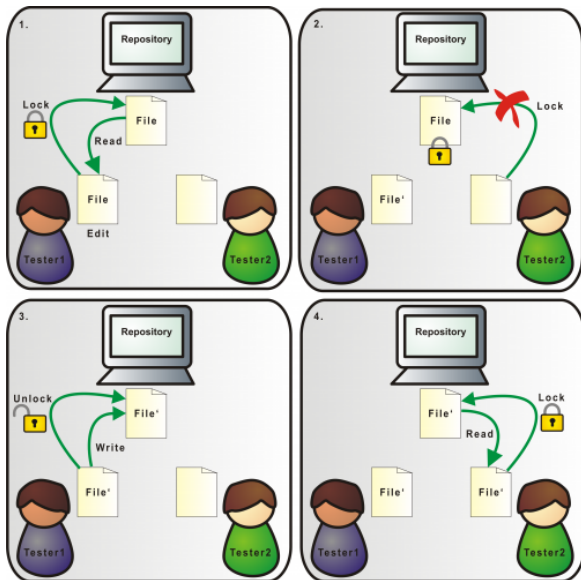




# Lock-Modify-Unlock Model

- ▶ Editor *checks-out* a file from a *repository*
  - ▶ Editor locks file
  - ▶ Others can check-out, but only for reading
- ▶ Editor makes changes
- ▶ Editor *checks-in* modified file to repository
  - ▶ Lock is released
  - ▶ Changes now viewable by others
  - ▶ Others now can make their own changes

# Lock-Modify-Unlock Example



# RCS

- ▶ Old, primitive VC system, much used on Unix.
- ▶ Uses Lock-Modify-Unlock model
- ▶ Keeps deltas between versions; can restore, compare, etc.
- ▶ Can manage multiple *branches* of development.
- ▶ Works on single files, not collection of files or directory hierarchies.
- ▶ Best suited for small projects, where only one person edits at a time.

## CVS and SVN

CVS is a much richer system, (originally) based on RCS.

Subversion (SVN) is very similar, but newer.

Both handle entire directory hierarchies or projects – keep a single master *repository* for project.

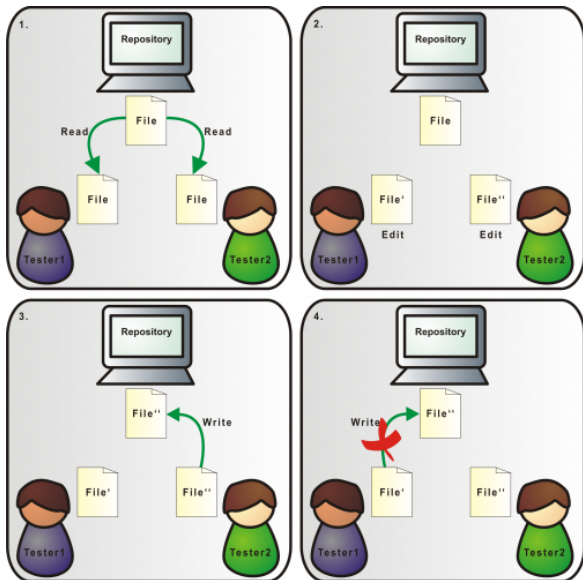
Designed for use by multiple developers working simultaneously –  
**Copy-Modify-Merge** model replaces **Lock-Modify-Unlock**.

Pattern of use for Copy-Modify-Merge:

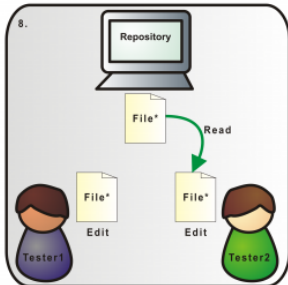
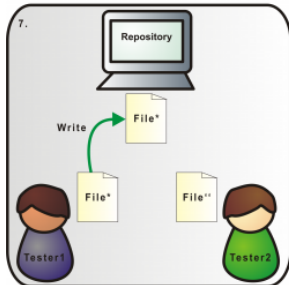
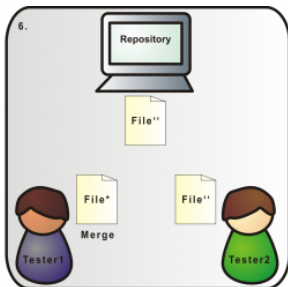
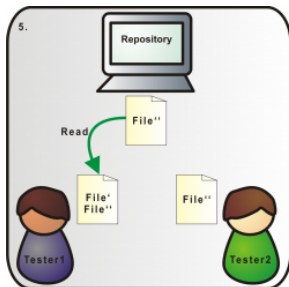
- ▶ *check out* entire project (or subdirectory) (not individual files).
- ▶ Edit files.
- ▶ Do *update* to get latest versions of everything from repository
  - ▶ system merges non-overlapping changes
  - ▶ user has to resolve overlapping changes - conflicts
- ▶ *check-in* version with merges and resolved conflicts

Central repository may be on local filesystem, or remote.

# Copy-Modify-Merge



# Copy-Modify-Merge



## Three-way Merge

1) Original file: Alpha                (*common ancestor*)  
                                Bravo  
                                Charlie

2) Tester 1 edits: Alpha  
Foxtrot  
Charlie

3) Tester 2 edits: Delta  
Alpha  
Echo  
Charlie

4) Tester 2 commits changes. 5) Tester 1 commit fails.

6) Tester 1 updates and merge reports conflicts:

```
Delta
Alpha
<<<<<< .mine
Foxtrot
=====
Echo
>>>>>> .r4
Charlie
```

7) Tester 1 fixes conflicts.    8) Tester 1 commits.

# Distributed version control

E.g. Git, Mercurial, Bazaar.

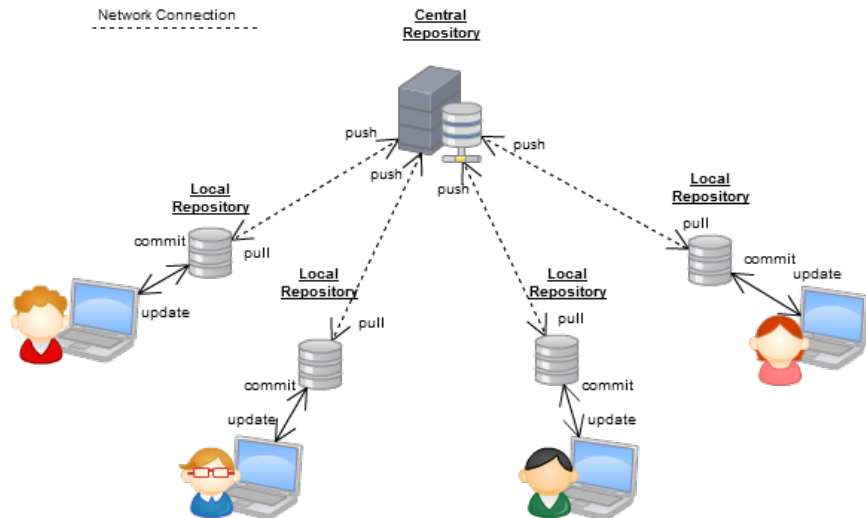
All the version control tools we've talked about so far use a single central repository: so, e.g., you cannot check changes in unless you can connect to its host, and have permission to check in.

Distributed version control systems (**dVCS**) allow many repositories of the same software to be managed, merged, etc.

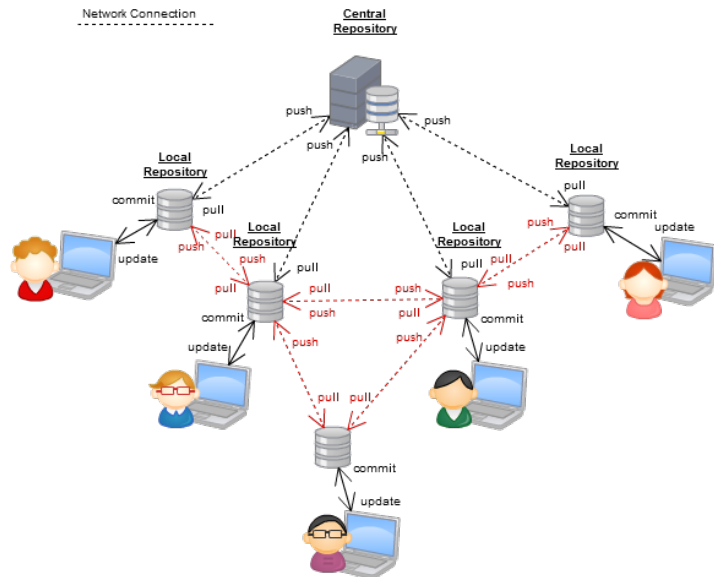
- ▶ reduces dependence on single physical node
- ▶ allows people to work (including check in, with log comments etc.) while disconnected
- ▶ much faster VC operations
- ▶ But... much more complicated and harder to understand



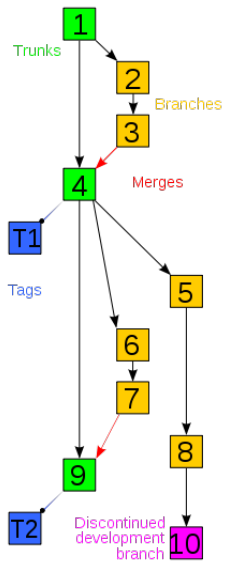
# Distributed VCS



# Distributed VCS



# Branches



# Branches

Simplest use of a VCS gives you a single linear sequence of versions of the software.

Sometimes it's essential to have, and modify, two versions of the same item and hence of the software: e.g., both

- ▶ the version customers are using, which needs bugfixes, and
- ▶ a new version which is under development

As the name suggests, branching supports this: you end up with a tree of versions.

What about [merging](#) branches, e.g., to roll bugfixes in with new development?

- ▶ In general need a 3-way merge between ends of two branches and a common ancestor
- ▶ Merge support good in Git and Mercurial
  - ▶ Developers with these VCSs use branches a lot more.
- ▶ Merge support has improved with recent SVN versions

## Build tools

Given a large program in many different files, classes, etc., how do you ensure that you automatically recreate the executable when a piece of code changes?

On Unix (and many other systems) the `make` command handles this, driven by a *Makefile*. Used for C, C++ and other 'traditional' languages (but not language dependent).

## part of a Makefile for a C program

```
OBJ = ppmtomd.o mddata.o photocolcor.o vphotocolcor.o dyesubcolcor.o
ppmtomd: $(OBJ)
    $(CC) -o ppmtomd $(OBJ) $(LDLIBS) -lpnm -lppm -lpqm -lpbm -lm

ppmtomd.o: ppmtomd.c mddata.h
    $(CC) $(CDEBUGFLAGS) -W -c ppmtomd.c

mddata.o: mddata.c mddata.h
```

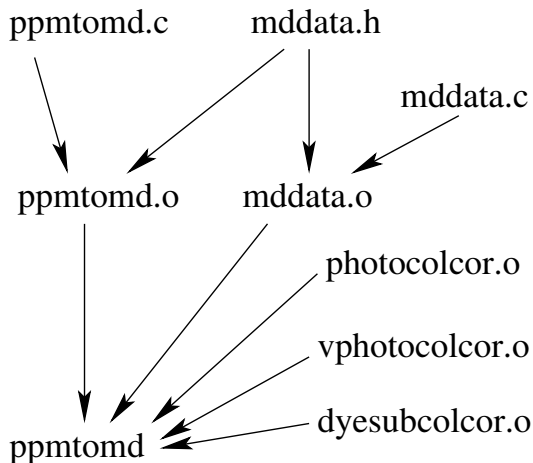
Makefile rule structure:      *target: dependencies*  
                                 *command1*  
                                 *command2*  
                                 ...

Running make *target* uses *commands* to

- ▶ create *target* from *dependencies* if it does not exist
- ▶ rebuild *target* when any of *dependencies* are newer.

Before creating / rebuilding *target*, make recursively considers whether any *dependencies* need creating or rebuilding.

## Make example



# Ant

`make` can be used for Java.

However, there is a pure Java build tool called [Ant](#).

Ant *Buildfiles* (typically `build.xml`) are XML files, specifying the same kind of information as `make`.



## part of an Ant buildfile for a Java program

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<project name="Dizzy" default="run" basedir=".">
<description>
    This is an Ant build script for the Dizzy chemical simulator. [...]
</description>
<!-- Main directories -->
<property name="source"          location="${basedir}/src"/> [...]
<!--General classpath for compilation and execution-->
<path id="base.classpath">
    <pathelement location="${lib}/SBWCore.jar"/> [...]
</path> [...]
<target name="run" description="runs Dizzy"
        depends="compile, jar">
    <java classname="org.systemsbiology.chem.app.MainApp" fork="true">
        <classpath refid="run.classpath" />
        <arg value="." />
    </java>
</target> [...]
</project>
```

# Maven

For making the building of Java projects simpler and more uniform.

Defines default support for

- ▶ compiling
- ▶ testing (using unit tests)
- ▶ packaging (e.g. as jar file)
- ▶ integration testing
- ▶ installing (e.g. into local repository)
- ▶ deploying (e.g. into release environment for sharing with other project)
- ▶ generating documentation

Buildfiles are also XML files.

# Gradle

The official build tool for Android, also used by LinkedIn, NETFLIX, Adobe and many others

Based on *Groovy*, a scripting language built on top of the Java JVM and similar to Java, and so:

- ▶ Easier to understand than XML-based build tools
- ▶ Concise and less verbose

Buildfiles can also be written using Kotlin (another JVM language)

Highly configurable, can handle obscure requirements in the build

Very performant, more so than Maven because of:

- ▶ Incremental builds: only running what is necessary
- ▶ Its build cache
- ▶ The Gradle Daemon keeping build information in memory

Provides interactive web-based UI for debugging, optimizing builds

# Reading

On version control:

**Essential:** Ch 1- Version Control Basics section of the SVN book  
(search for 'Version Control Basics' in table of contents)  
available [here](#)

**Essential** This Git & GitHub tutorial

**Essential** This tutorial written by a former SEPP student

# Reading

On build tools:

**Essential:** This introduction to build tools

**Recommended:** This Gradle tutorial

**Recommended:** This Gradle Building Java Applications Sample

**Recommended:** This Maven Tutorial

See other optional resources under 'Resources on other tools'