Lecture 15: [Construction II] Version Control and System Building

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School of Informatics, University of Edinburgh

This Lecture: Topics Covered

Construction: version control and system building

- The problem of systems changing
- Software Configuration Management
- Version control overview
  - How file updates can be lost
  - Lock-Modify-Unlock model (RCS)
  - Copy-Modify-Merge model (CVS and SVN) and 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
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- Multiple versions might have to be maintained at each point in time
- Easy to lose track of which changes were realised in which version
- Help is needed in managing versions and the processes that produce them

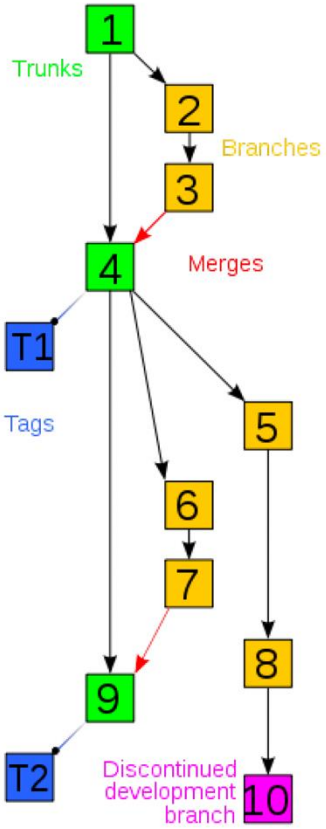
Software Configuration Management

CM provides help managing the evolution of complex systems. Provides activities such as:

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

Focus today: version control and system building

Version Control



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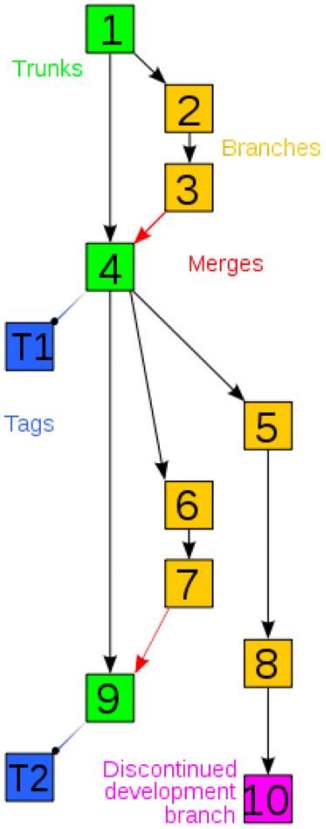


Important terminology:

- **Check in or commit:** push your changes to the central repo
- **Check out:** pull the changes from the central repo to your local repo

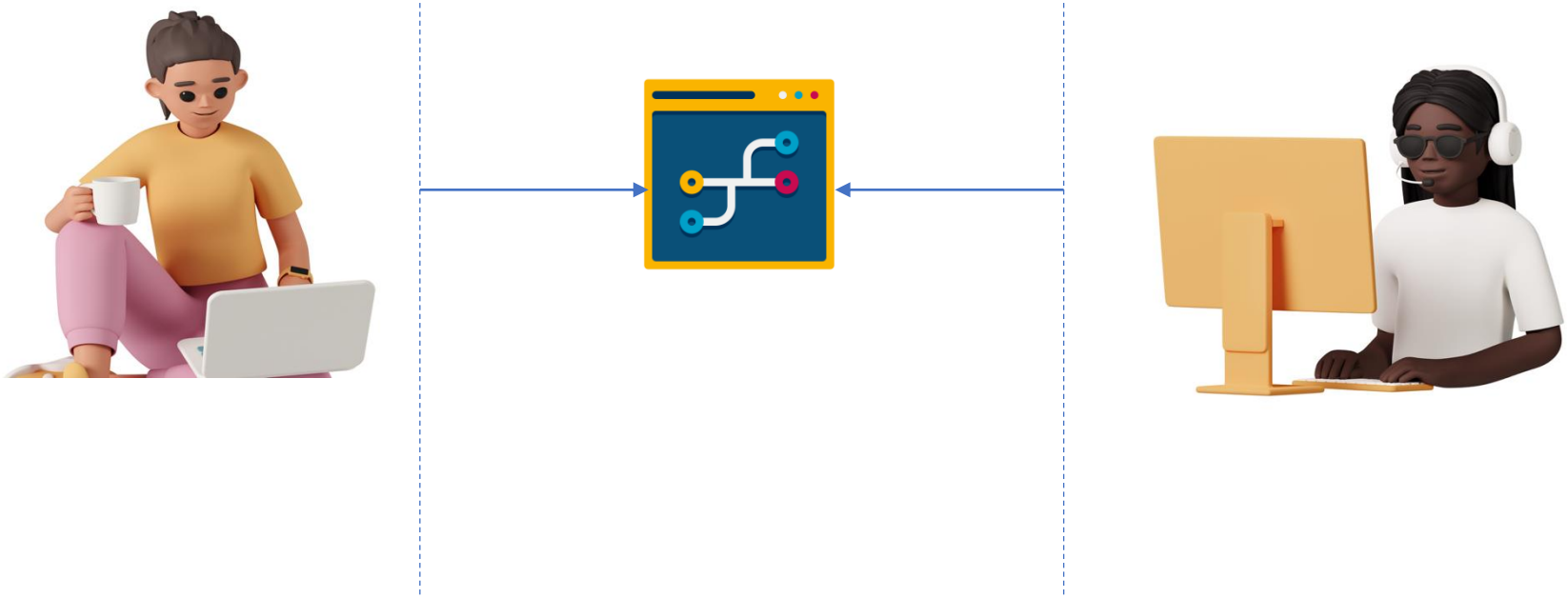
Version Control

The core of configuration management

- Keep copies of every version (every edit?) of files
- Provide change logs
- Manage the situation where several people want to edit the same file
- Provide diffs/deltas between versions

How do you manage your code?

When you work with others…



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File will be overwritten

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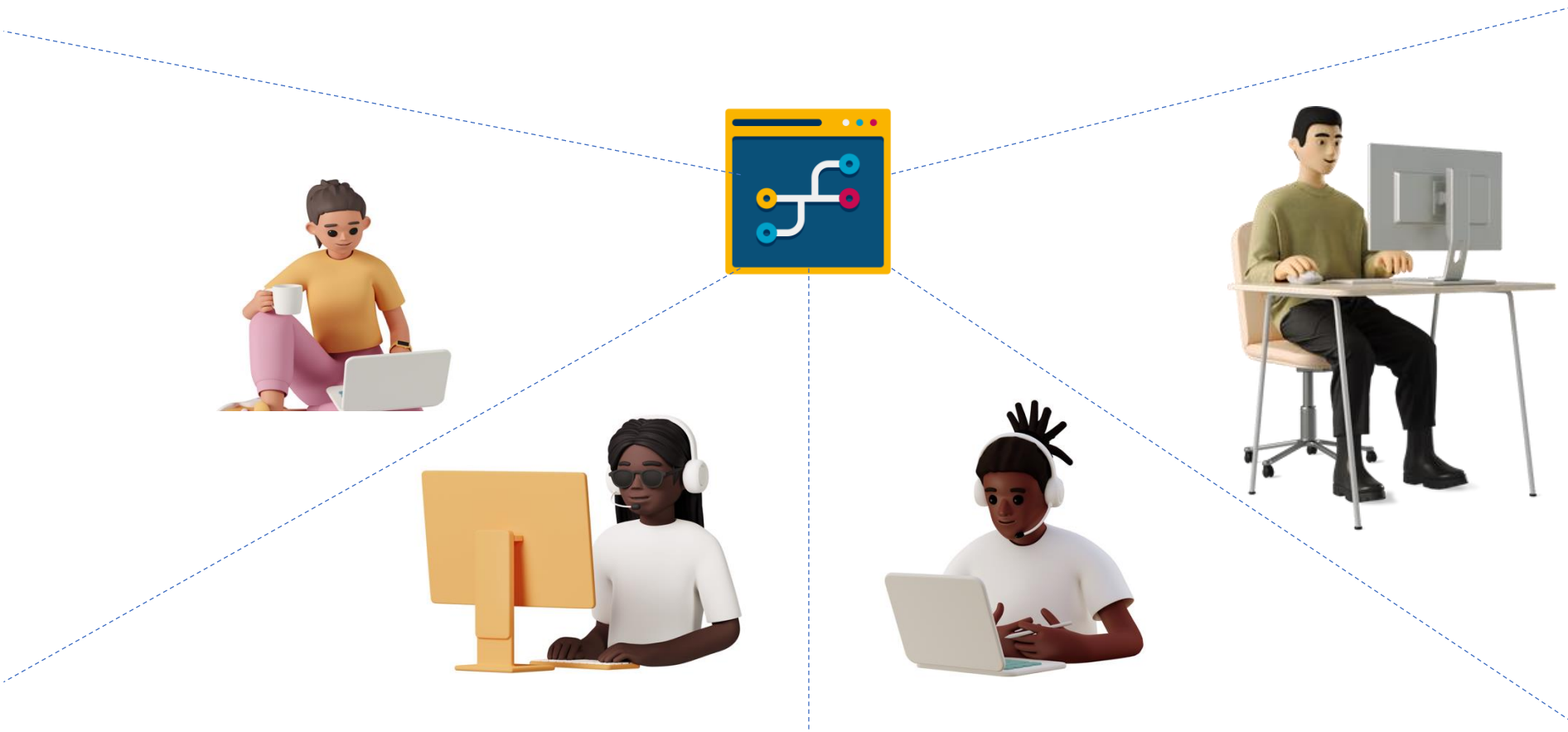
How is code managed in big companies?



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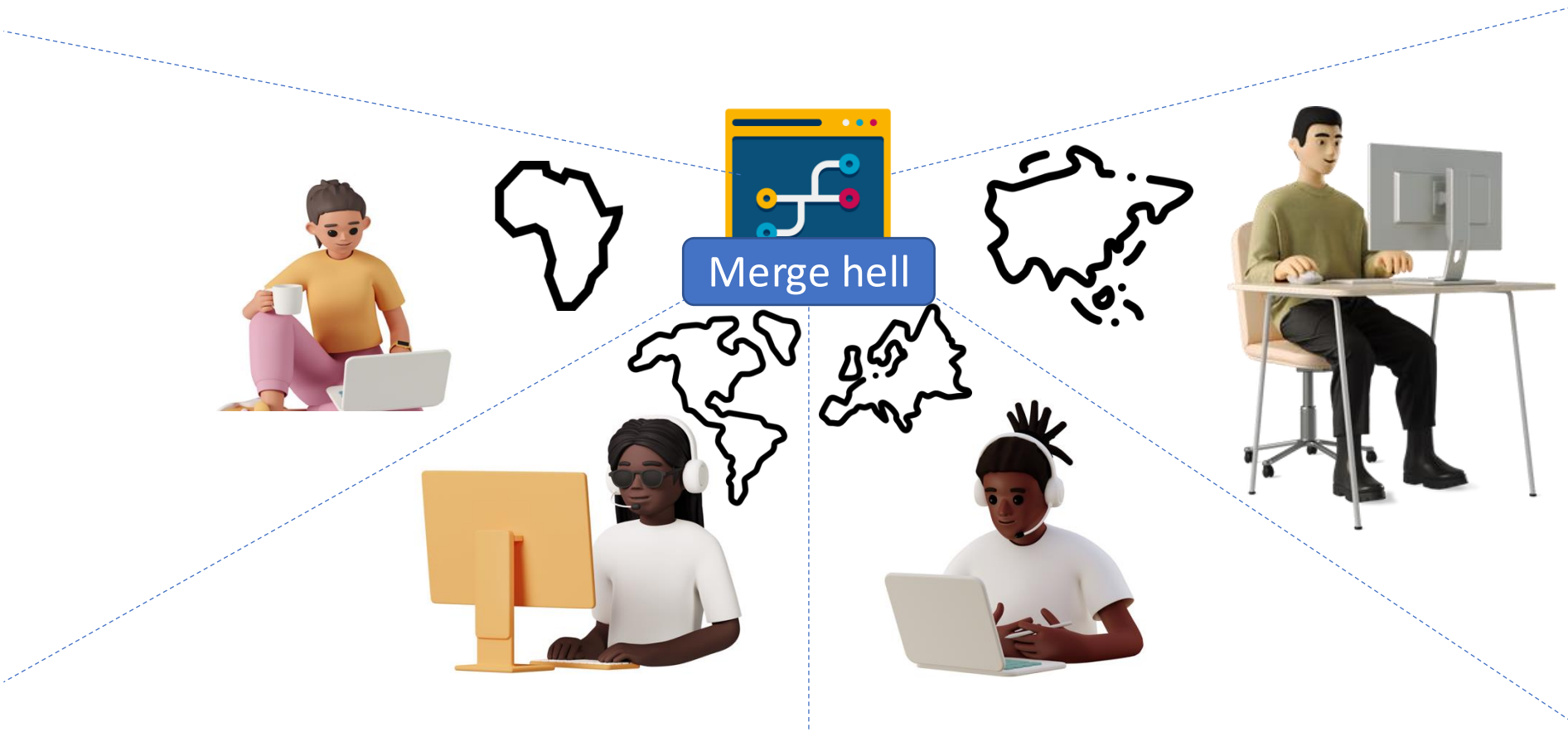

How File Updates Can Be Lost

- Two developers both read the same file from the repository
- Each makes their own edits independently (File' and File'')
- Developer 1 writes their version back first
- Developer 2 writes their version back next — overwriting Developer 1's changes
- Result: Developer 1's changes are silently lost
- Version control systems are designed to prevent this problem

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  - Changes are now viewable by others, who can now make their own changes

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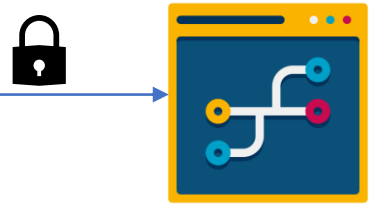

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- Used by RCS: old Unix system, works on single files, best for small projects with one editor at a time
  - Keeps deltas, can restore, compare etc

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- Pattern of use:
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  - User resolves overlapping changes — conflicts
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- Central repository may be on local filesystem or remote

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4. Tester 2 commits
5. Tester 1 commit fails
6. Tester 1 updates and merges conflicts:
   Delta,
   Alpha,
   <<<<< .mine
   Foxtrot,
   ======
   Echo,
   >>>>>> .r4
   Charlie

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- Each developer has a full local repository; pushes and pulls to/from central or peer repos

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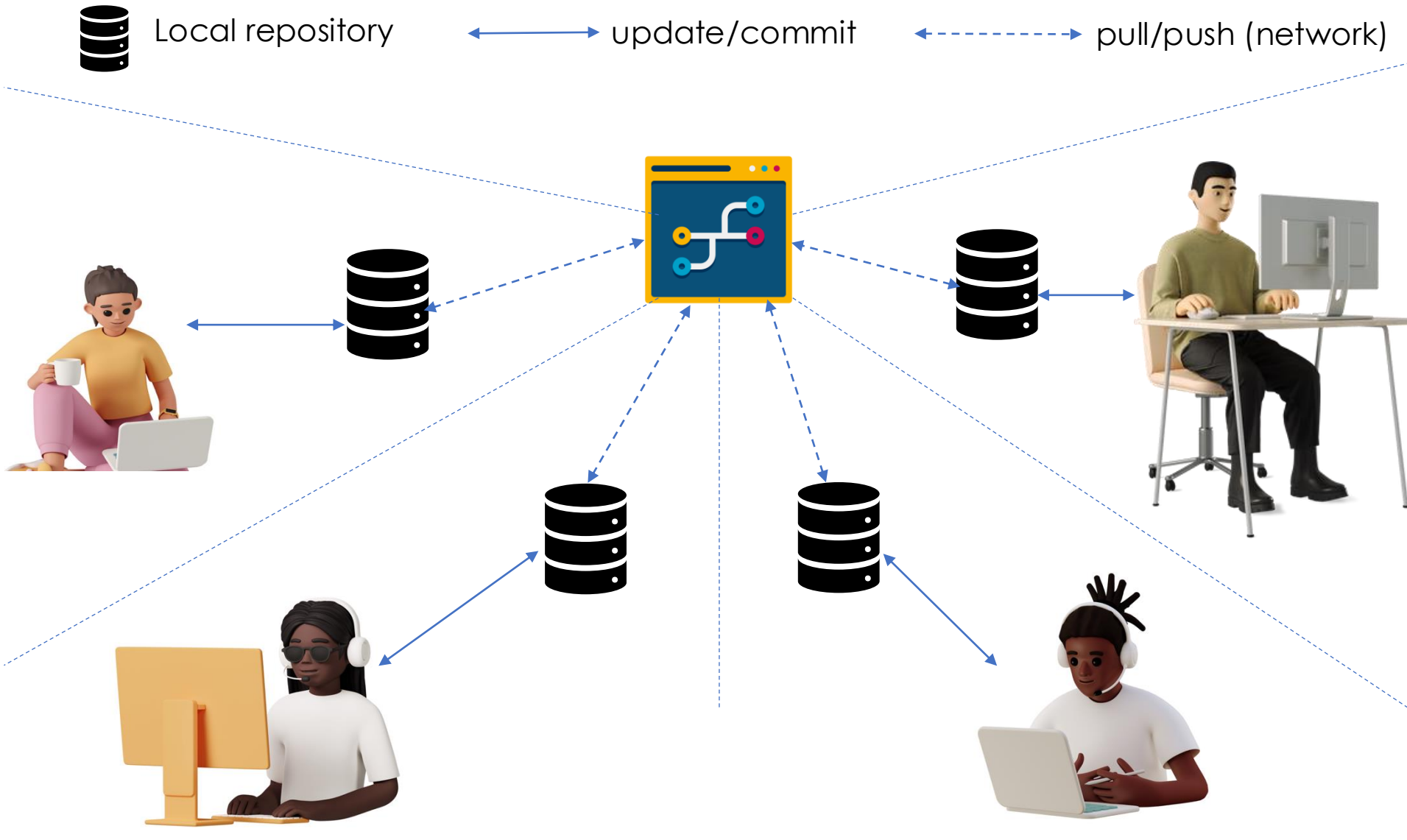

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- Git and Mercurial have strong merge support — developers use branches heavily
- SVN merge support has improved in recent versions

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- On Unix the make command handles this, driven by a Makefile
- Used for C, C++ and other traditional languages — not language-dependent

Build Tools: Make

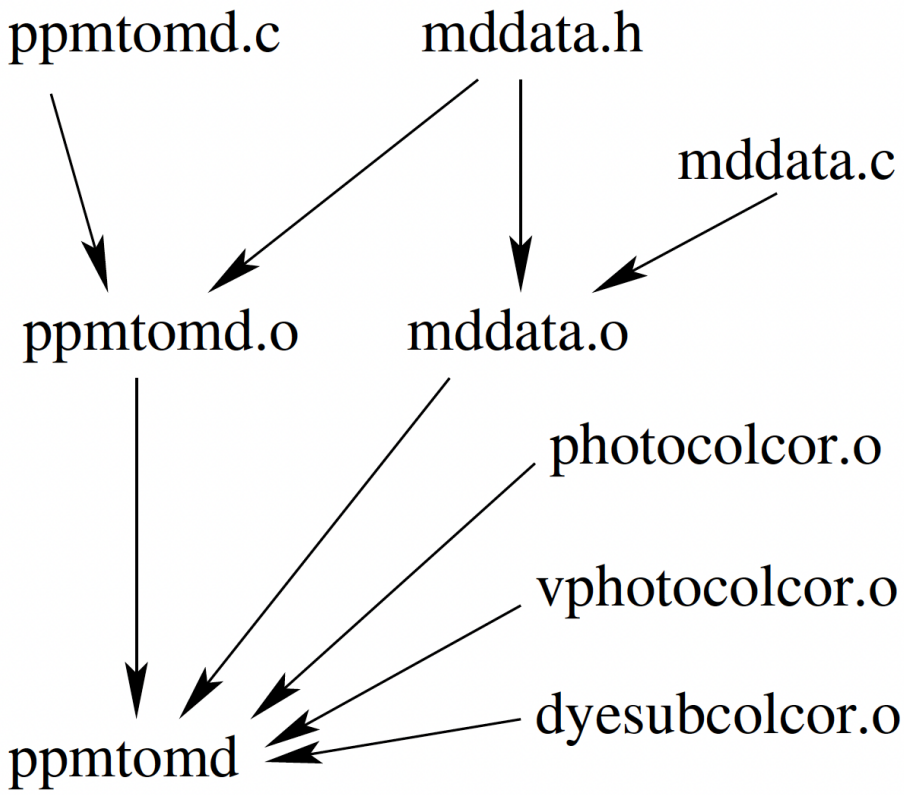
```
OBJS = ppmtomd.o mddata.o photocolcor.o vphotocolcor.o dyesubcolcor.o
ppmtomd: $(OBJS)
        $(CC) -o ppmtomd $(OBJS) $(LDLIBS) -lpnm -lppm -lpgm -lpbm -lm

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

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

- Makefile rule structure: target: dependencies, followed by commands
- Running make creates or rebuilds a target when any dependency is newer
- Before building, make recursively checks whether dependencies also need rebuilding

Make example



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- Paths and classpaths specified declaratively in XML
- Platform-independent — runs wherever Java runs

Ant example

```
<?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>
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- Dependency management via online repositories such as Maven Central

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  - Gradle Daemon keeps build information in memory
- Provides an interactive web-based UI for debugging and optimising 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)
  - Essential: Git & GitHub tutorial
  - Essential: A tutorial written by a former SEPP student

- On build tools:
  - Essential: Introduction to build tools
  - Recommended: Gradle tutorial
  - Recommended: Gradle Building Java Applications Sample
  - Recommended: Maven Tutorial
  - See other optional resources under 'Resources on other tools'