Remote Development on SciNet Systems

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Outline

General

- What is remote development?
- Decisions
- Use-cases
- Tools

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- What is remote development?
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- Use-cases
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Technical details

- Important technical details (port and X forwarding)
- Example development setups
- Debugging

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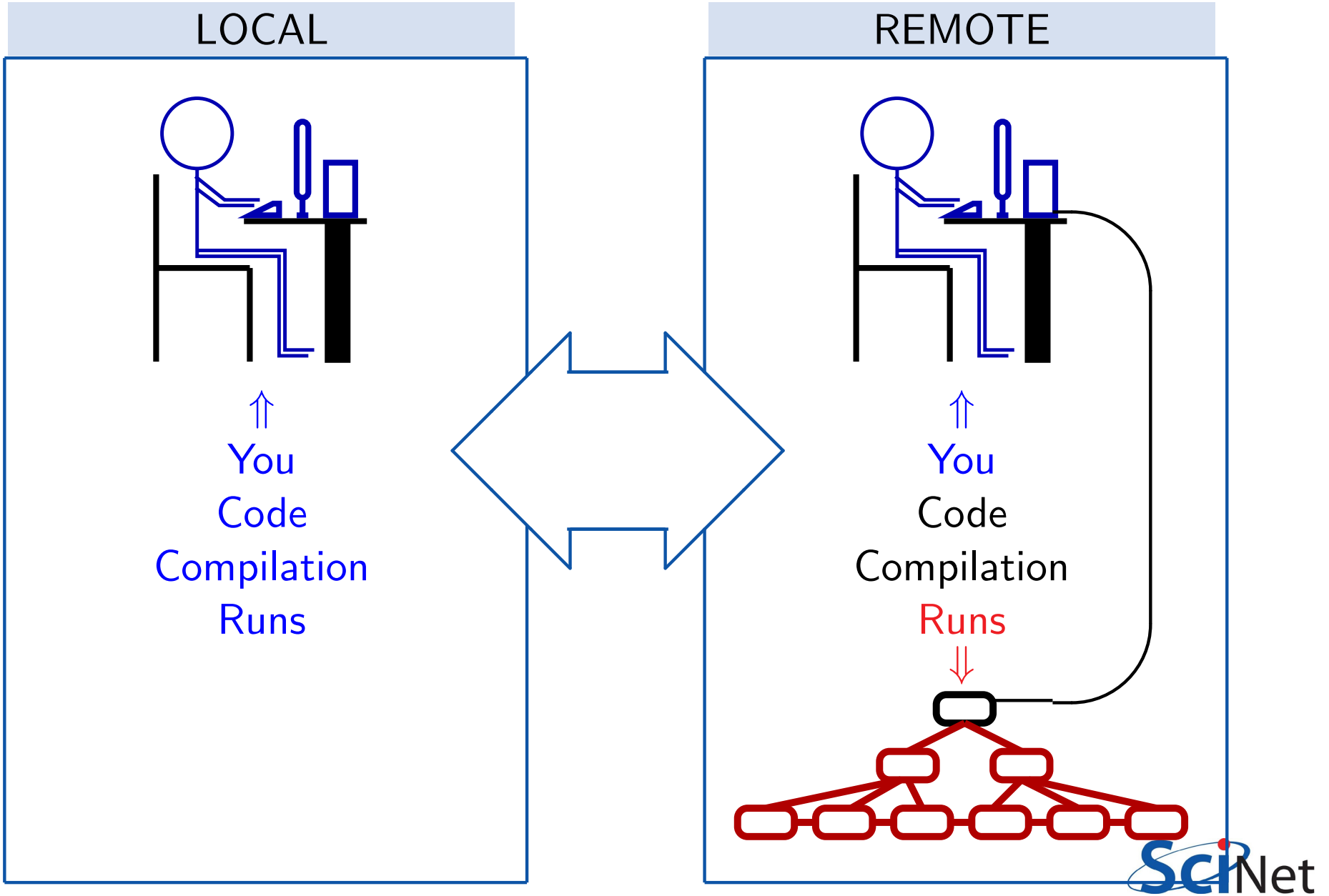
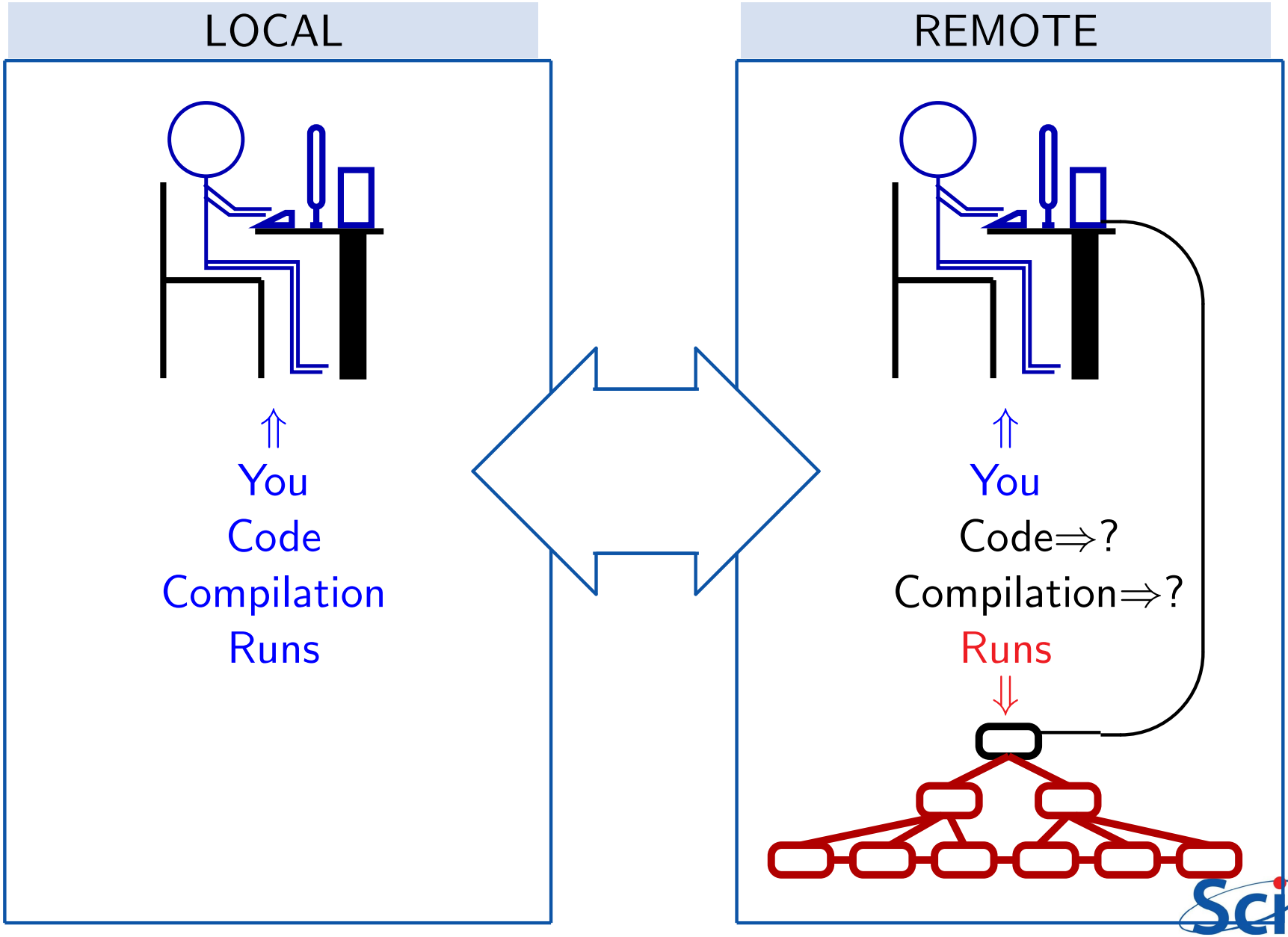
Local vs. Remote Development



Local vs. Remote Development



Decisions, decisions

What setup you need depends on the answers to the following questions:

- What tools/ide will you use?
- Where's the code?
- Can you cross compile?
- Do you need to debug? At what scale?

. Let's look at some use-cases ...

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Six Degrees of Separation

Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
local code local edit local compile local debug local run					

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Tools

NetBeans An IDE with Java, C, C++ (Fortran) support. Mainly supports remote devel case 3 (5 can be made to work).

Eclipse An IDE with Java, C, C++ and Fortran support. Remote devel cases 3, 4 and 5.

Command line+editor Without tricks: remote devel case 6. Emacs is an editor which can run over X.

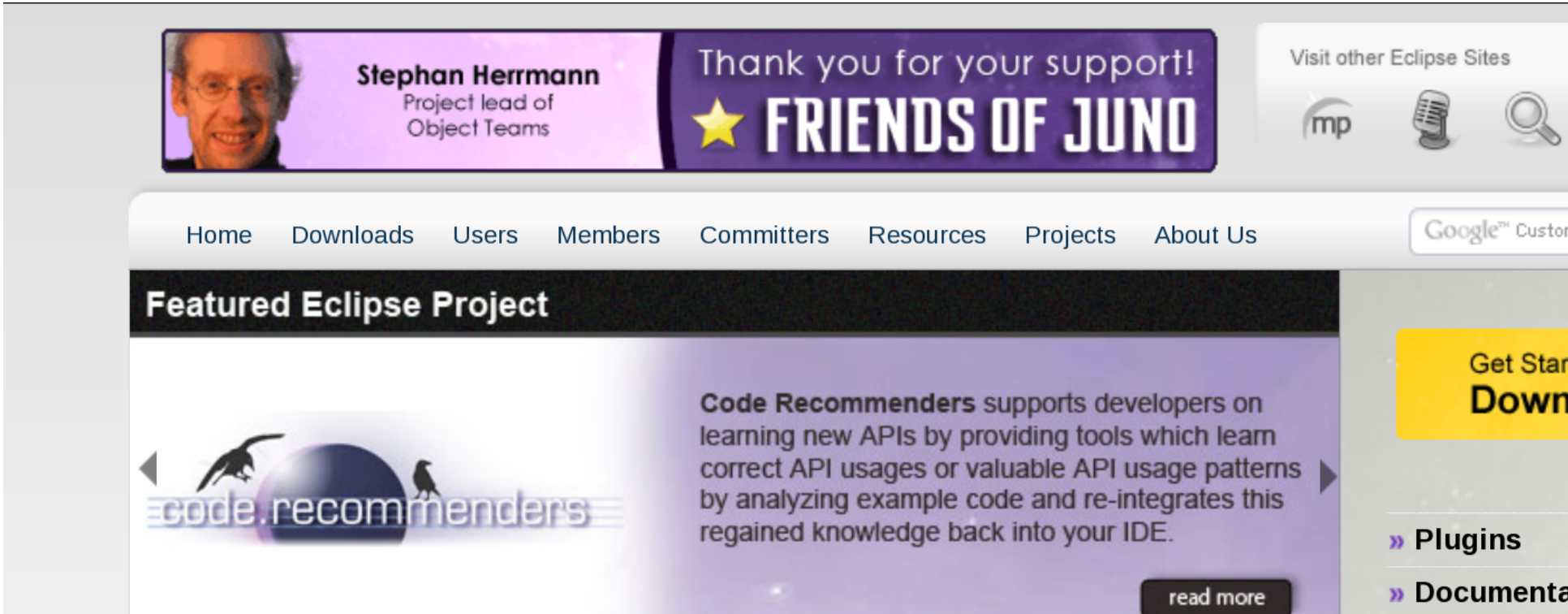
DDT A commercial graphical debugger installed on all SciNet systems. Can run remotely (over X), ie. case 6.

NetBeans

- Open-source IDE for Windows, Mac, Linux, and Solaris.
- Developed originally by Sun (acquired by Oracle).
- Supports C, C++, Fortran, Java, PHP, and others.
- Current version 7.1.2
- netbeans.org:

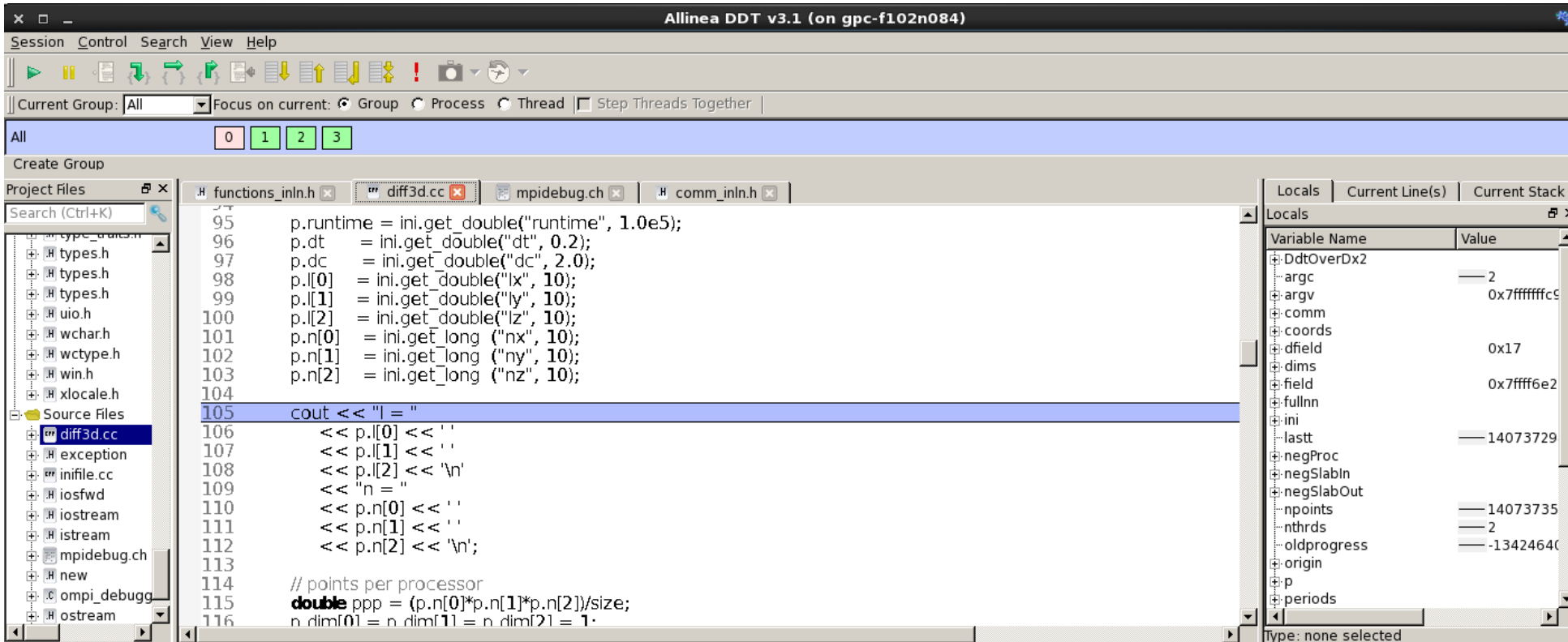
Eclipse

- Open-source IDE for Windows, Mac, Linux, and Solaris.
- Finds its origins in IBM.
- Can support C, C++, Fortran, Java, PHP, and others.
- PTP: parallel tools plugin (MPI, OpenMP)
  Will not cover in this talk.
- Current version Indigo
- eclipse.org:



DDT

- Distributed Debugging Tool
- Made by Allinea
- Installed on all SciNet's systems (`module load ddt/3.1`).
- Runs remotely over X.
- Very good for debugging MPI, OpenMP and CUDA.



Important Technical Details

Ssh
X Tunnels
Port Forwarding

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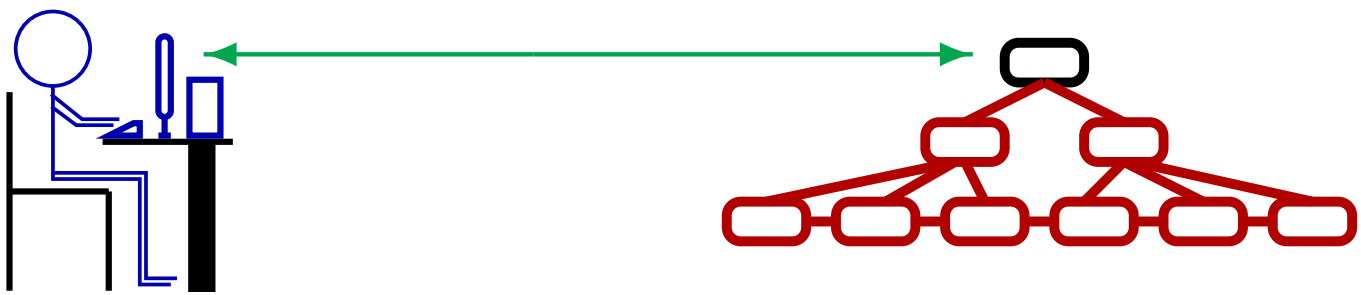
SSH

SSH

- Secure way to login or exchange data with a remote machine.
- Linux/MacOS users: very likely you'll have ssh.
- Windows users will have to install SSH software. SciNet recommends, roughly in order of preference:
  1. Cygwin with OpenSSH and X forwarding
  2. MobaXterm
  3. PuTTY (does not have X forwarding).
- User authentication either by password,
- Or using cryptographically secure keys.



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SSH Keys (optional)

- Keys guarantee request is coming from a trusted source;
- If done properly, as secure as requiring a password;
- More convenient (and necessary for some apps).

```
local:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key ($HOME/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in $HOME/.ssh/id_rsa.
Your public key has been saved in $HOME/.ssh/id_rsa.pub.
...
local:~$ scp $HOME/.ssh/id_rsa.pub me@login.utoronto.ca:lockey
local:~$ ssh me@login.utoronto.ca
me@login.scinet.utoronto.ca's password:
scinet01:~$ cat lockkey >> .ssh/authorized_keys
```

Don't Use passphrase-less keys!

Do **NOT** generate ssh keys on your SciNet account.

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Sshfs (optional)

With ssh setup, can't I just see my remote files as if they're local?

Why, yes you can, using sshfs!

```
local~$ mkdir $HOME/remote
local~$ sshfs me@login.scinet.utoronto.ca:  $HOME/remote
```

Notes:

- Will need to install sshfs first.
- Can you any editor now, but still not seeing the compilers, nor can you run or debug. (case 6, but with command line)
- Reading/writing not as fast as local files (may want to tune down auto-save features).
- On windows, you can try win-sshfs or Uniwin (I have not tested these).

X tunneling/forwarding

X forwarding

- X is a window system for unix/linux that can run remotely, i.e., display and place where apps runs are different.

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```
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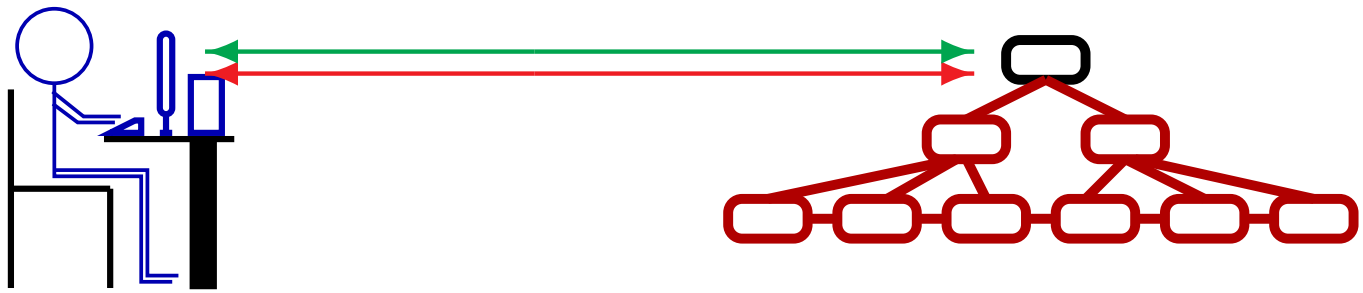
scinet01:~$ export DISPLAY=local.utoronto.ca:0.0
scinet01:~$ xterm...
```



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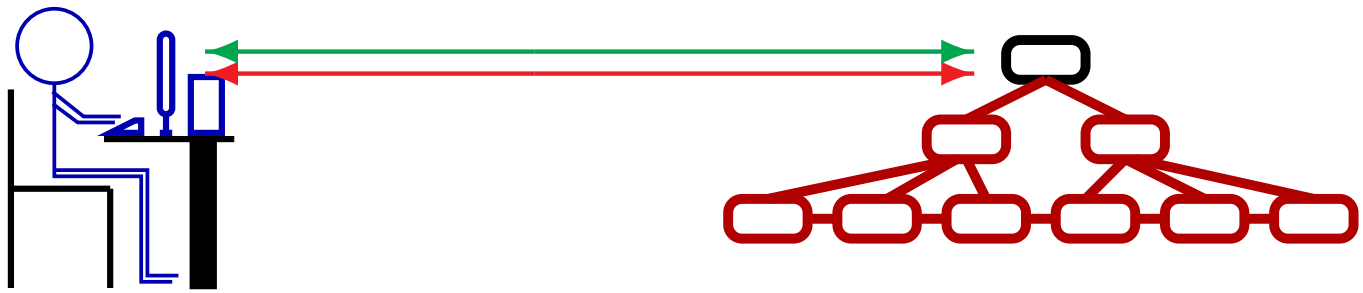

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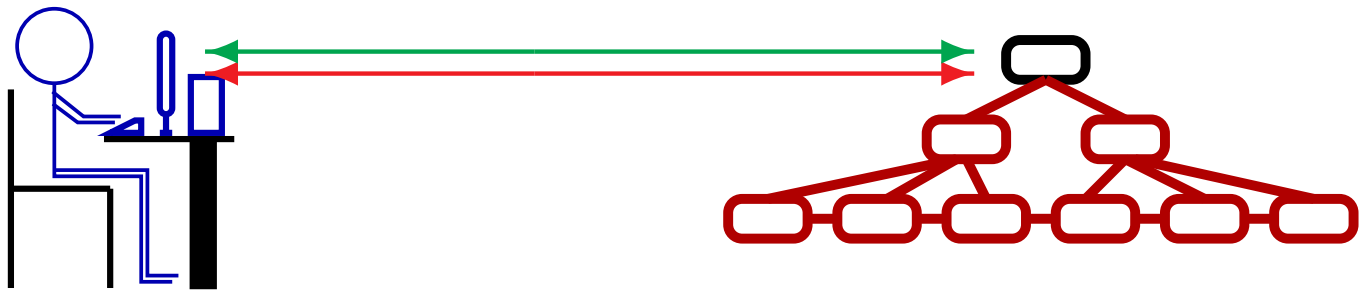

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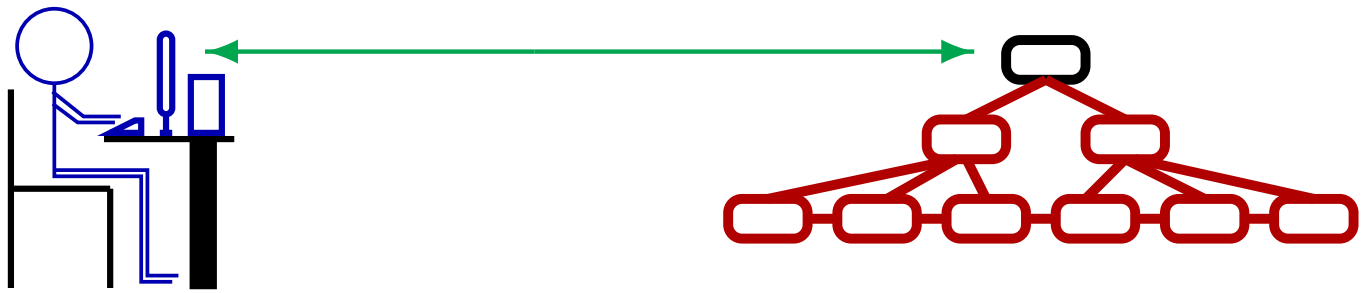

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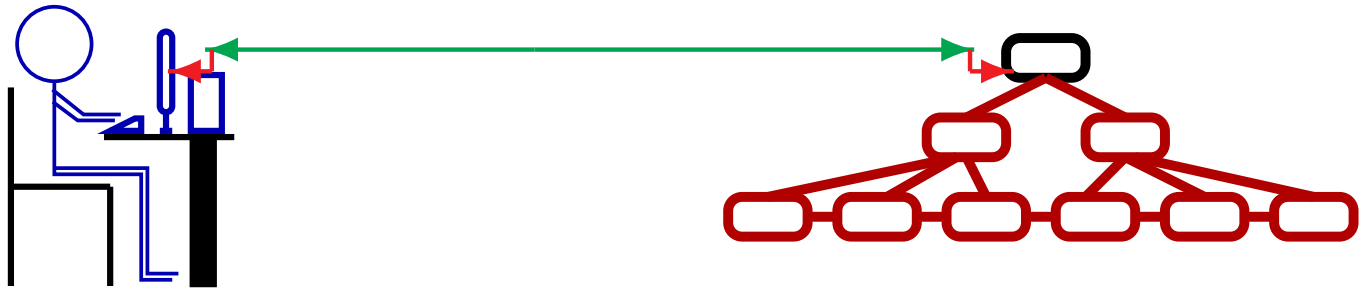

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local:~$ ssh me@login.scinet.utoronto.ca -X
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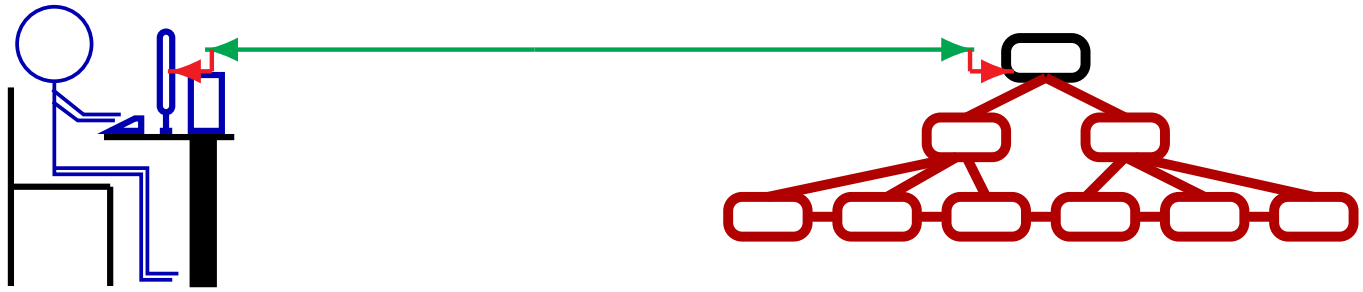

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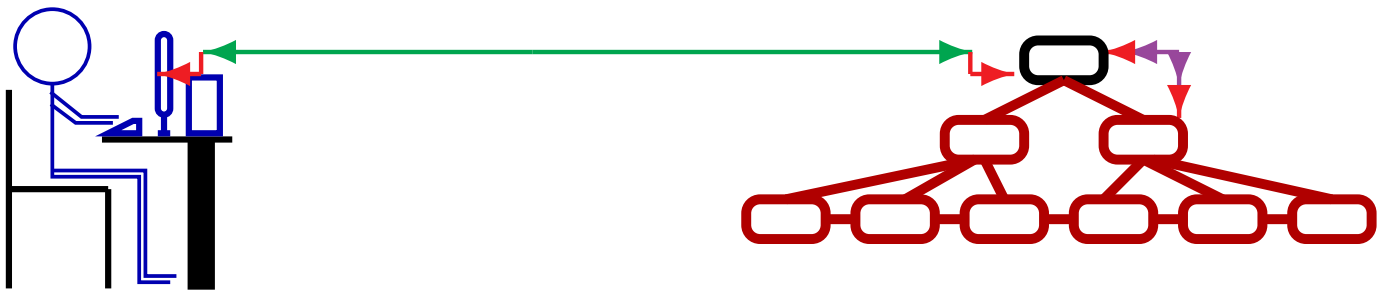
scinet01:~$ xterm...
```

- Note: `xterm` needs `module load Xlibraries`.

X forwarding X forwarding . . .

- X can be forwarded once more:

```
local:~$ ssh me@login.scinet.utoronto.ca -X
scinet01:~$ ssh gpc02 -X
gpc02:~$ xterm...
```



- Cannot forget -X at any intermediate stage.
- Don't set DISPLAY!

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When to use X forwarding?

X can be rather slow.
Depends on amount of network traffic and graphics.

Very graphics heavy?

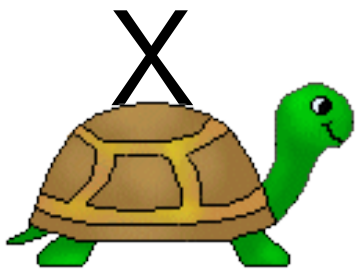
Try to use an **alternative** that has a client run locally, connection to server in other ways.

Examples: paraview, eclipse, netbeans

Light graphics/no choice?

X forwarding

Examples: emacs, ddt



http://clipartmountain.com/clipart1/turtles1.htm

Port Forwarding

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Port forwarding - Why?

What is a port?

- In addition to an IP address, communications between computers use ports.

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  - 22: ssh
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  - 80: http ...

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Why do ports need forwarding?

- Only port 22 of SciNet login nodes is accessible from outside
- Other nodes not visible behind the firewall.
- Hence the *double hop* to get to devel node (e.g. gpc01).
- Many IDEs will need more direct access:

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Port forwarding to the rescue!

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Port forwarding - How?

- Very analogous to X forwarding: use ssh.
- Make a port on one machine go to another port on another machine.
- Syntax a bit confusing at first.

```
local:~$ ssh me@remote -N -L<port>:<amachine>:<aport>
```

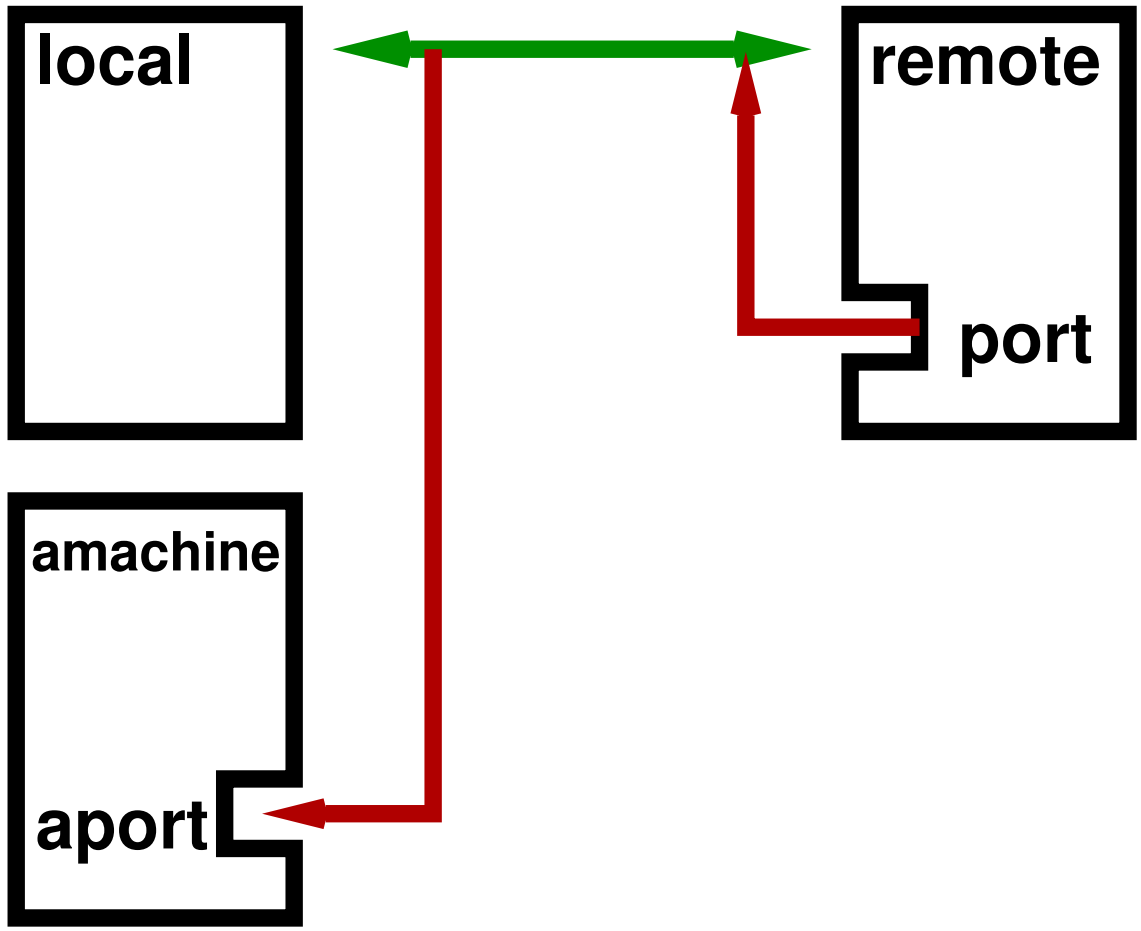
```
local:~$ ssh me@remote -N -R<port>:<amachine>:<aport>
```

- `-N` means: do not start a shell

Port forwarding - remote ports

```
local:~$ ssh me@remote -N -R<port>:<amachine>:<aport>
```

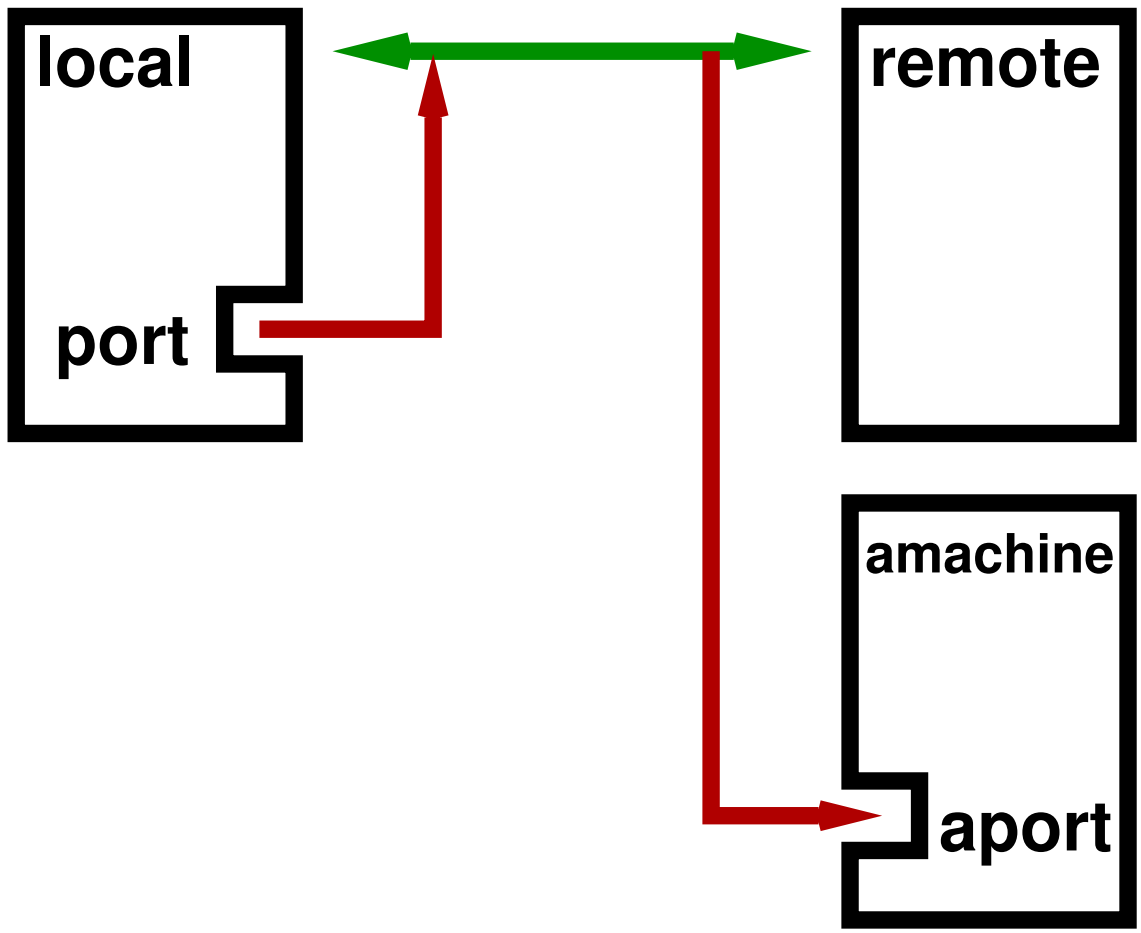
- `-R` stands for 'remote' and makes port `<port>` on `remote` act as if it were port `<aport>` on `<amachine>`.
- `local` is just a 'broker' that sets up the forwarding path.
- Not very useful here (why?)



Port forwarding - local ports

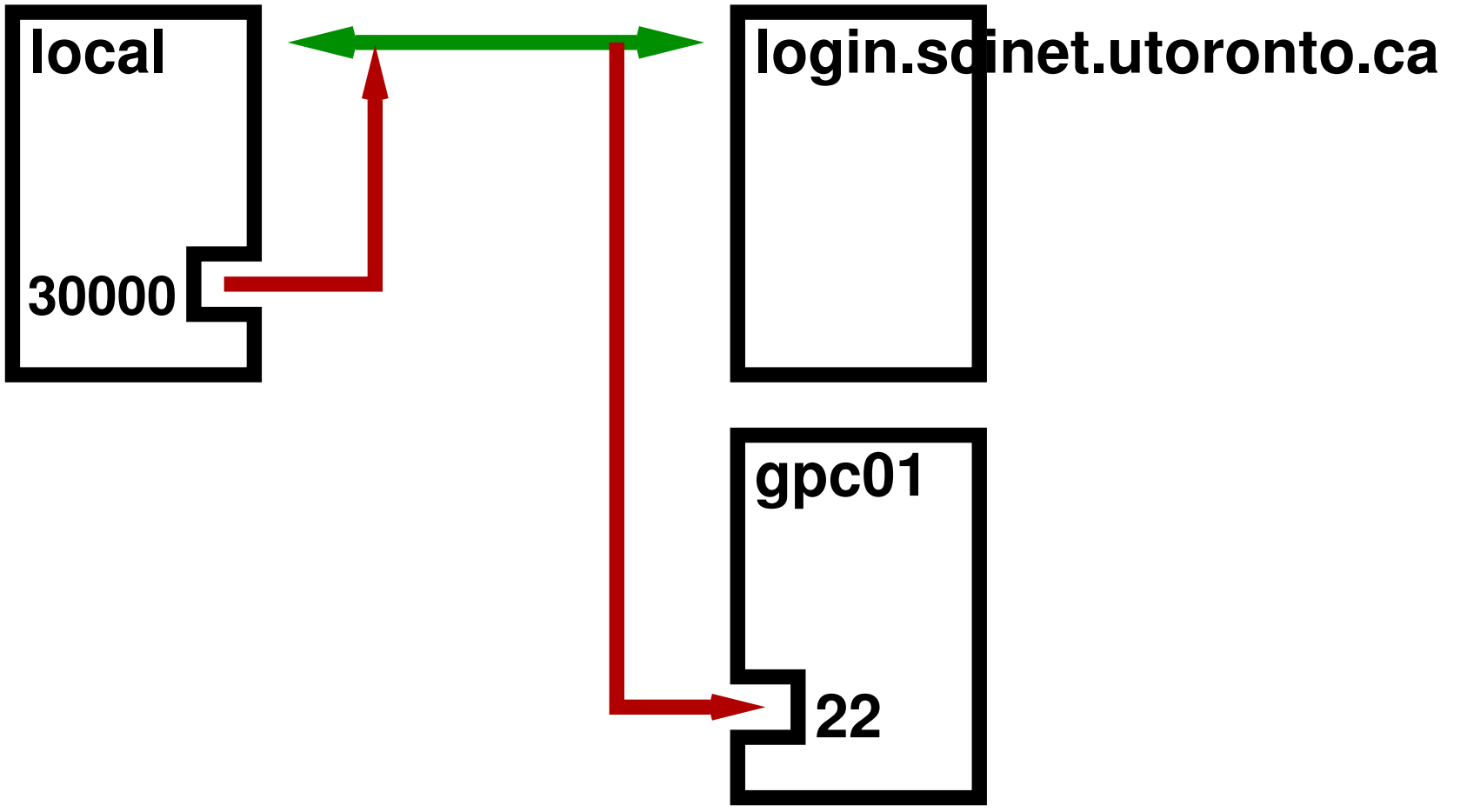
```
local:~$ ssh me@remote -N -L<port>:<amachine>:<aport>
```

- `-L` stands for 'local' and makes port `<port>` on `local` act as if it were port `<aport>` on `<amachine>`.
- `remote` is just a 'broker' that sets up the forwarding path.



Port forwarding - Example

```
local:~$ ssh login.scinet.utoronto.ca -N -L30000:gpc01:22
```



- From another window on `local`, can now ssh to gpc01:

```
local:~$ ssh localhost -p 30000
```

NetBeans setup example

- netbeans.org:
  Download NetBeans with c/c++ support
  Will then have Fortran as well.
- Hybrid MPI+OpenMP diffusion code (3d)
- NetBeans running locally
- Code remote on SciNet, but files shared to the local machine
- Aim: Remote build and remote run on GPC
- Little snag: netbeans does not read .bashrc when doing remote commands.
  $\Rightarrow$ wrapper scripts for compilers.

A few steps to be taken...

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1 Setup Remote Host	2 Setup Compiler	3 Create Project	4 Setup Run
Configure remote host: a) Forward ports b) Mount remote files c) NetBeans: New 'C/C++ Build Host'			

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Configure remote host: a) Forward ports b) Mount remote files c) NetBeans: New 'C/C++ Build Host'	No modules and wants gcc: a) use wrappers for modules and for mpi b) Create a new tools chain, set paths	a) New C/C++ project with existing source b) Set host c) Set compiler	Serial run with no modules to be loaded? NetBeans will guess what you want to run. Otherwise: setup a run command/ script.

Netbeans screencast....

Eclipse setup example

- eclipse.org:
  Download "Eclipse IDE for Parallel Application Developers"
- Warning: In eclipse, everything is a plugin.
  - Great for new features:
    - CDT : C/C++ development
    - Photran: Fortran development
    - Remote Tools: remote development
    - PTP: parallel tools
  - Common operations are sometimes nested deeply in the menus. Google is your ally.
  - With changes from release to release.
- Will show preview release "Juno" here.
- Eclipse remote commands for seem to read .bashrc.
  $\Rightarrow$ should have compilers, mpi versions, in .bashrc.
- Needs java on the remote end: `module load java` in `.bashrc` .

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Eclipse screencast....