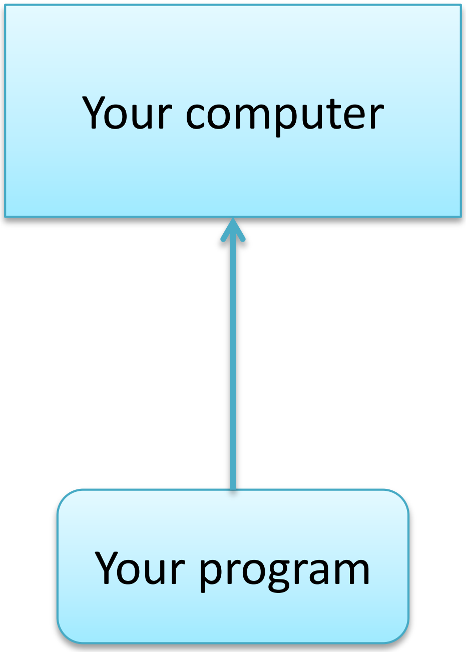
An overview of batch processing

01-Jun-2023

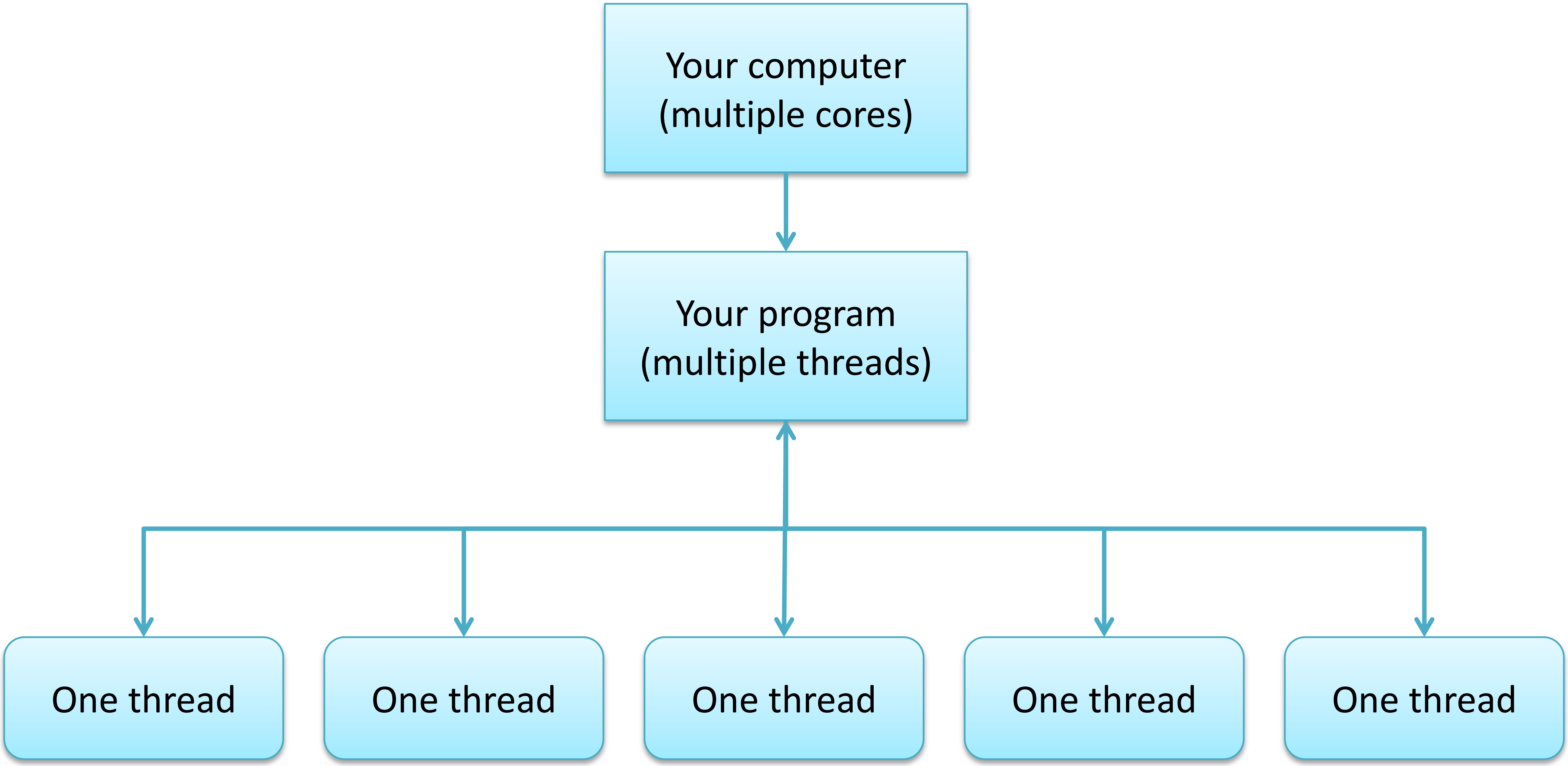
One-on-one



Your computer

Your program

One way to speed things up within ROOT: multi-threaded code (RDataFrame, PROOF)



Your computer
(multiple cores)

Your program
(multiple threads)

One thread

One thread

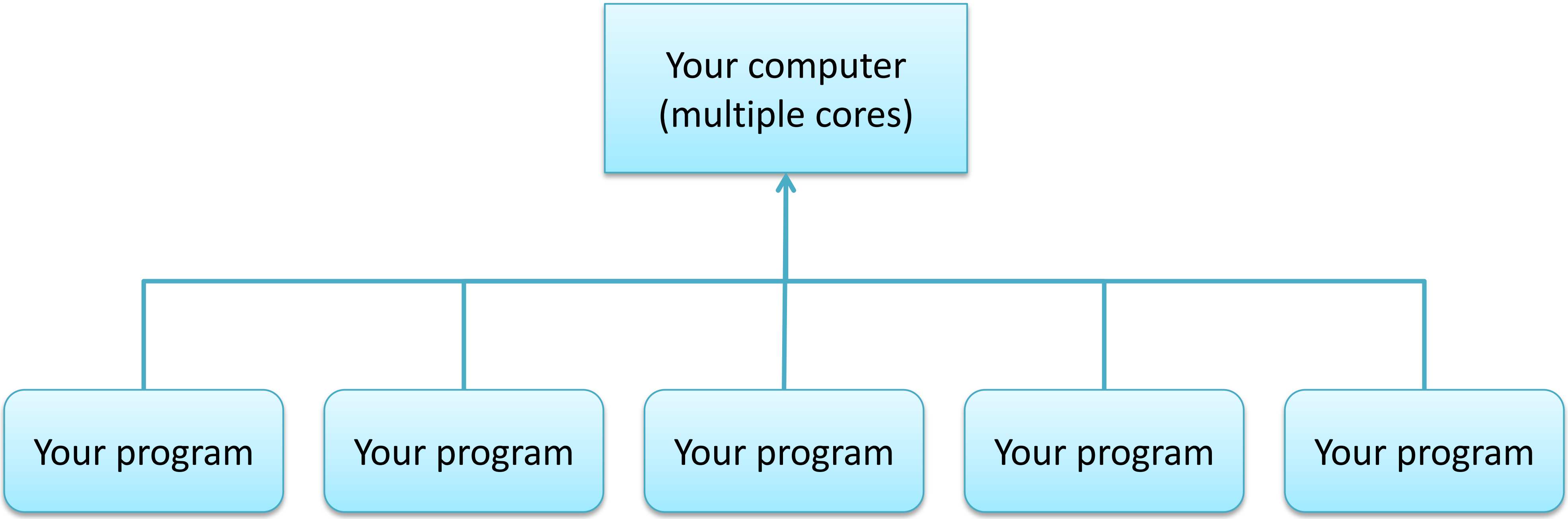
One thread

One thread

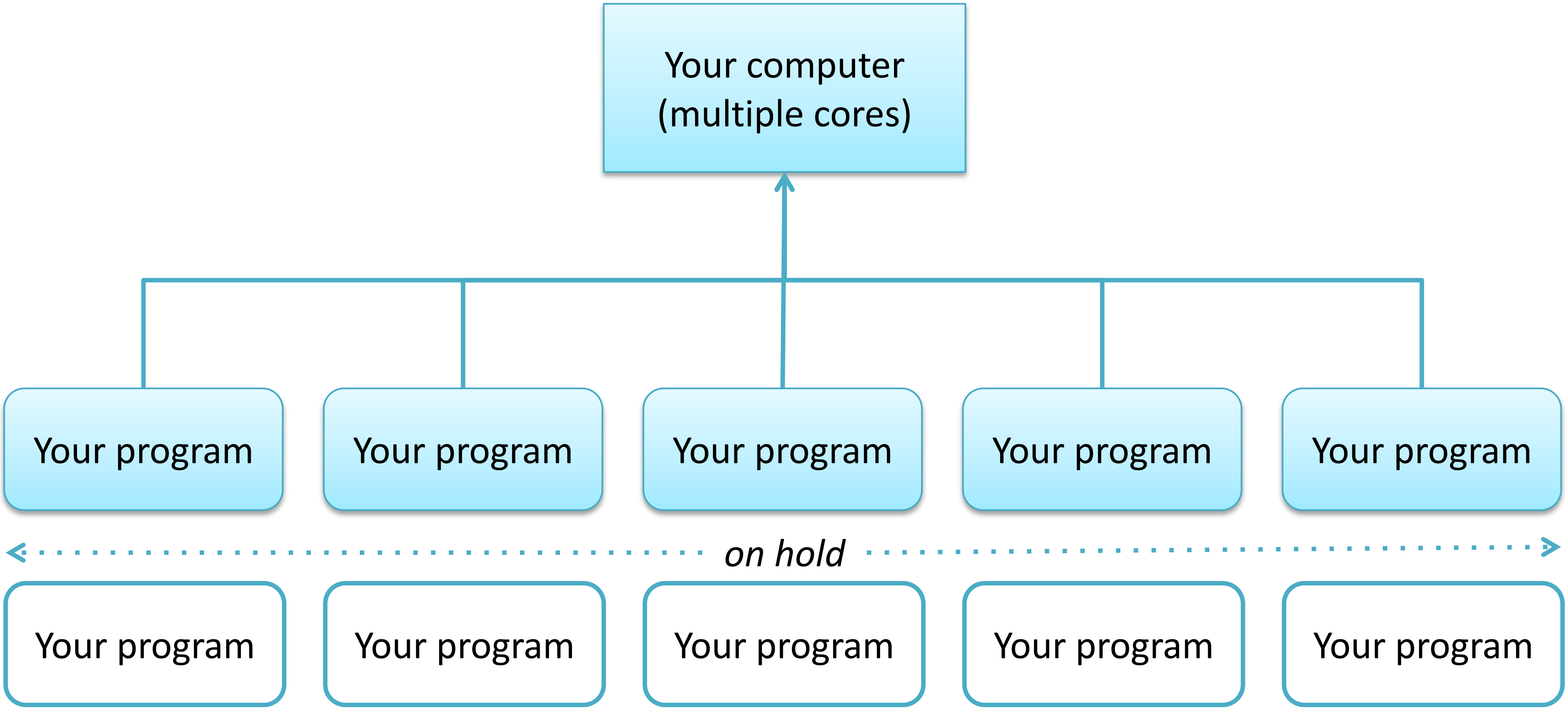
One thread

Outside of ROOT, you can have multiple programs on a single computer (UNIX command “at”)

You have to remember not to submit too many jobs or you’ll overload the computer



A batch system managing multiple programs on a single computer (UNIX command “batch”)



Your computer (multiple cores)

Your program

Your program

Your program

Your program

Your program

on hold

Your program

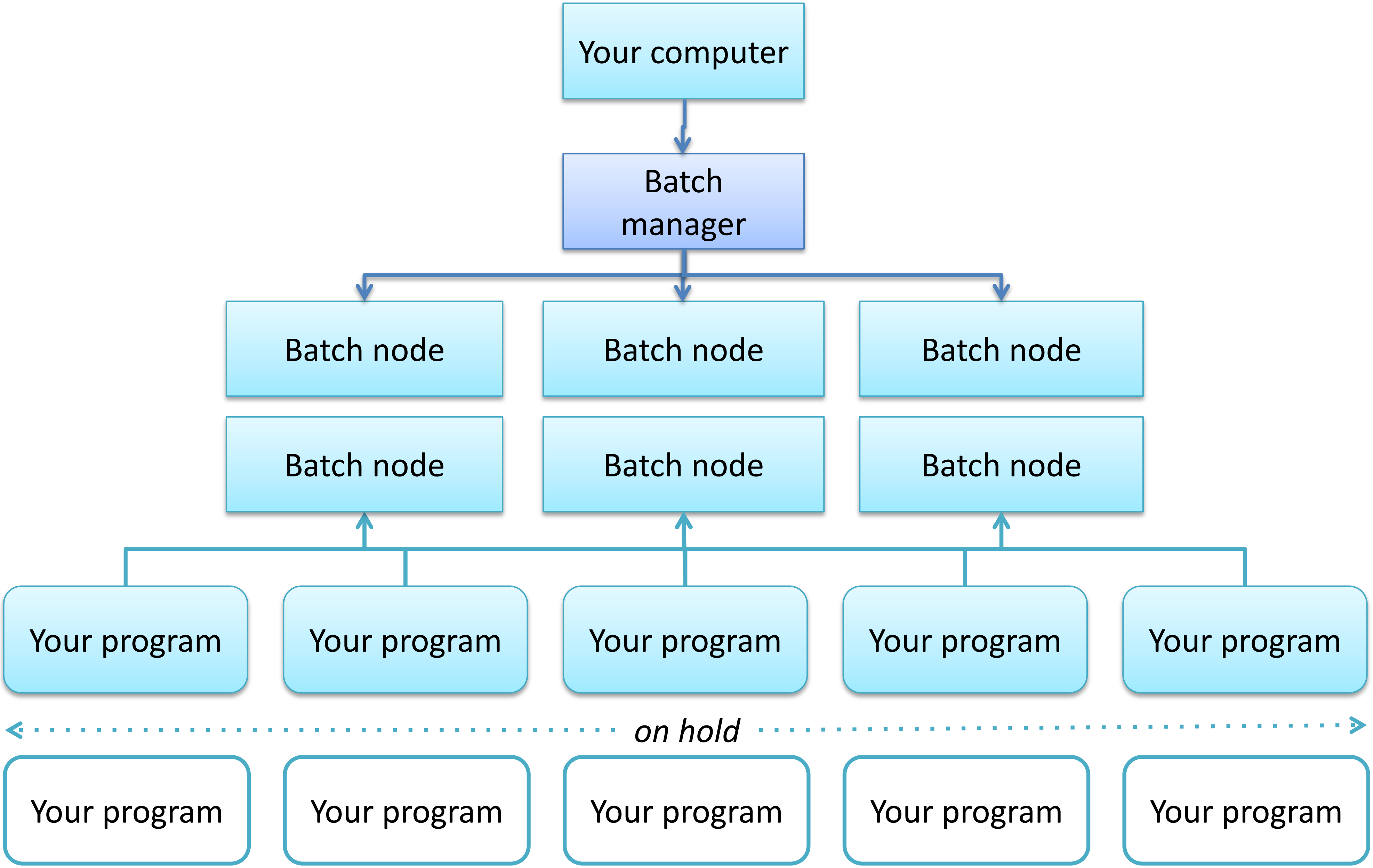
Your program

Your program

Your program

Your program

A batch system managing multiple programs on multiple computers



Your computer

Batch manager

Batch node

Batch node

Batch node

Batch node

Batch node

Batch node

Your program

Your program

Your program

Your program

Your program

on hold

Your program

Your program

Your program

Your program

Your program

The standard software for managing batch systems in scientific computing is HTCondor (or just Condor)

Main web page

http://research.cs.wisc.edu/htcondor/

Quick start

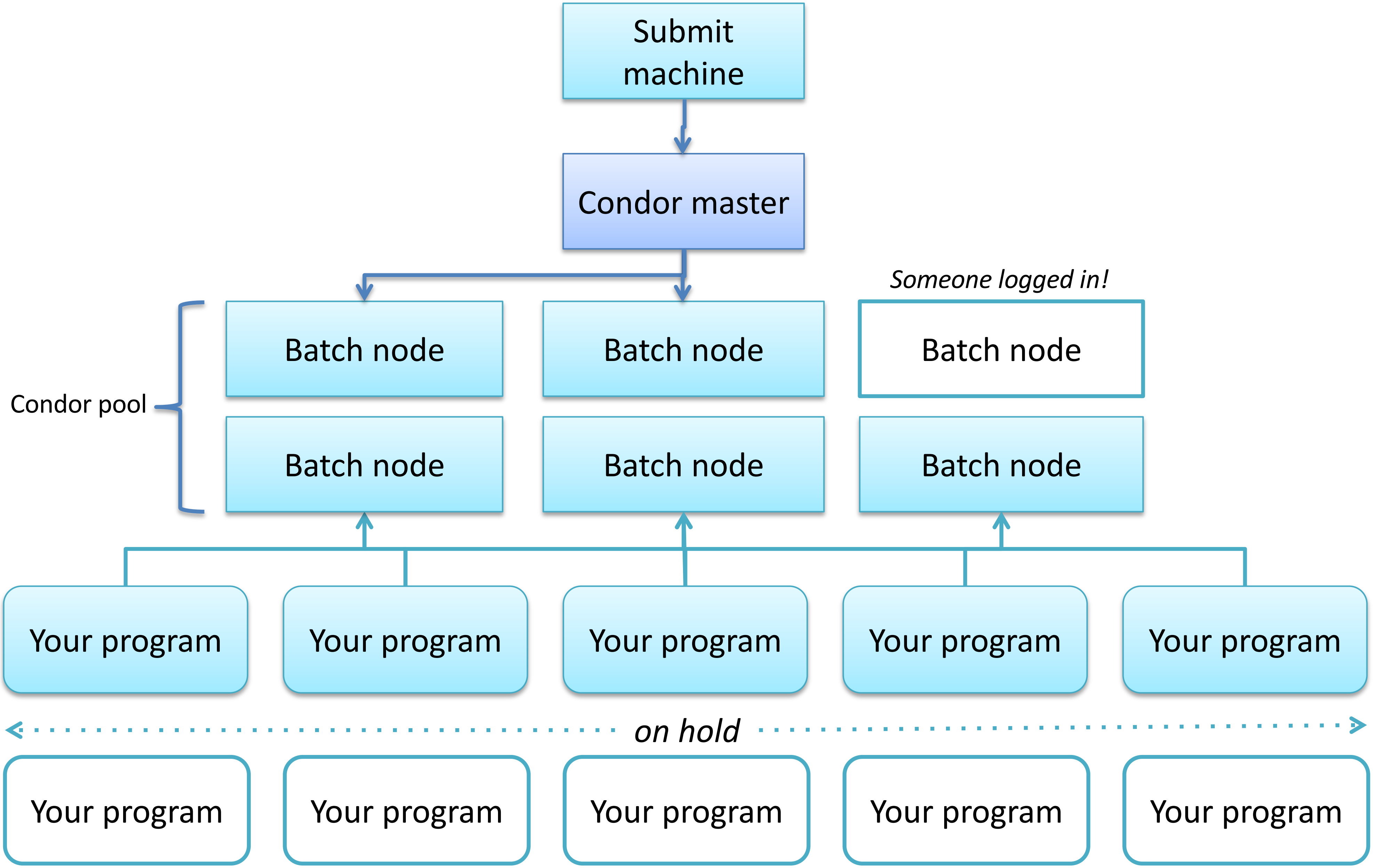
https://htcondor.readthedocs.io/en/latest/users-manual/quick-start-guide.html

Full manual

https://htcondor.readthedocs.io/en/latest/

- Stick to the “vanilla” universe; the “standard” universe won’t work for ROOT or any other particle-physics software (so you don’t need condor_compile).

Condor will halt a queue in favor of an interactive program



Submit machine

Condor master

Someone logged in!

Condor pool

Batch node

Batch node

Batch node

Batch node

Batch node

Batch node

Your program

Your program

Your program

Your program

Your program

on hold

Your program

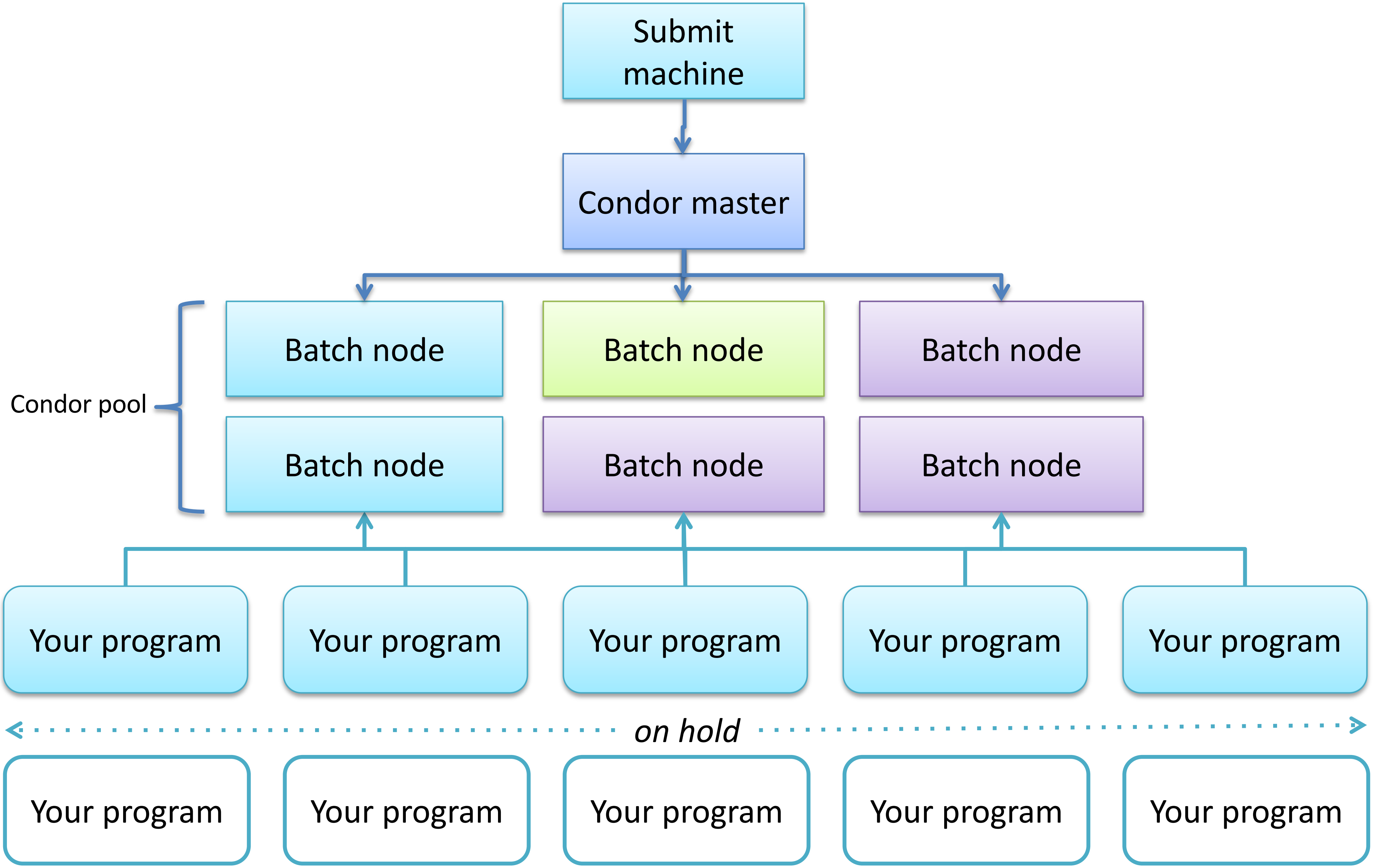
Your program

Your program

Your program

Your program

Condor managing multiple programs on multiple computers with multiple configurations



Submit machine

Condor master

Condor pool

Batch node

Batch node

Batch node

Batch node

Batch node

Batch node

Your program

Your program

Your program

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on hold

Your program

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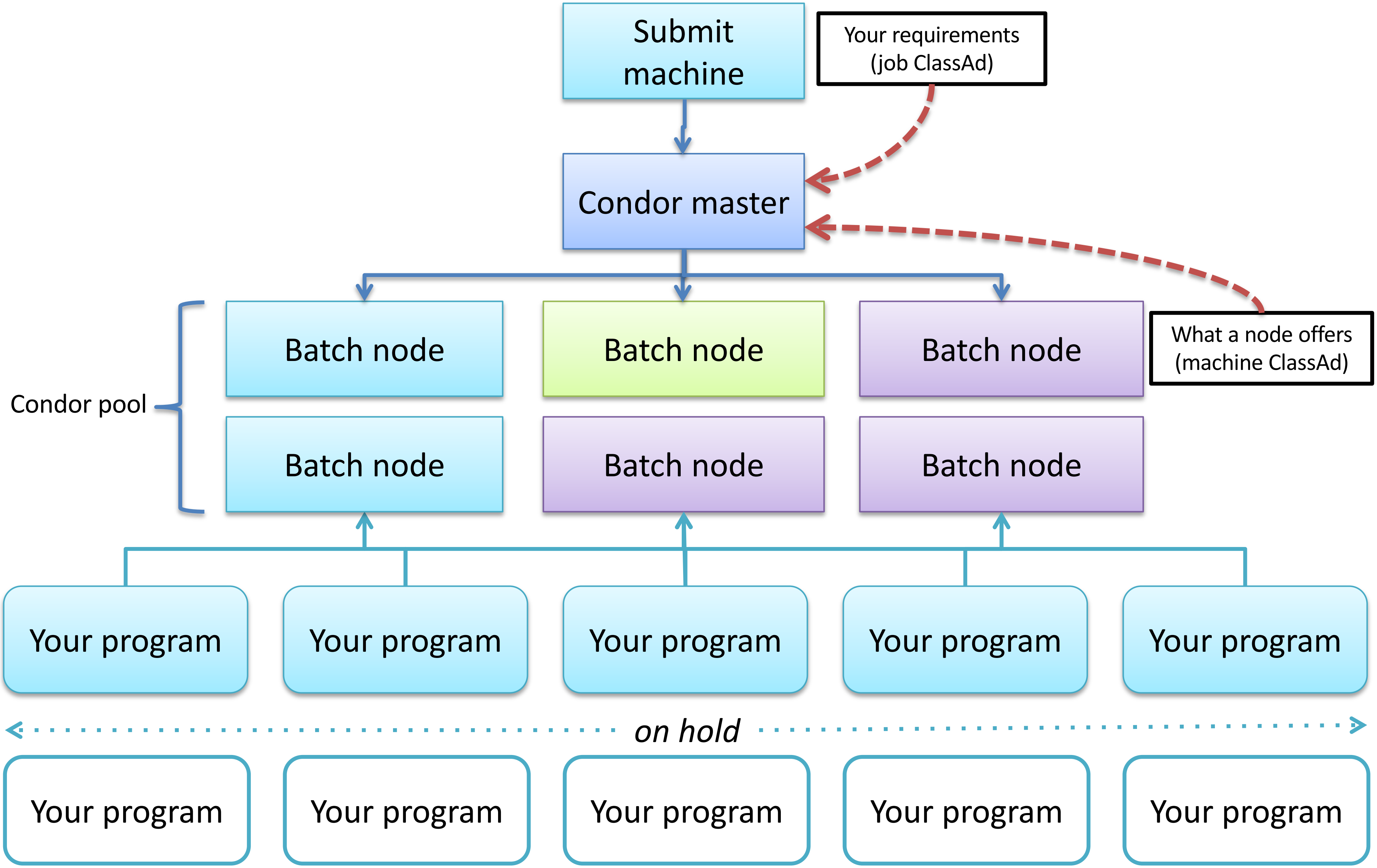
Condor uses “ClassAds” to match your requirements with what each node offers



Submit machine

Your requirements (job ClassAd)

Condor master

What a node offers (machine ClassAd)

Condor pool

Batch node

Batch node

Batch node

Batch node

Batch node

Batch node

Your program

Your program

Your program

Your program

Your program

on hold

Your program

Your program

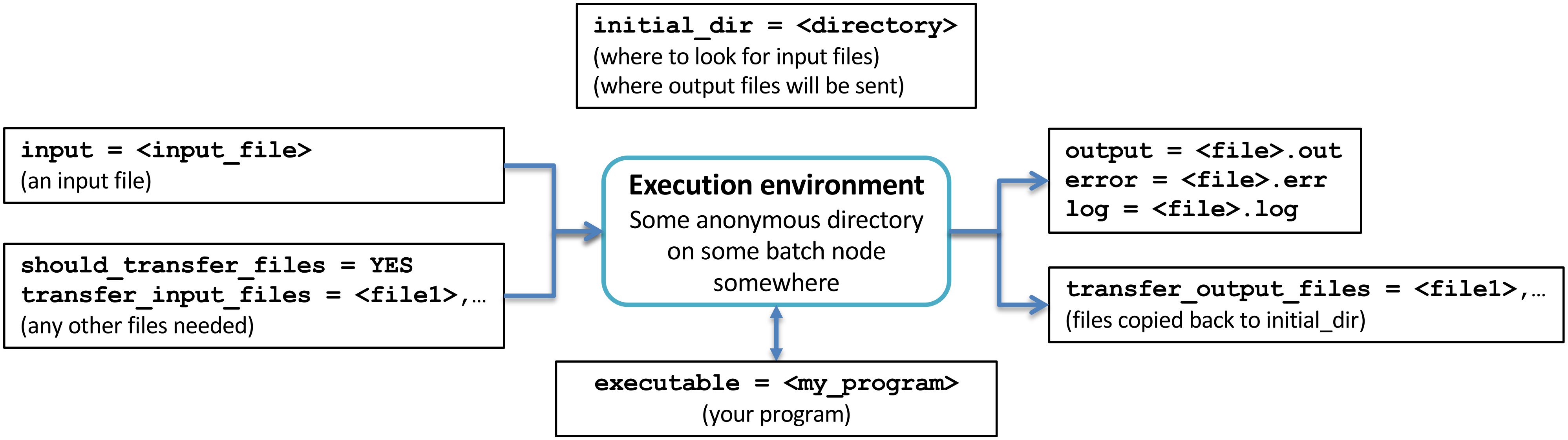
Your program

Your program

Your program

Resource Planning

- Condor can’t do *everything* for you.
- Think about input files (including programs) and output files and how they’ll be accessed.
- Think about disk space. “`df -h`” and “`du -shx *`” can help.
- Fun fact: The particle-physics Condor pools **can’t** see your home directory!
- Moral: Let condor transfer your files… when possible.



`initial_dir = <directory>`
(where to look for input files)
(where output files will be sent)

`input = <input_file>`
(an input file)

`should_transfer_files = YES`
`transfer_input_files = <file1>,…`
(any other files needed)

Execution environment
Some anonymous directory
on some batch node
somewhere

`output = <file>.out`
`error = <file>.err`
`log = <file>.log`

`transfer_output_files = <file1>,…`
(files copied back to initial_dir)

`executable = <my_program>`
(your program)

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When you can’t let condor transfer your files,
here are disk-sharing methods outside of condor:

- NFS – used at Nevis
- CVMFS – Fermilab and CERN
- Grid, BlueArc – only used at Fermilab

Resource Planning

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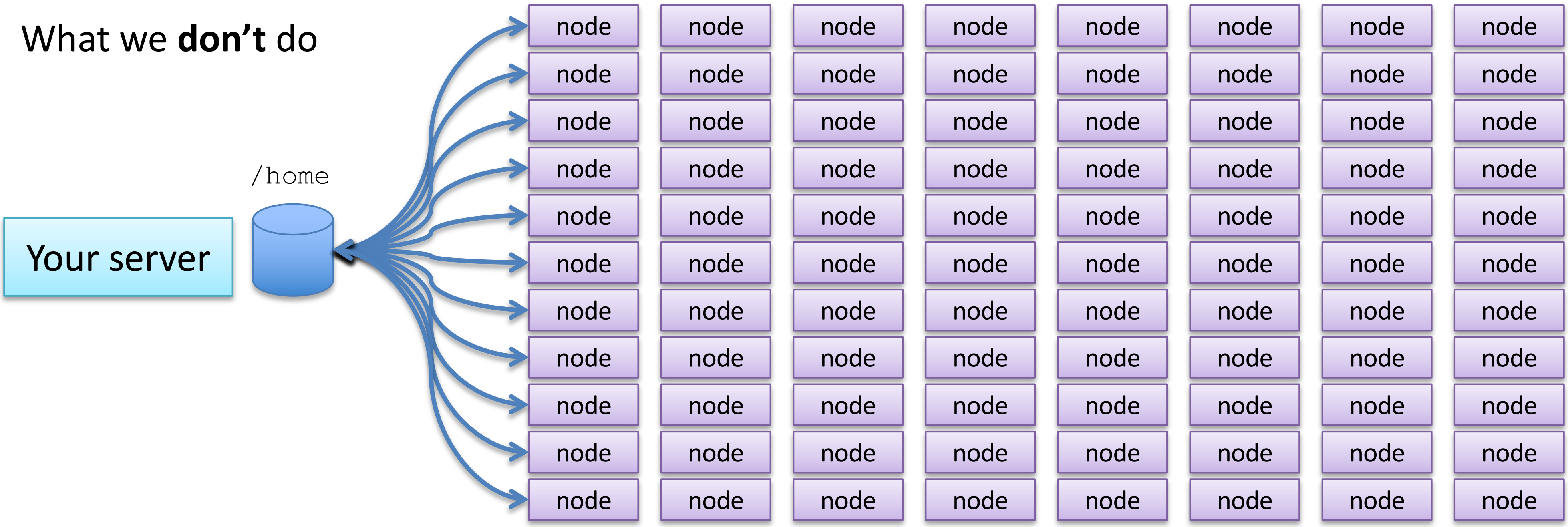
What we **don't** do



Resource Planning

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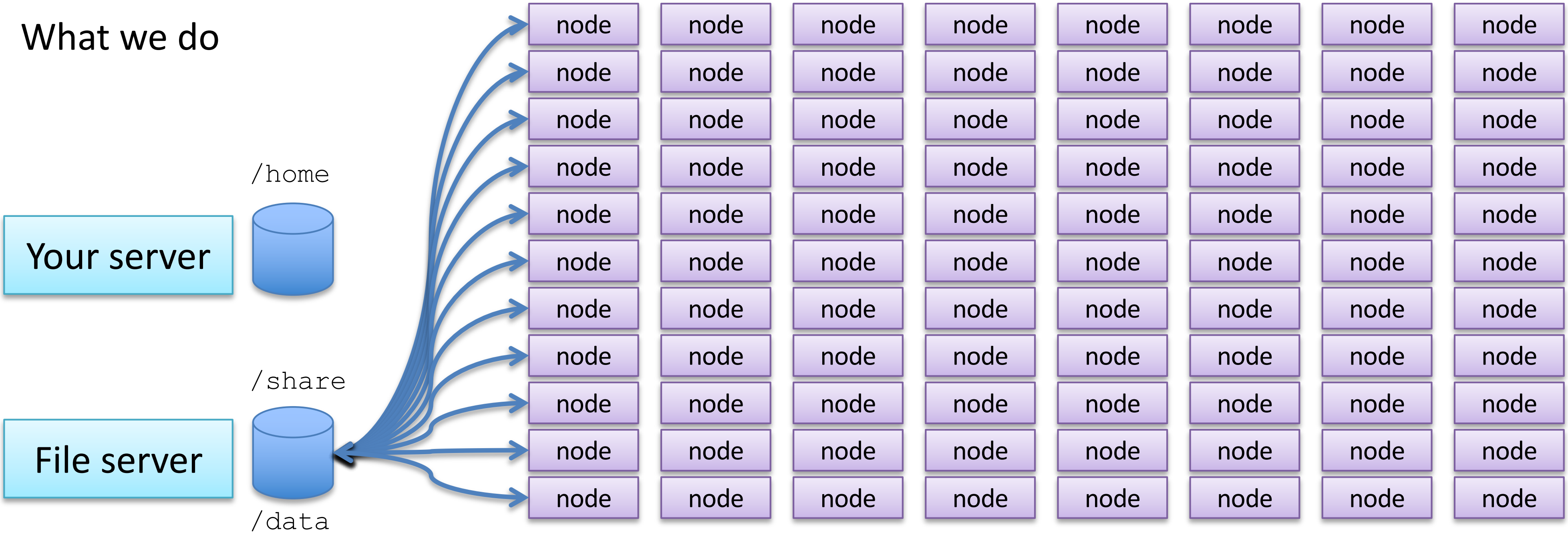
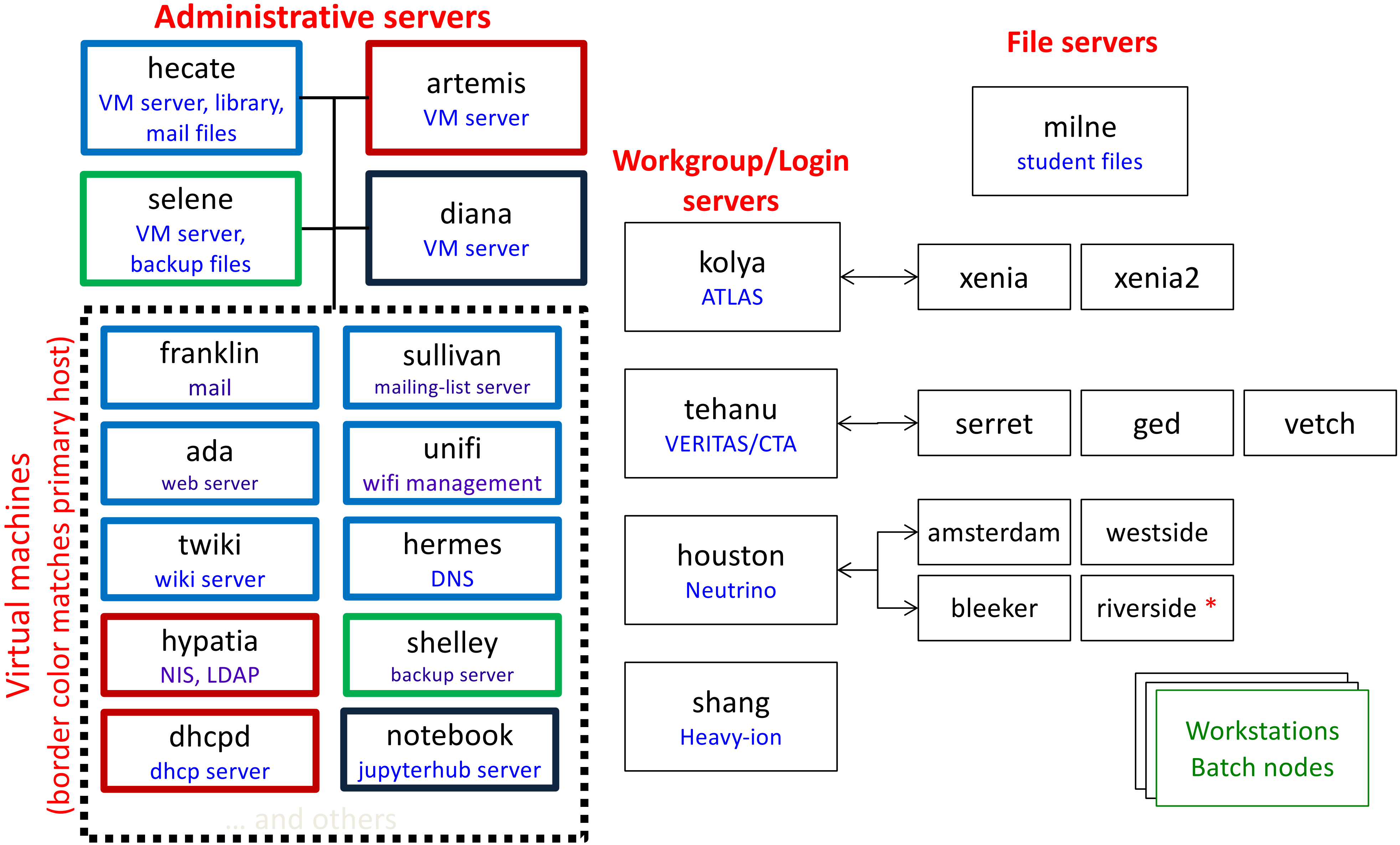


Particle-Physics Computer Systems

Linux Cluster



Administrative servers

hecate
VM server, library, mail files

selene
VM server, backup files

artemis
VM server

diana
VM server

Virtual machines
(border color matches primary host)

franklin
mail

sullivan
mailing-list server

ada
web server

unifi
wifi management

twiki
wiki server

hermes
DNS

hypatia
NIS, LDAP

shelley
backup server

dhcpd
dhcp server

notebook
jupyterhub server

... and others

Workgroup/Login servers

kolya
ATLAS

tehanu
VERITAS/CTA

houston
Neutrino

shang
Heavy-ion

File servers

milne
student files

xenia

xenia2

serret

ged

vetch

amsterdam

westside

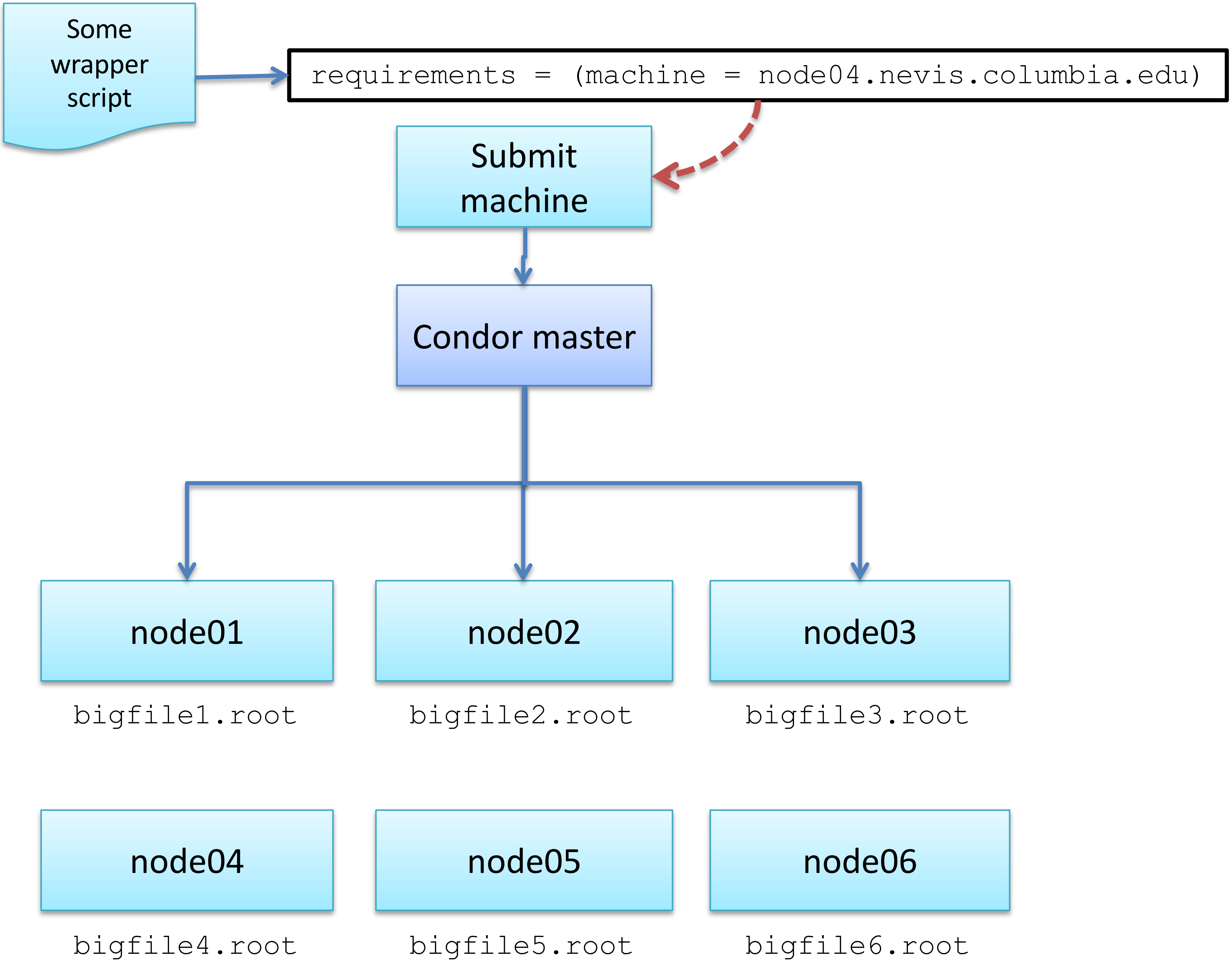
bleeker

riverside *

Workstations
Batch nodes

https://twiki.nevis.columbia.edu/twiki/bin/view/Main/LinuxCluster
https://twiki.nevis.columbia.edu/twiki/bin/view/Main/ListOfMachines

Bringing the job to the data



Some wrapper script

`requirements = (machine = node04.nevis.columbia.edu)`

Submit machine

Condor master

node01

`bigfile1.root`

node02

`bigfile2.root`

node03

`bigfile3.root`

node04

`bigfile4.root`

node05

`bigfile5.root`

node06

`bigfile6.root`

Final tips

- Split up your task so each condor job takes 20-60 minutes
- If your job must be preempted, it will have to run from the beginning on the same machine that cancelled the job
- Test your job with one process before submitting it for 10,000 processes!

Resources

Main web page

http://research.cs.wisc.edu/htcondor/

Quick start

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Full manual

https://htcondor.readthedocs.io/en/latest/

Nevis particle-physics condor guide

https://twiki.nevis.columbia.edu/twiki/bin/view/Nevis/Condor

Basic Condor@Nevis tutorial

https://www.nevis.columbia.edu/~seligman/root-class/html/appendix/batch/index.html