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Concepts of Condor and Condor-G

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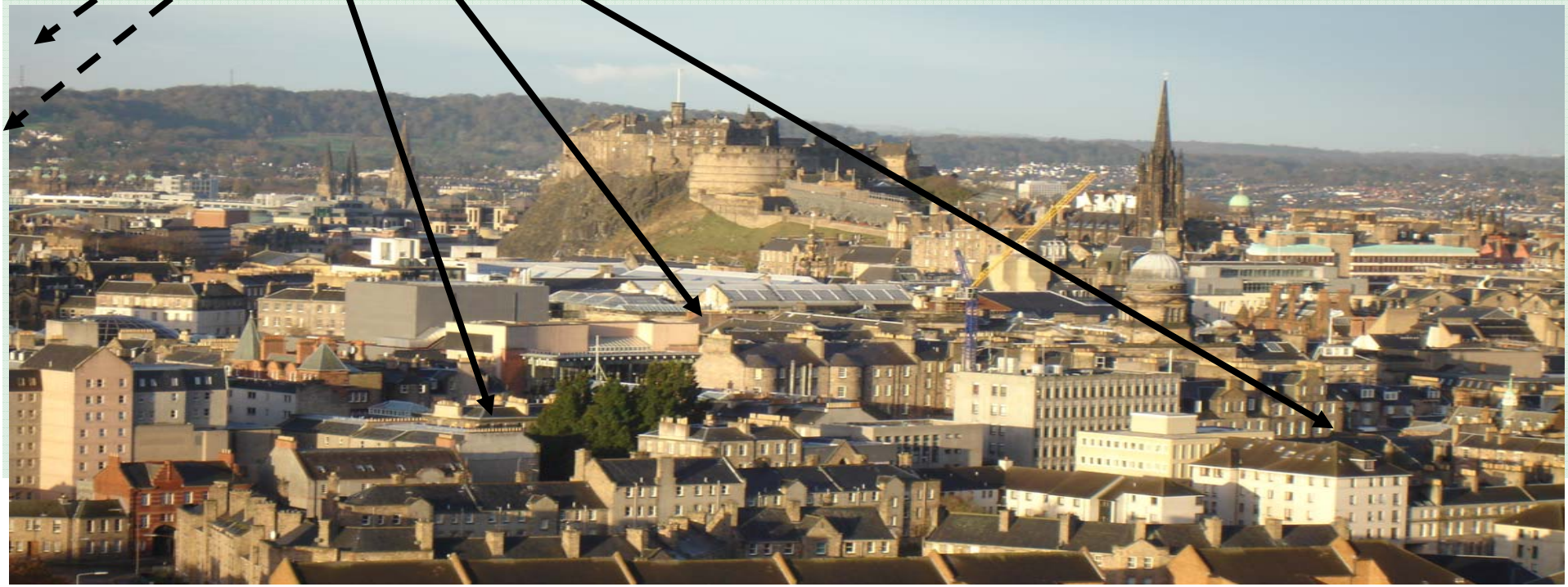
Harvesting CPU time

Often-idle processors!!

Teaching labs. + Researchers

Analyses constrained by CPU time!



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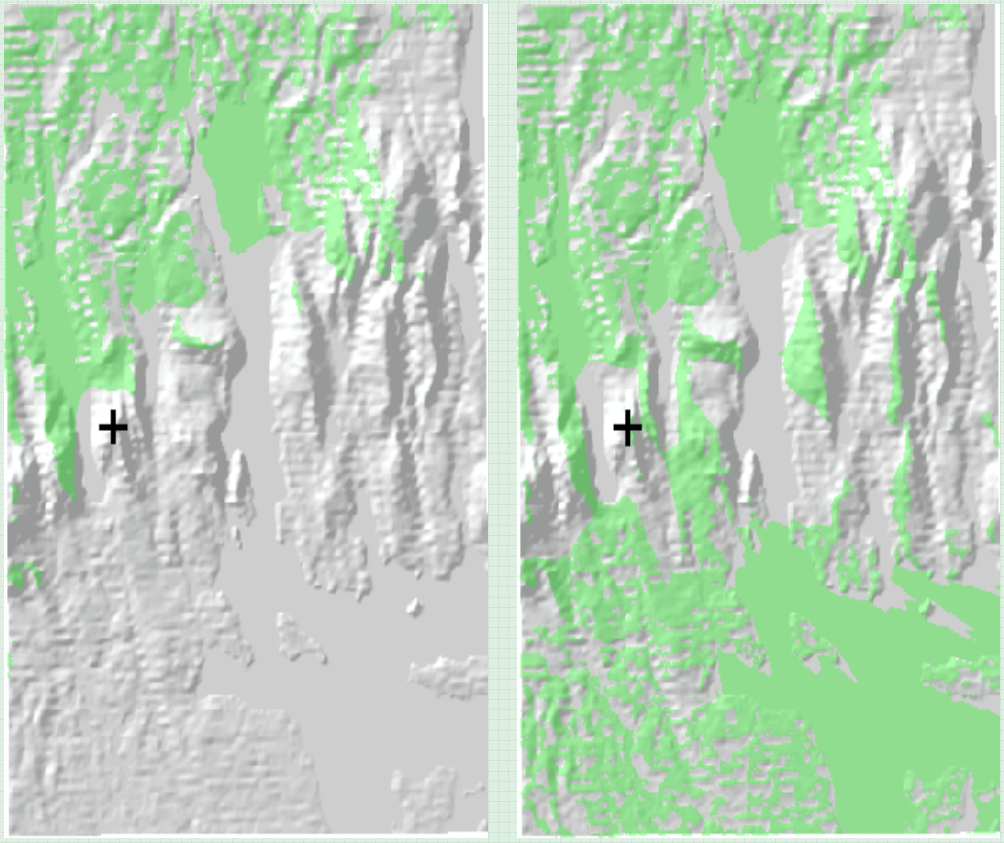
Harvesting CPU time

- Teaching lab machines lie idle for most of the time
- Harvest spare compute cycles to create a low-cost “high throughput computing” (HTC) platform
  - Goal: run many tasks in a week, month, …
  - Typically: many similar tasks invoked from workflow or a script
    - Monte-Carlo
    - Simulation – parameter sweeps
- Pool processors as a batch processing resource
- Submit jobs that run when a machine is free
- Condor most common approach
  - http://www.cs.wisc.edu/condor/

Example: viewshed analyses

Viewsheds: what can be seen from point at "+"



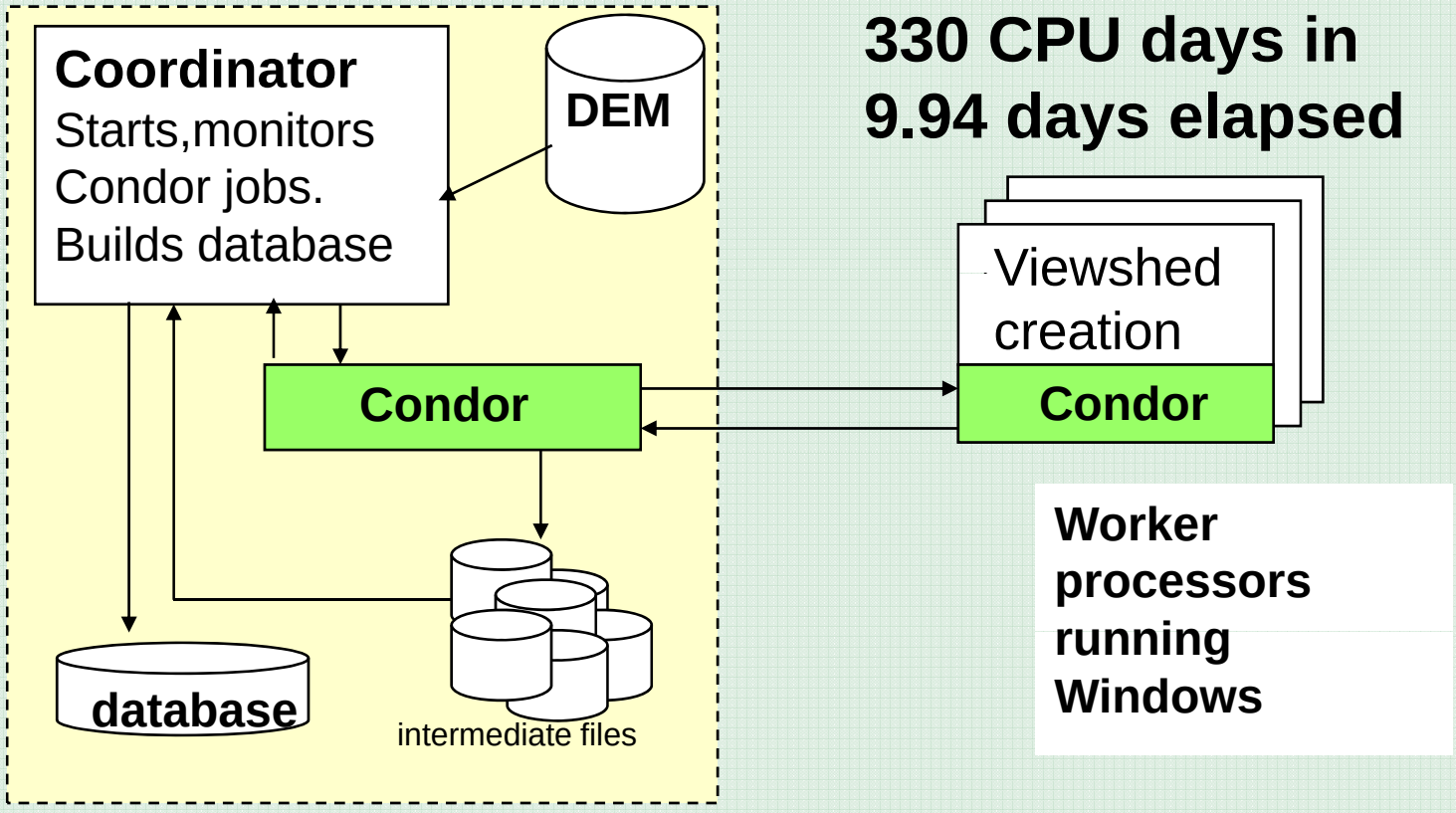
- Derive viewsheds for all points in "digital elevation model" (DEM)
- Build a database to allow
  - Derivation of indices to characterise viewsheds
  - Applications to access pre-calculated viewsheds

Mineter, Dowers, Caldwell

Example: viewshed analyses

Typical run:

39 PCs (Windows)
330 CPU days in
9.94 days elapsed



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Condor

- Converts collections of distributed workstations and dedicated clusters into a high-throughput computing (HTC) facility
  - Condor Pool
- Manages both resources (machines) and resource requests (jobs)
- Cycle scavenging
  - Using a non-dedicated resource when it would otherwise be idle.

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Terminology

- Cluster – a dedicated set of computers not for interactive use (definition by Alain Roy)
- Pool – a collection of computers used by Condor
  - May or may not be dedicated
  - Single administrative domain
- Central Manager – one per pool
  - Matches resource requests to resources (Matchmaking)
  - Pool Management
- (Flocking – running jobs submitted from pool A on pool B
  - Sharing resources with administrative domains possibly with user prioritization)

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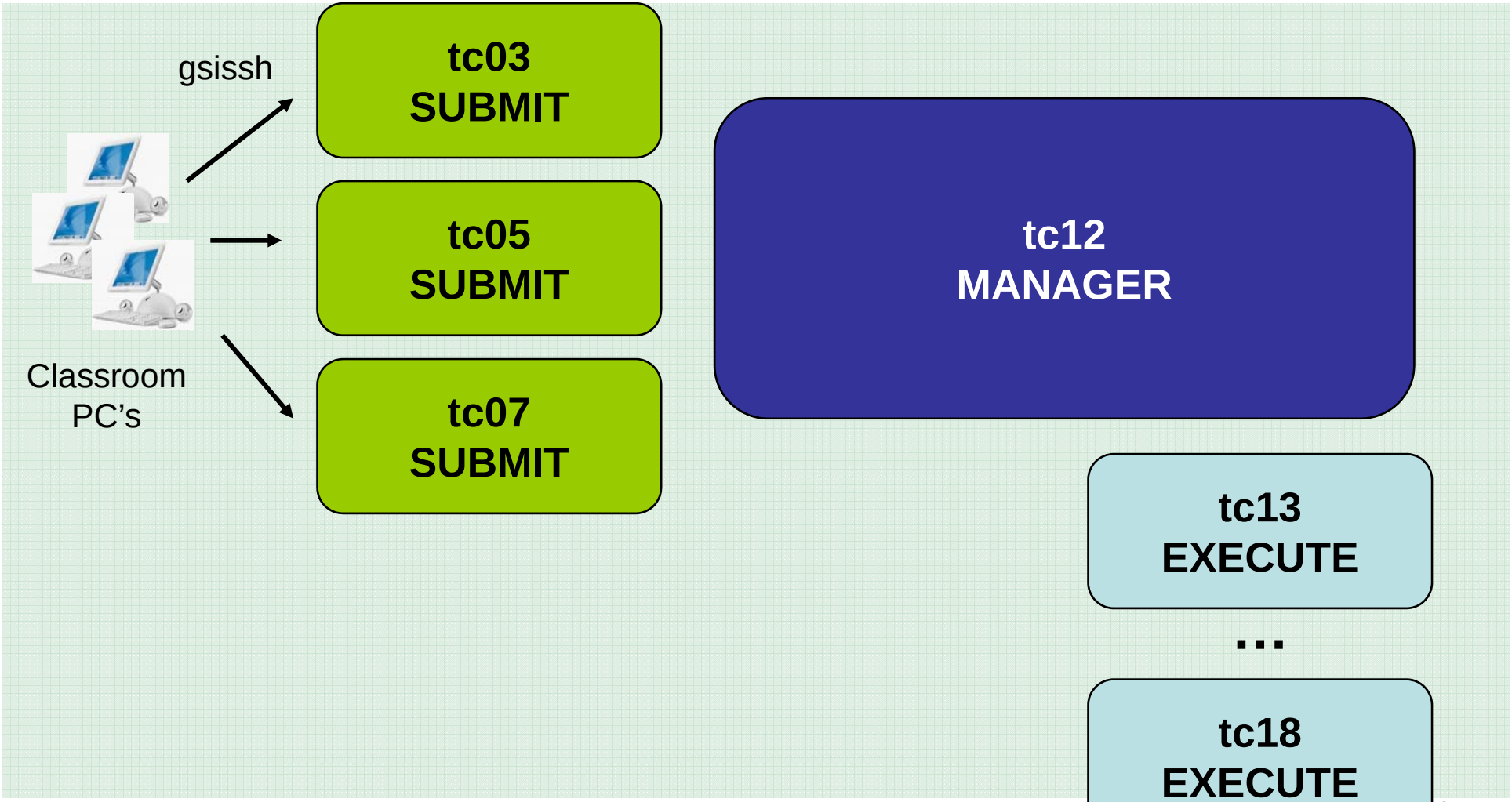
Architecture

- All nodes run condor_master
  - Responsible for control of a node.
- The Central Manager additionally runs condor_collector and condor_negotiator
  - Responsible for matchmaking
- An Execute Node additionally runs condor_startd
  - Responsible for starting a job
- A Submit Node additionally runs condor_schedd
  - Responsible for submitting jobs (and allowing user to monitor jobs)
- A Node must be at least one of Manager/Execute/Submit but may be more

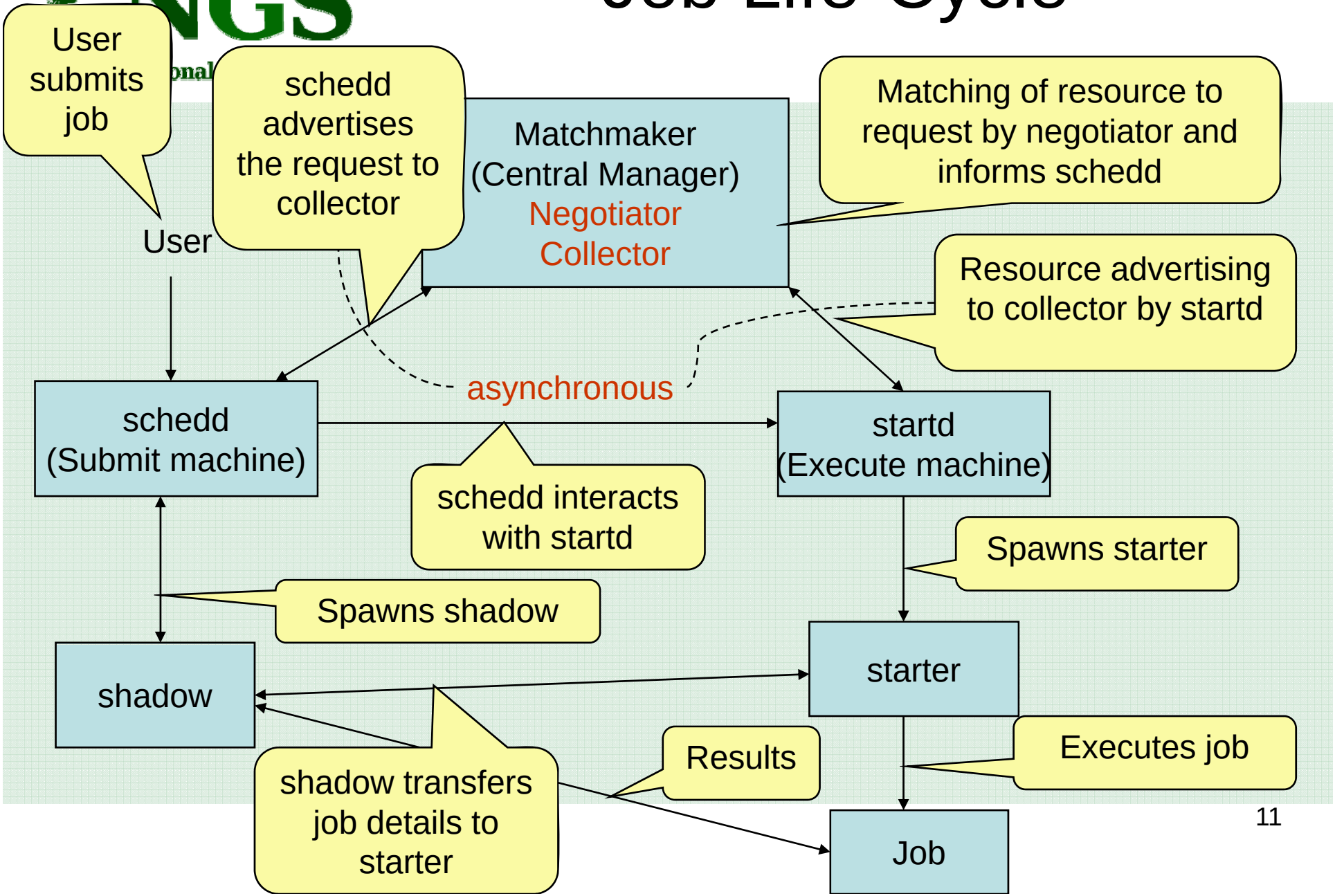
Example Configurations

- Personal Condor – all services on one node
  - Gain benefits of Condors job management
  - E.g. only run jobs on your desktop PC when you are not using it.
- Dedicated Cluster – Manager/Submit on head-node all other nodes are Execute.
  - Users ssh to head-node.
- Shared workstations – one workstation dedicated as Manager, all others as Submit/Execute
  - Submission from any workstation (except Manager)
  - Nodes join the pool as Execute Nodes when idle and leave the pool when Keyboard/Mouse activity detected.

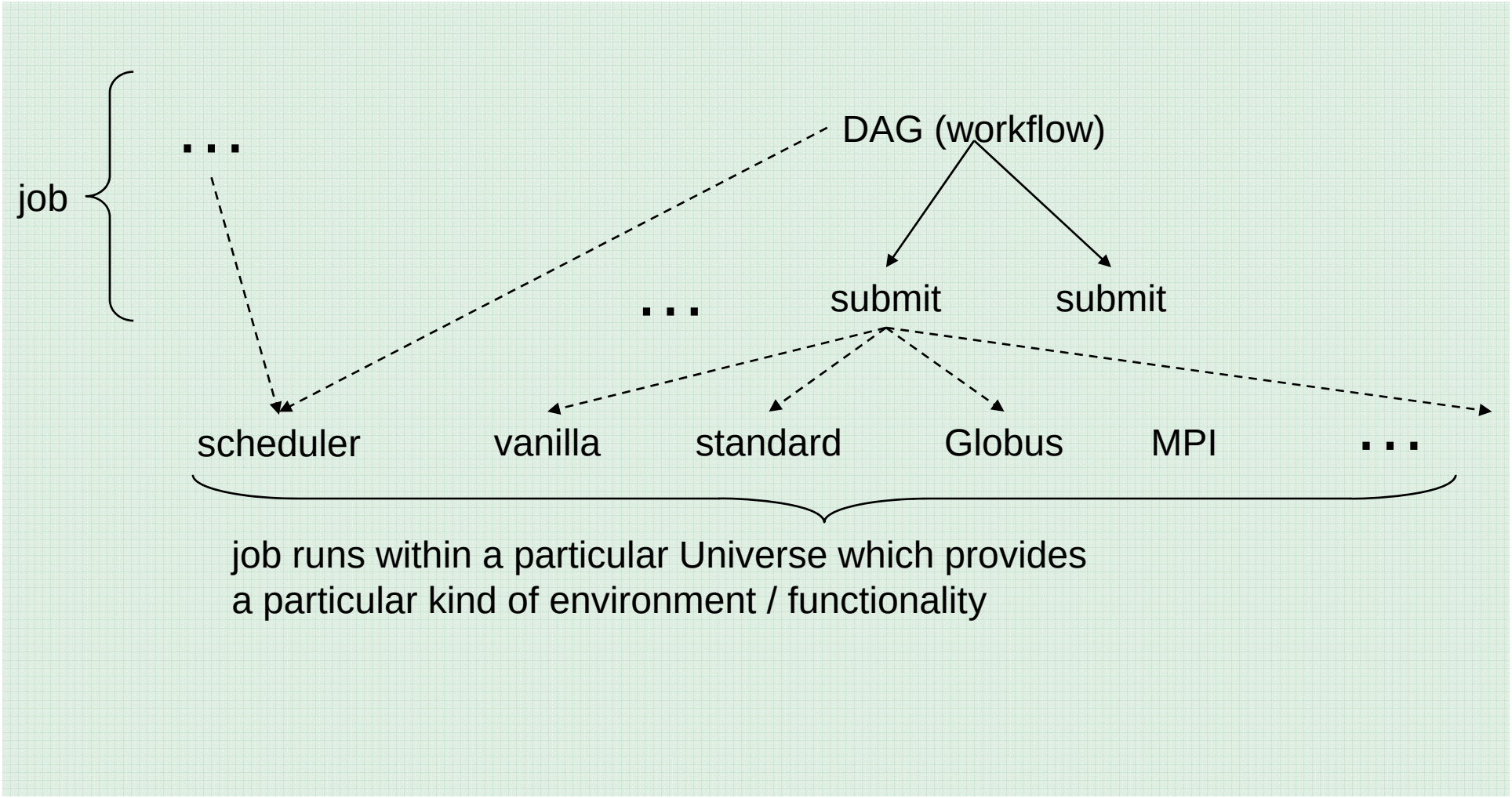
Our setup


gsissh
tc03
SUBMIT
tc05
SUBMIT
tc07
SUBMIT
Classroom
PC's
tc12
MANAGER
tc13
EXECUTE
...
tc18
EXECUTE

Job Life-Cycle



Job types – “Universes”



Some Universes

- Vanilla
  - Any job that does not require the features of the other universes
- Standard
  - goal – to reproduce home Unix environment
    - emulates standard system calls
      - file I/O
        - » remote access to home files
      - signal routing
      - resource management
  - + checkpointing
    - save the entire state into checkpoint file
    - can then restart from there – possibly on a different machine
    - for
      - migration
      - backwards error recovery
    - important for very long running jobs

Some More Universes

- Java
  - to provide a standard Java environment
- MPI
  - to allow use of message passing interface between component processes
- Scheduler
  - For running a job that schedules other jobs
  - Standard is DAGMAN
- Globus – “Condor-G” –
  - access to Globus Job Manager

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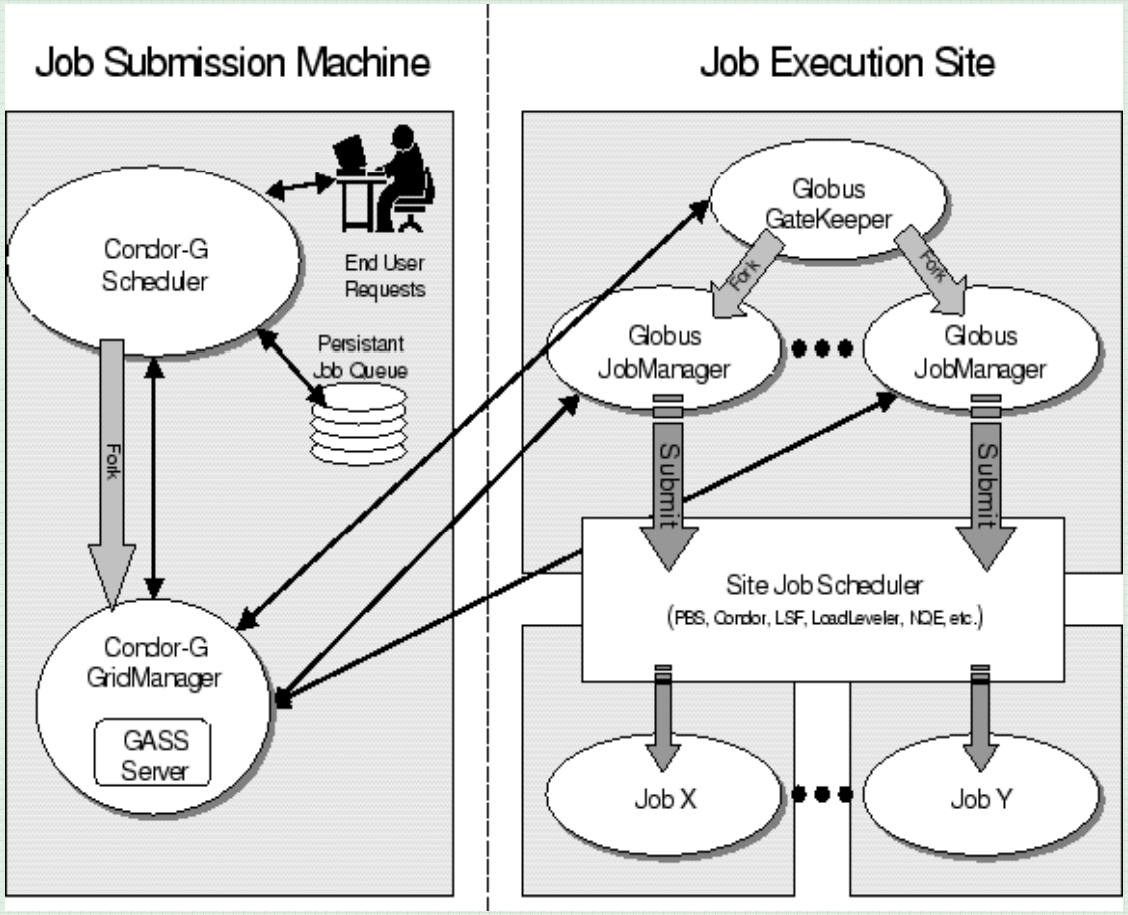
Condor-G

- Tool that provides globus universe – Condor-G
- The same Condor tools that access local resources are now able to use the Globus protocols to access resources at multiple sites.
  - One additional line in submit file
- Condor-G
  - manages both a queue of jobs and the resources from one or more sites where those jobs can execute.
  - communicates with these resources and transfers files to and from these resources using Globus mechanisms.
  - more than just a replacement for globusrun

Condor & Globus

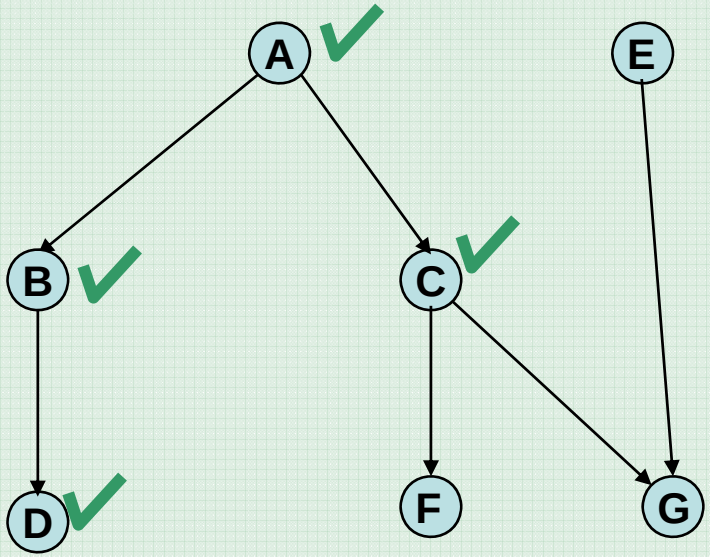


Condor uses the following Globus protocols

- **GSI** – for authentication and authorization
- **GRAM** – protocol that Condor-G uses to talk to remote Globus jobmanagers.
- **GASS** – to transfer the executable, stdin, stdout, and stderr between the machine where a job is submitted and the remote resource.
- **RSL** – to specify job information.

DAGMAN

- Directed Acyclic Graph Manager
  - specify dependencies as a DAG
  - re-start a partially completed DAG
    - records what has been done



Each vertex (DAG node) is a normal submit command For any universe (most appropriate for a scheduler universe)

Each arc is a sequencing constraint - Parent must finish before child starts

Match Making

- Matchmaking is fundamental to Condor
- Matchmaking is two-way
  - Job describes what it requires: I need Linux && 2 GB of RAM
  - Machine describes what it provides: I am a Mac
- Matchmaking allows preferences
  - I need Linux, and I prefer machines with more memory but will run on any machine you provide me
- Condor conceptually divides people into three groups:
  - Job submitters
  - Machine owners
  - Pool (cluster) administrator

  } May or may not be the same people
- All three of these groups have preferences

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ClassAds

- ClassAds state Facts
  - Submit-side e.g. My job's executable is analysis.exe
  - Execute-side
    - Dynamic e.g. My machine's load average is 5.6
    - Static e.g. My machine's operating system is Linux
- ClassAds state preferences:
  - Job submitter preferences e.g. I require a computer with Linux
  - Machine owner preferences e.g. I prefer jobs from the physics group
  - System Administrator preferences e.g. When can jobs pre-empt other jobs?

The Tutorial

- The tutorial covers:
  - Basic Condor Usage
    - Vanilla universe
  - Standard Universe
  - Condor-G
  - DAGMan
  - Matchmaking

http://homepages.nesc.ac.uk/~gcw/NGS/AppDev/Condor.html