Introduction to glideinWMS

From the point of view of the CMS VO

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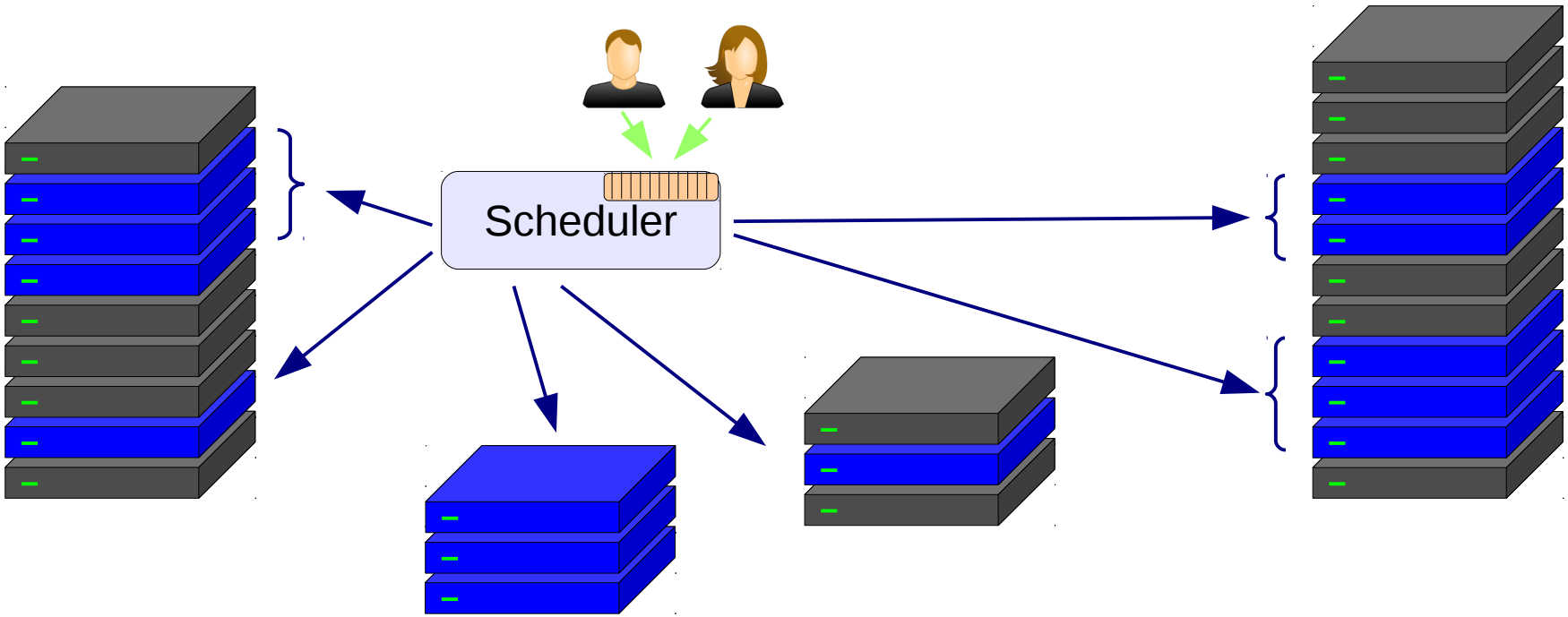
HTC, DHTC and overlays

- **H**igh **T**hroughput **C**omputing is about efficient and effective scheduling of user jobs on top of a compute resource pool
- **D**istributed HTC is about aggregation of many unrelated HTC systems
  - With overlays being the preferred operation mode

Overlays in DHTC

- A DHTC overlay is about creating a global HTC system on top of leased resources

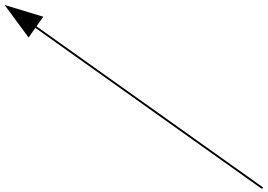


HTC vs DHTC products

- There are several mainstream HTC products available, e.g.
  - Condor
  - PBS, with variants like Torque/Maui
  - LSF
  - SGE, also known as Oracle Grid Engine
- None natively supports DHTC overlays
  - They all assume full control of the managed compute resources

DHTC overlay systems

- There are a few full-stack DHTC overlay systems available, e.g.
  - DIRAC
  - PANDA
  - Alien
- glideinWMS instead heavily relies on HTCondor for the HTC part
  - glideinWMS proper only handles the D- part



i.e. they implement all the bits and pieces needed to make the DHTC overlay logic work

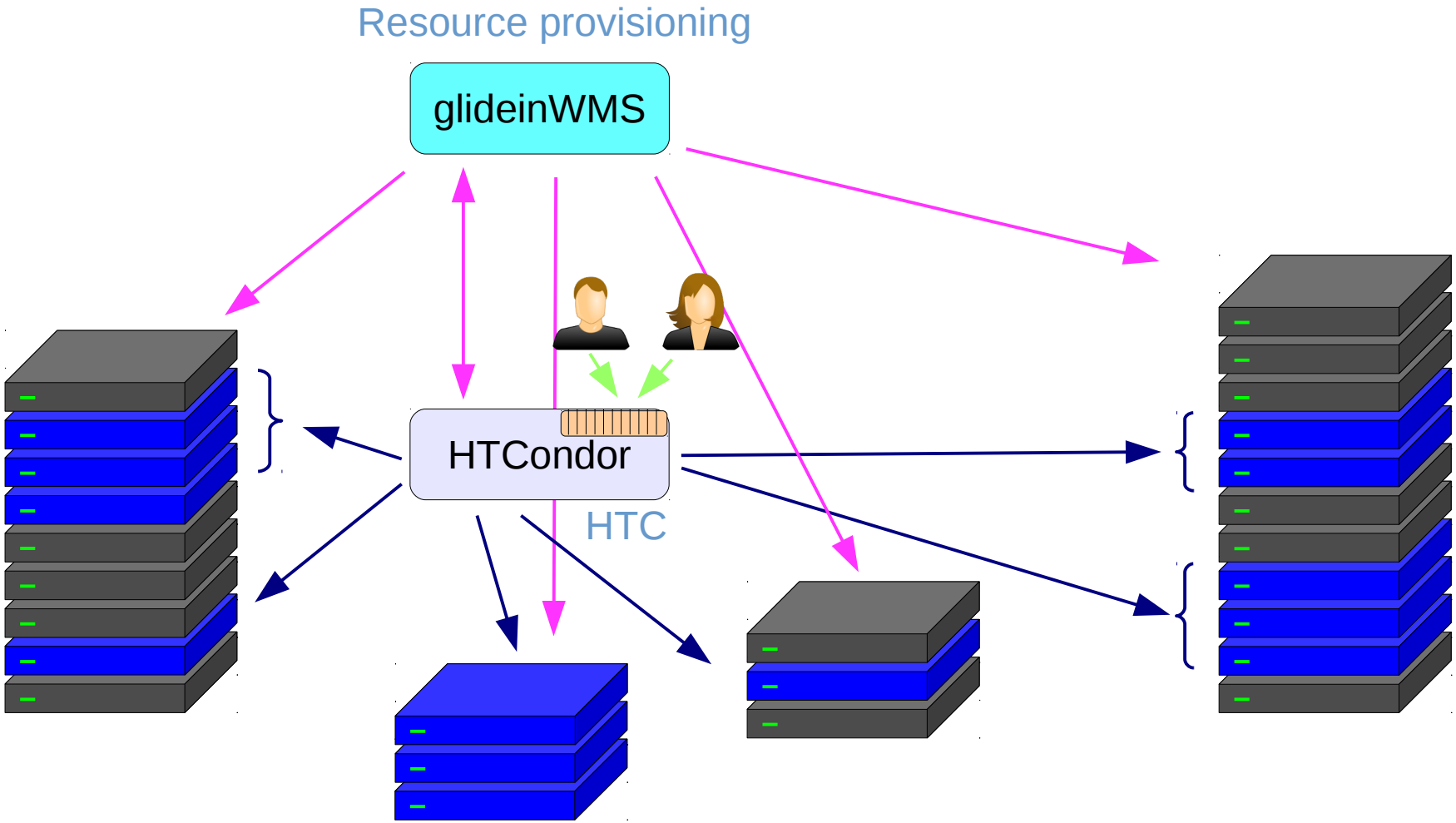
Pros and cons of layered approach

- The glideinWMS approach of relying on HTCondor for the HTC part has its benefits
  - Very mature HTC layer, with “standard” tools
  - Relatively low development and maintenance cost for the glideinWMS-proper code
- But it does have its disadvantages
  - Less integration between the two layers
  - The need to work around some “dedicated HTC” assumptions in HTCondor

Resource provisioning

- The glideinWMS-proper part is mostly about **resource provisioning**
  - Deciding **when** more resources are needed,
  - Deciding **where** to lease the from
  - **Validating** and **configuring** them after the lease
- It also assists in deciding when resources should be returned to the resource owner
  - Although HTCondor itself implements the core logic

Resource provisioning



Grid and Cloud

- Grids and Clouds are the two main paradigms for providing non-dedicated resources
  - Both offer **resource elasticity**

- Grid computing is basically a federation of HTC clusters
  - Thus a true **Distributed HTC**
- Job queuing is a native paradigm

- (Commercial) Clouds are about leasing resources on a pay-as-you-go basis
  - And they happen to use virtualization
- Instances expected to start almost immediately

Grid and Cloud

- Grids and Clouds are the two main paradigms for pro ted resources
  - **sticity**
- **glideinWMS currently optimized for the Grid model**
- (C re
  - p n
  - of H s
  - Thus a true **Distributed HTC**
- Job queuing is a native paradigm

Note:
So-called “scientific clouds” are typically just Grid systems that use virtualization (and a different middleware stack)

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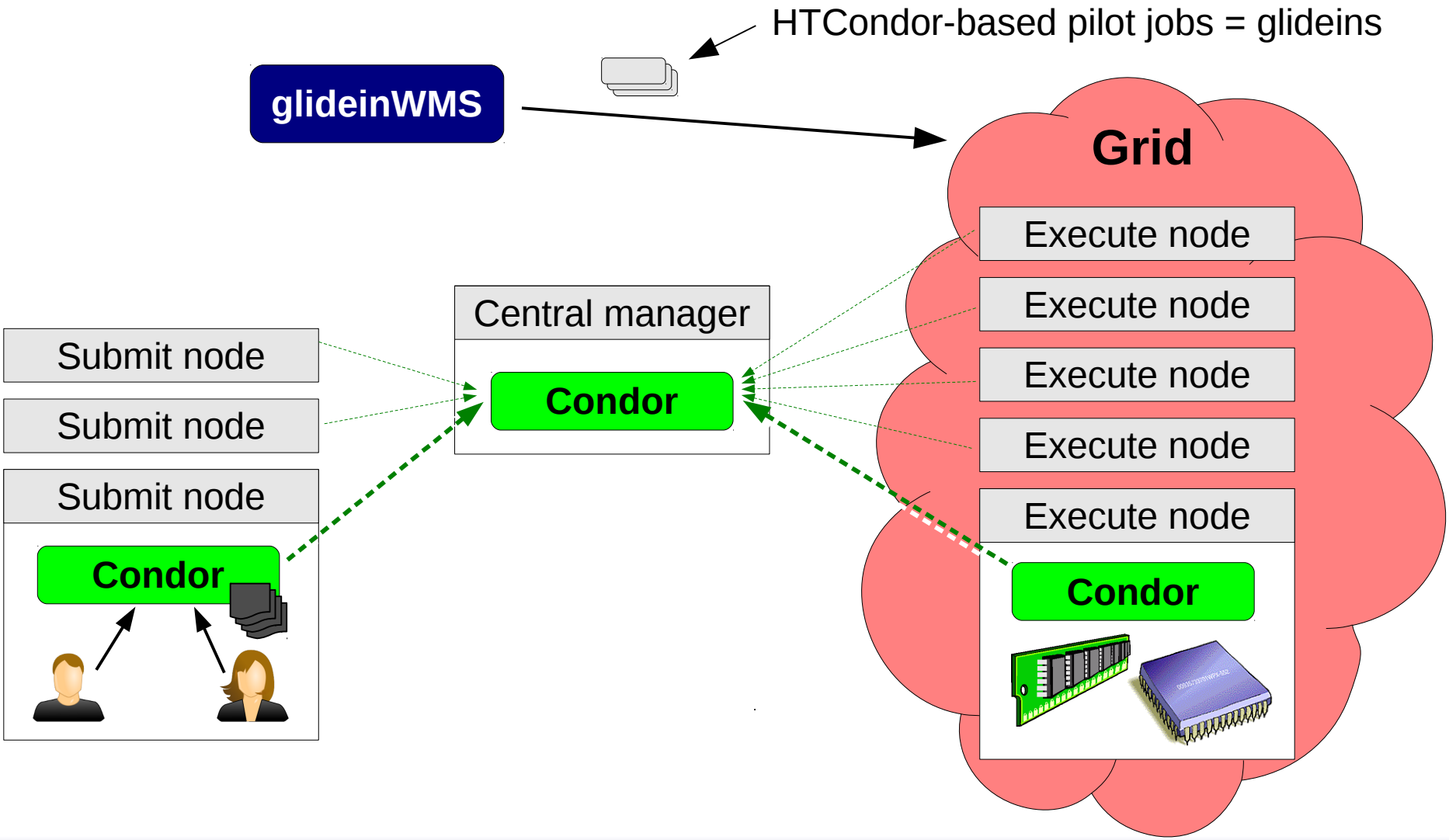
  - on sis
  - And they happen to use virtualization
- Instances expected to start almost immediately

R.P. as pilot job submission



Two layers

- glideinWMS is composed of two layers
  - **Glidein Factory** – The abstraction layer
  - **VO Fronend** – The policy layer - i.e. the brain
- The splitting in two allows for the **Glidein Factory** to be **generic**
  - It can thus serve many different VO Frontends
  - It can (and should) be shared between many independent VOs
- A VO Frontend can also use more than one Glidein Factory
  - For scalability and reliability

With CMS being one such VO (Virtual Organization)

The VO Frontend

- The name may be misleading
  - It is really the "**matchmaker of Grid resources**"
- Introduces a new quanta
  - **Entry** – logical equivalent of a "**queue at a site**"
    Basic working block of a G.F.
- The VO Frontend
  1) **Matches idle Jobs to Entries**
  2) **Instructs the affected G.F.** to increase or decrease the number of glideins on that Entry

Thus regulates the resource provisioning

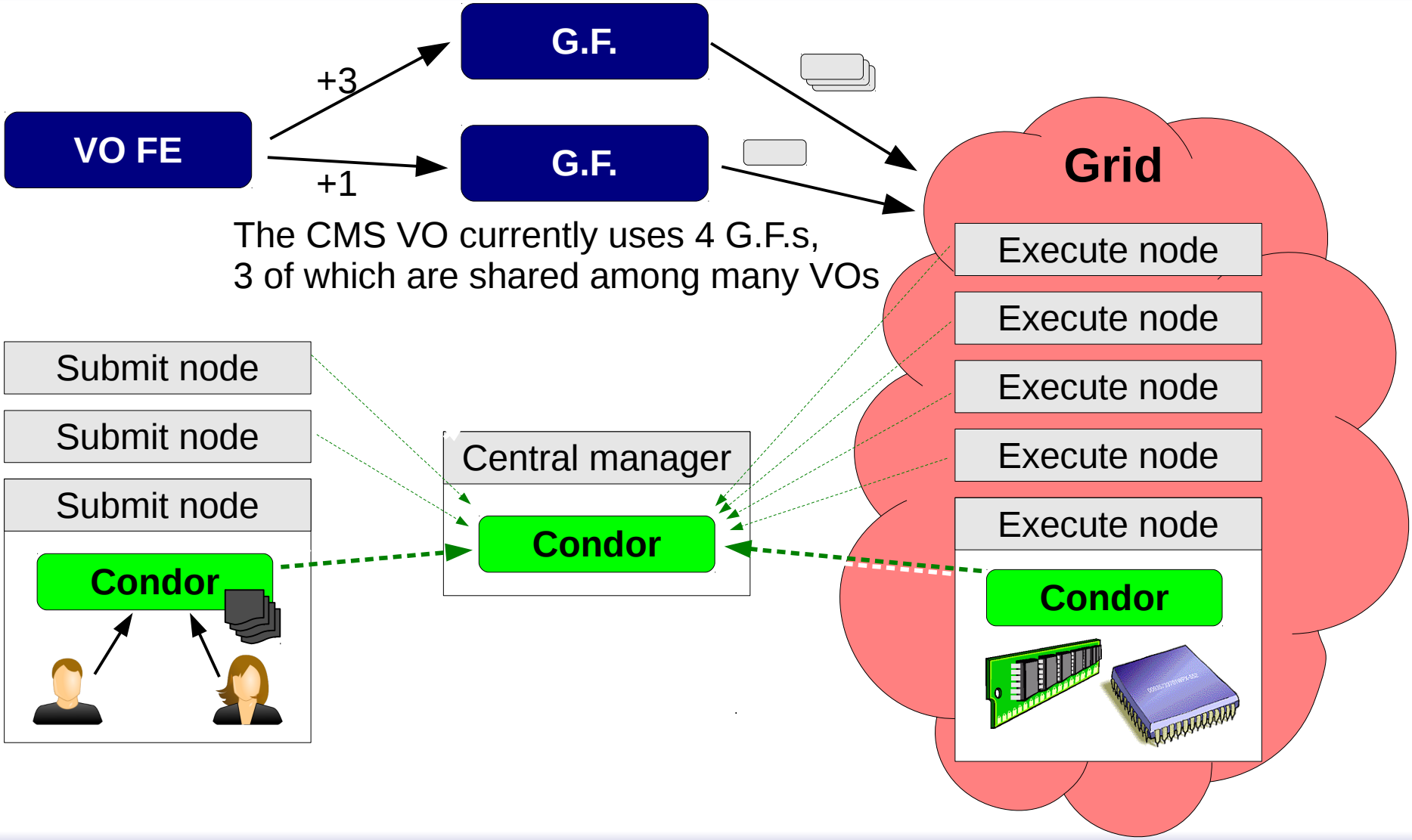
Glidein Factory

- The G.F. is really just an **abstraction layer**
  - Provides a logical description of the resources
    - As a set of attributes
  - Insulates the Frontend from the resource details
    - e.g. knowing the nodes a site uses for job submission
  - Allows new technology to be added seamlessly (e.g. GRAM vs CREAM and interfacing to Clouds)
- It also provides a **troubleshooting service**
  - The factory operators are supposed to **address any Grid related problems they observe**
    - e.g. missing libraries or firewall problems

Working relationship

- The Glidein Factory is just a slave
  - It will do whatever the VO Frontend asks it to do
  - e.g no G.F. submission logic or throttling
- The glideins are submitted in the VO Frontend's name
  - The VO Frontend owns the credential (e.g. x509 proxy)
  - And delegates it so the G.F. can submit glideins

Typical VO Frontend setup



Two level matchmaking

- In a glideinWMS system there are **two layers** that do job matchmaking
  - The VO Frontend, for resource provisioning
  - The HTCondor Central Manager for HTC
- The two layers **must be in sync**, else
  - Jobs may never start,
    since no resources are provisioned, or
  - Provisioned resources are never used,
    since no jobs match

Matchmaking logic defined in VO FE

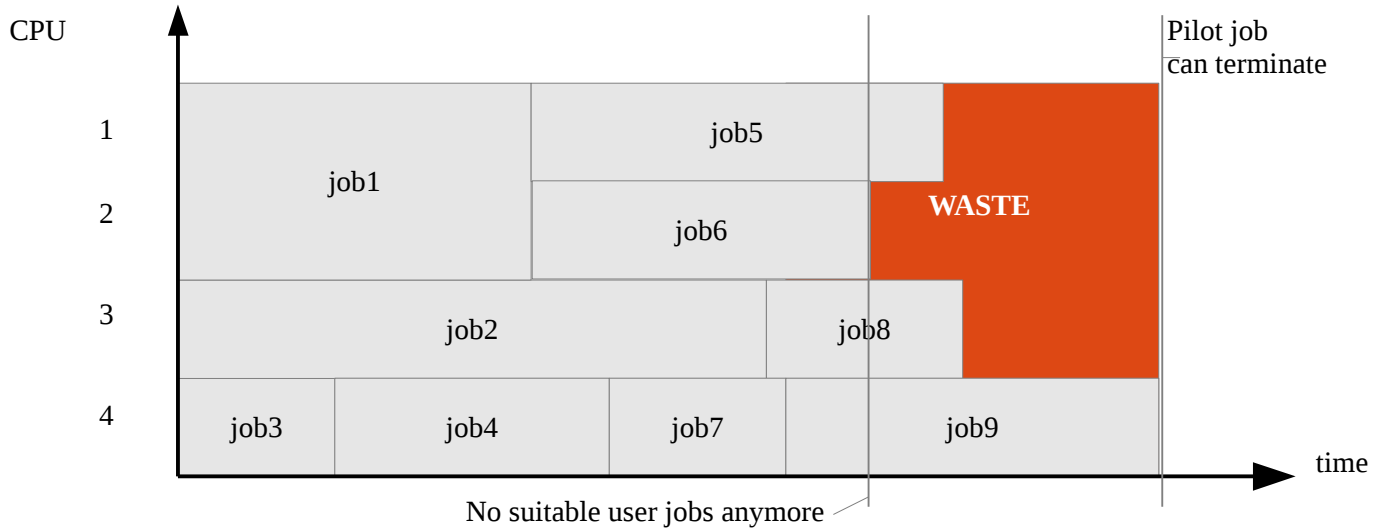
- The VO Frontend contains both
  - **Its own matchmaking logic** vs Entries, and
  - **the HTCondor matchmaking logic**,
    in the form of Machine Requirements
  - The two may be slightly different,
    since Entries have less detail than Machines
- User jobs should not define any Requirements
  - Since those are only used by HTCondor
  - They should **only define attributes**
    describing the desired outcome

Limited lease lifetime

- glideinWMS operates on leased resources
  - And all **leases have a limited lifetime**
- In the Grid, currently, the leases are quite short
  - Typically 24h to 48h
  - And cannot be extended at runtime
- All user jobs must terminate before the lease end
  - Or they will killed
- Each glidein can run multiple jobs
  - **Policy must prevent matching jobs that cannot finish in time**

Multi-core glideins

- A single glidein can lease multiple CPUs
  - And then partition them among several jobs
- Be wary of the **termination waste**, though
  - Since unlikely that all jobs terminate together



Security considerations

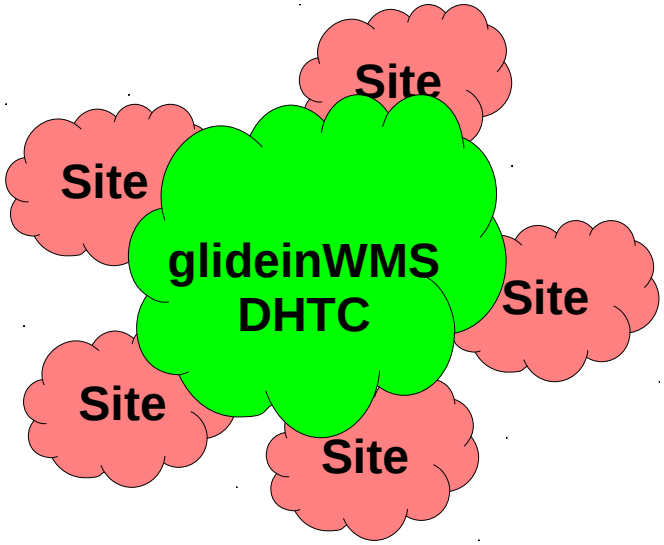
- Pilot jobs typically don't have superuser privileges
  - At least in most of the Grid ecosystem
- HTC system needs system-level protections
  - To **protect itself from the user jobs**
  - To **protect jobs from different users**, running on the same node
    - Most nodes are multi-core these days
- Most of CMS sites support gLExec
  - Allows UID switching by presenting a user x509 proxy
  - Requires user jobs to have a valid proxy at all times

Security considerations

- DHTC has nodes that communicate via WAN
  - Which cannot be considered safe on face value
- All glideinWMS processes, including HTCondor, enable for all network communciation
  - Strong authentication methods (based on x509 proxies)
  - Integrity checks
- Network security can be expensive
  - The setup has to account for it

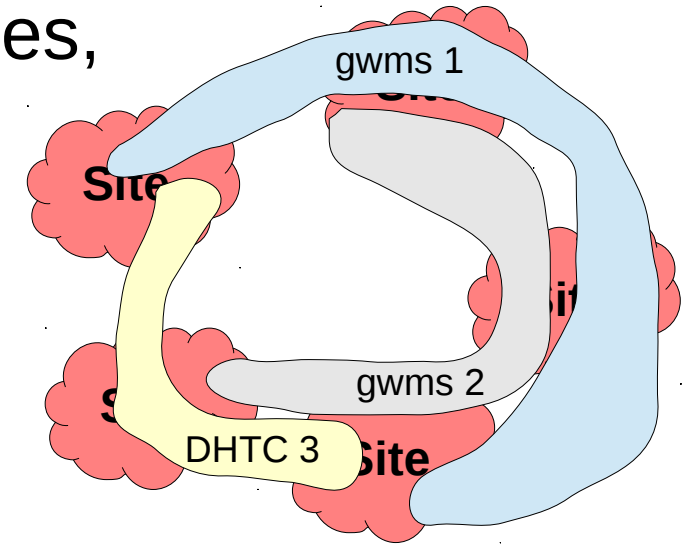
The big picture

- As a reminder, glideinWMS creates an overlay DHTC system on top of resources provided by many sites



The big picture

- The previous slide could led you to believe that there can only be one overlay
- In reality, **there can be any number of them**!
  - Each serving its own user community
  - Can be other DHTC technologies, too
- Not necessarily all using the same set of Sites, i.e. HTC clusters



Why many DHTC instances?

- Different VOs typically don't want to share a glideinWMS DHTC instance
- While technically possible, there are
  - Security risks
  - Increased maintenance complexity
  - Politics!
- Typically we get one glideinWMS DHTC instance per VO
  - But some VOs have more than one

Immagine co-scheduling of CMS and ATLAS jobs!

The CMS VO currently has 3

Pointers

- glideinWMS development team is reachable at glideinwms-support@fnal.gov
- The official project Web page is http://tinyurl.com/glideinWMS
- HTCondor Web page http://research.cs.wisc.edu/htcondor/

Acknowledgments

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  and by the UC system