HTCondor Security Basics

European HTCondor Workshop Sept 2019

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Overview

- What are the threats?
- Who do you trust?
- What are the mechanisms?
- Other security concerns?

Threats

- The purpose of HTCondor is to accept arbitrary code from users and run it on a large number of machines

Threats

- The purpose of HTCondor is to accept arbitrary code from users and run it on a large number of machines
- The purpose of a botnet is to take arbitrary code and run it on a large number of machines

Threats

- So what's the difference?
- You wish to prevent unauthorized access
- Ultimately, it just comes down to who can use your pool, and how they can use it.

Basic Concepts

- “Who can use your pool” is really two concepts:
- The “Who” is authentication
- The “can use” is authorization

Basic Concepts

- In the context of an HTCondor pool:
  - You want only hosts (machines) that you trust to be in the pool
    - ^^^ Is that enough?
  - You want only people you trust to submit jobs

Authentication

- For a secure pool, both users and HTCondor daemons must authenticate themselves
- HTCondor supports several mechanisms :
  - Host based (by just using source IP address)
  - File System (FS) – used by schedd by default
  - Pool Password (PASSWORD)
  - KERBEROS
  - SSL
  - GSI

Other Security Features

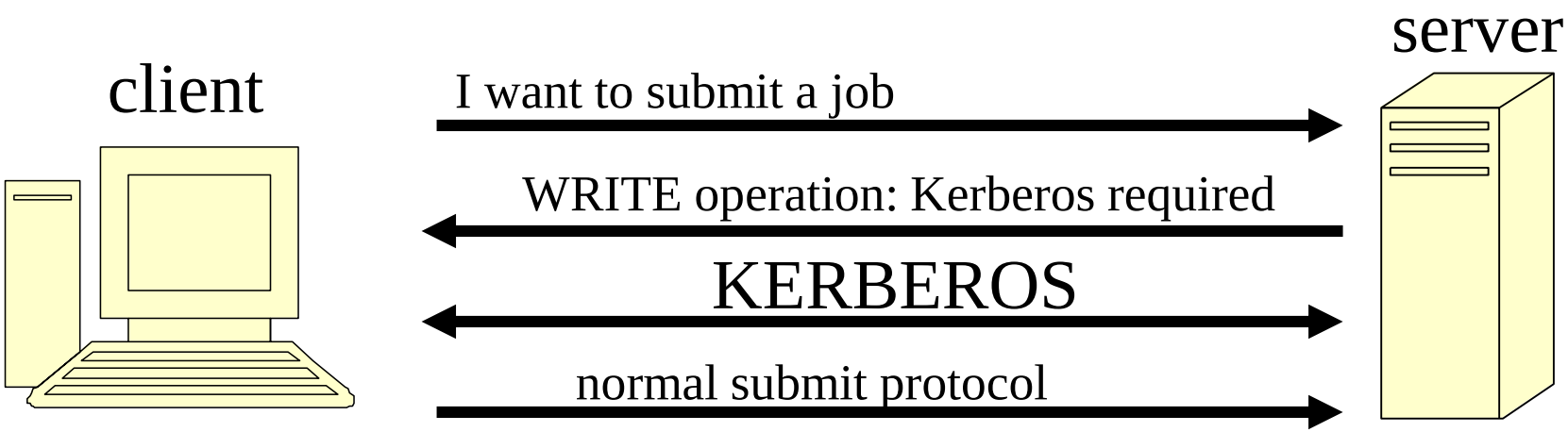
- In addition to authenticating network connections, you may also wish to use:
- Integrity Checks (MD5)
  - Allows HTCondor to know if traffic has been tampered with
- Encryption (3DES, Blowfish)
  - Allows HTCondor to transmit encrypted data so it cannot be spied on while in transit

Authorization Levels

- READ
- WRITE
  - submit jobs, …
- DAEMON
  - Advertise ads into the collector, claim slots, …
- ADMINISTRATOR
  - Change user priorities, reconfig
- NEGOTIATOR
  - Can give matches (slots) to schedds

Security Negotiation

- When first contacting each other, HTCondor daemons have a short negotiation to find out which mechanisms are support and what features are required for the connection



Security Negotiation

- Policy Reconciliation Example:

CLIENT POLICY

SEC_DEFAULT_ENCRYPTION = OPTIONAL
SEC_DEFAULT_INTEGRITY = OPTIONAL
SEC_DEFAULT_AUTHENTICATION = OPTIONAL
SEC_DEFAULT_AUTHENTICATION_METHODS = FS, GSI, KERBEROS, SSL, PASSWORD

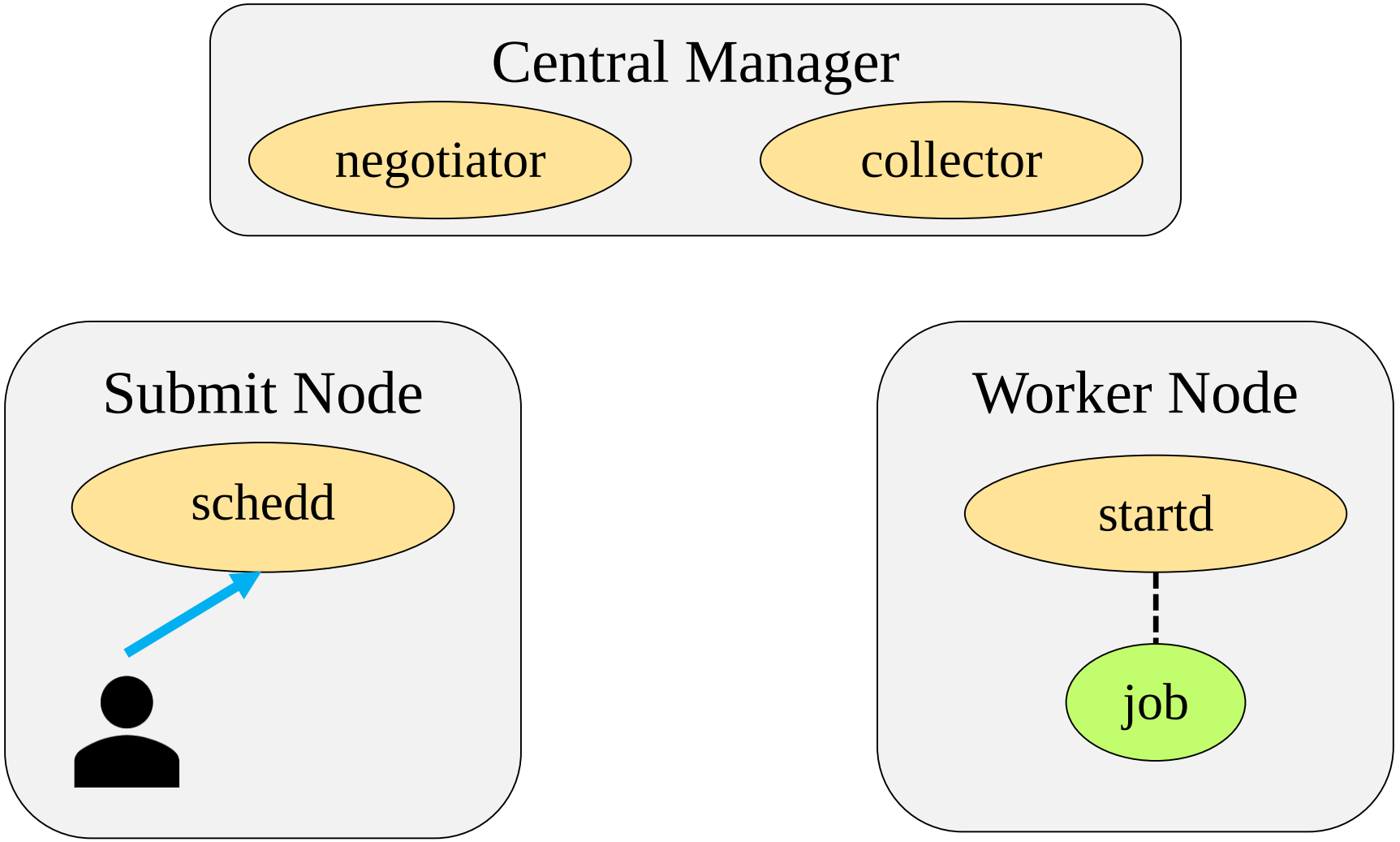
SERVER POLICY

SEC_DEFAULT_ENCRYPTION = REQUIRED
SEC_DEFAULT_INTEGRITY = REQUIRED
SEC_DEFAULT_AUTHENTICATION = REQUIRED
SEC_DEFAULT_AUTHENTICATION_METHODS = SSL

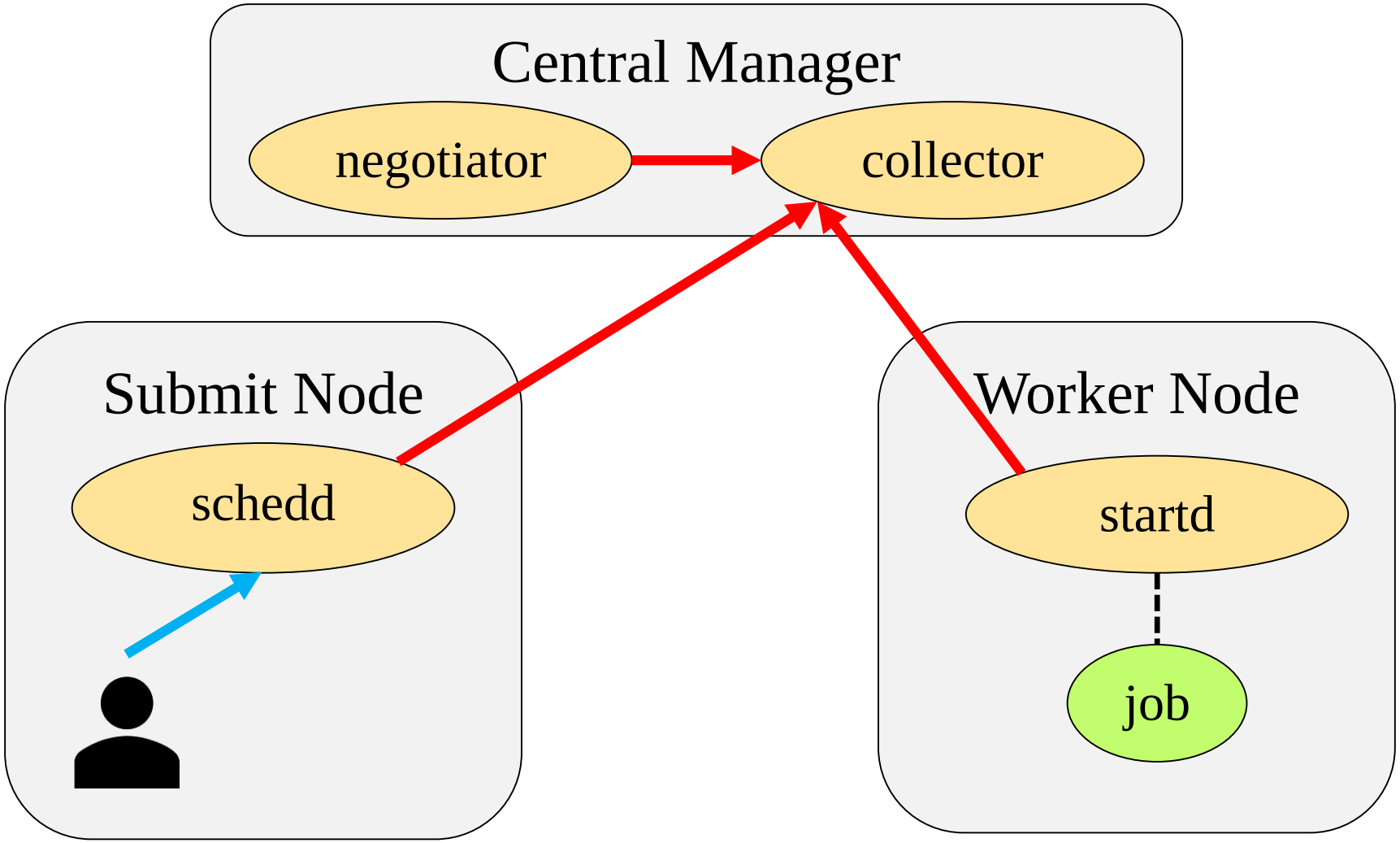
RECONCILED POLICY

ENCRYPTION = YES
INTEGRITY = YES
AUTHENTICATION = YES
METHODS = SSL

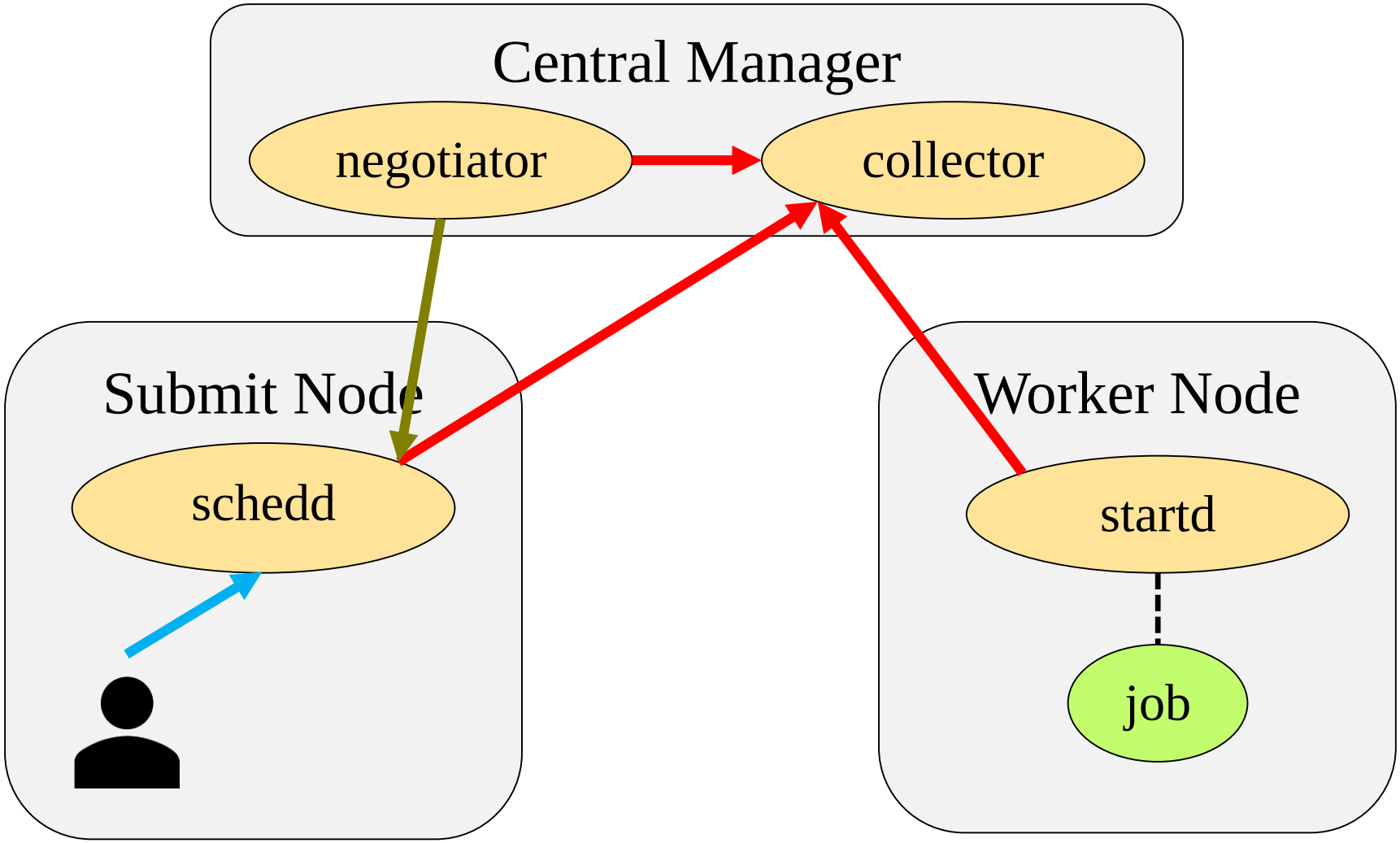
```
CONDOR_HOST  = my-central-manager.wisc.edu
ALLOW_READ = *
```



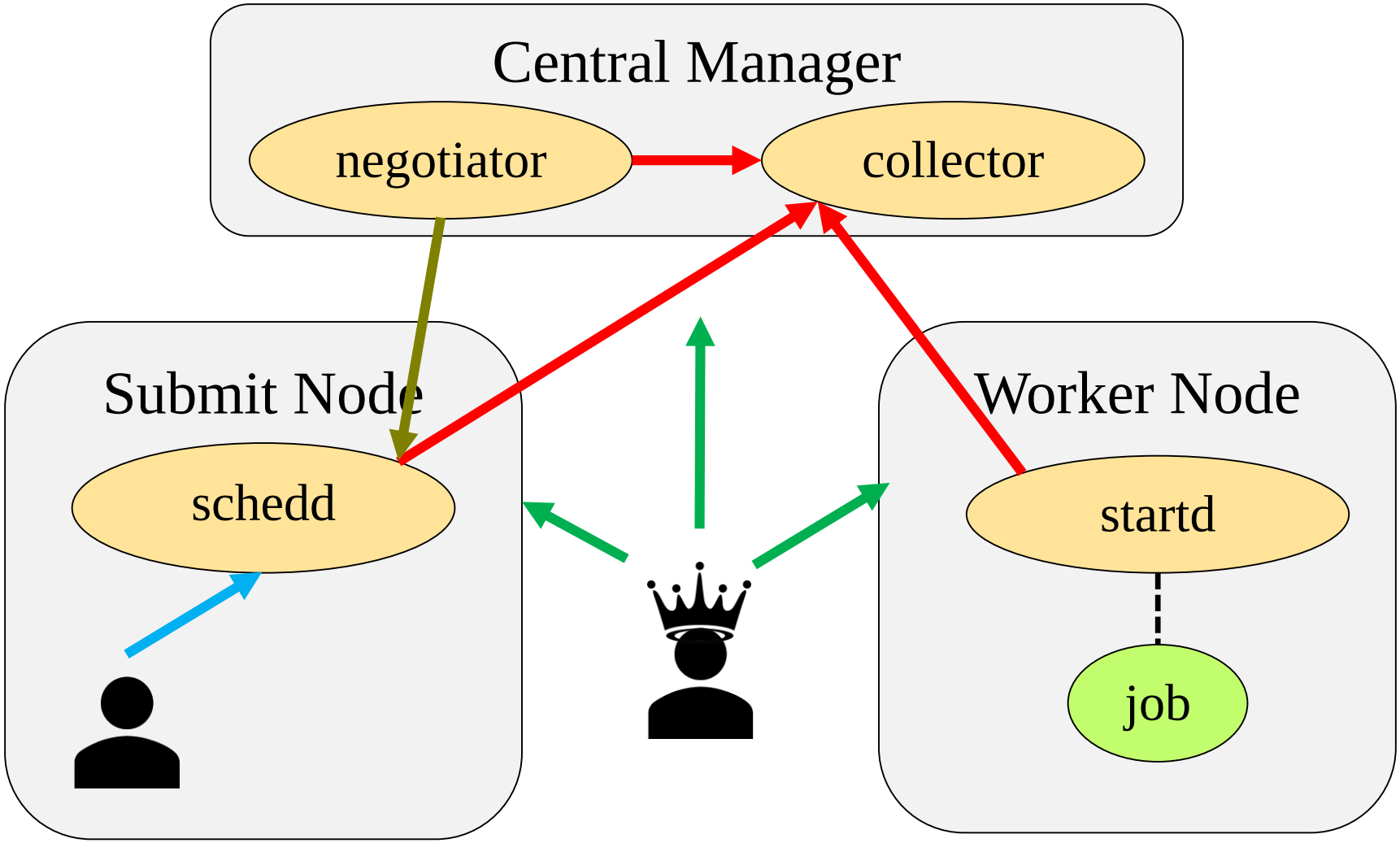
```
CONDOR_HOST  = my-central-manager.wisc.edu
ALLOW_READ = *
ALLOW_DAEMON = $(CONDOR_HOST), submit*.wisc.edu, worker*.wisc.edu
```



```
CONDOR_HOST  = my-central-manager.wisc.edu
ALLOW_READ = *
ALLOW_DAEMON = $(CONDOR_HOST), submit*.wisc.edu, worker*.wisc.edu
ALLOW_NEGOTIATOR = $(CONDOR_HOST)
```



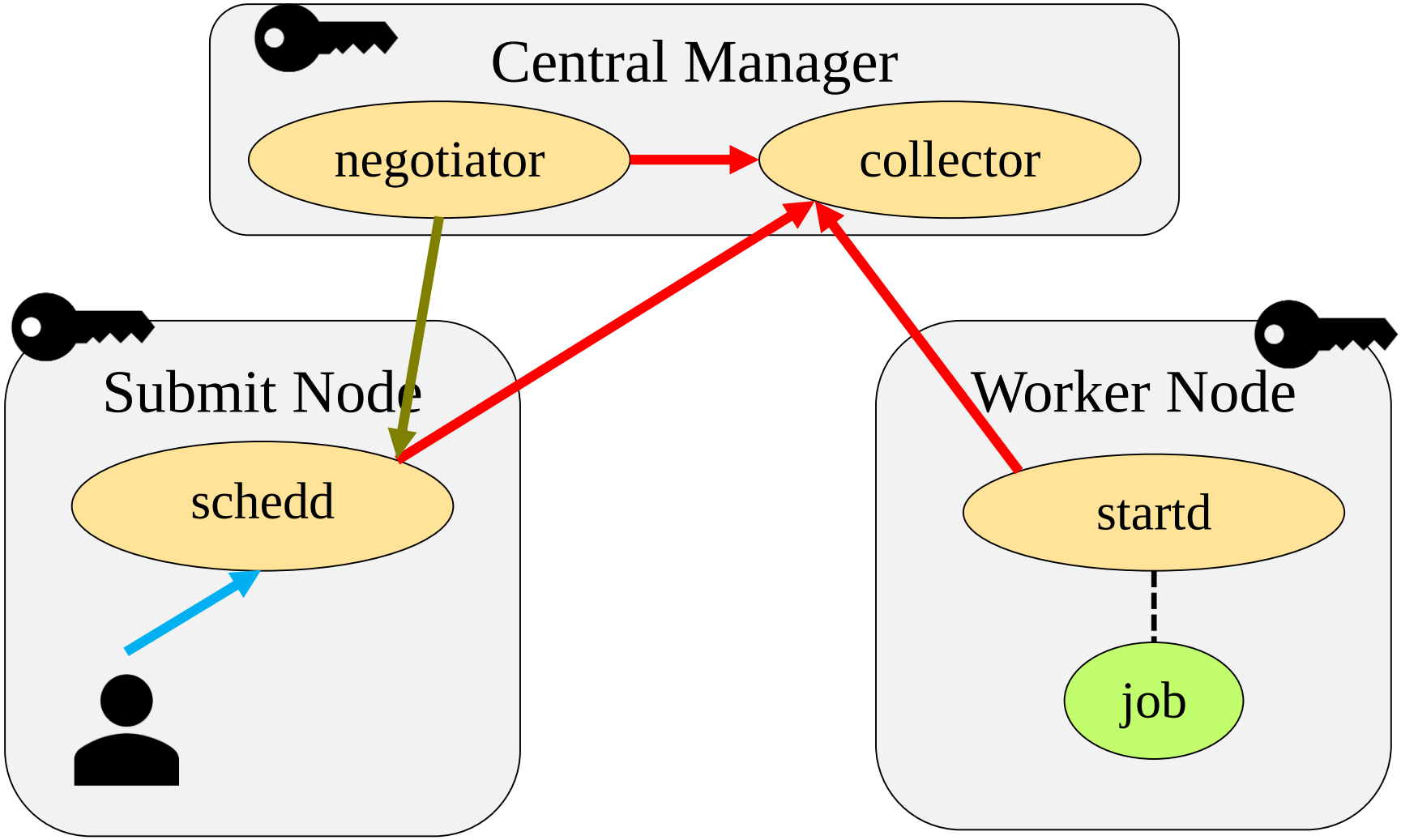
```
CONDOR_HOST  = my-central-manager.wisc.edu
ALLOW_READ = *
ALLOW_DAEMON = $(CONDOR_HOST), submit*.wisc.edu, worker*.wisc.edu
ALLOW_NEGOTIATOR = $(CONDOR_HOST)
ALLOW_ADMINISTRATOR = $(CONDOR_HOST)
```



Thoughts?

```
CONDOR_HOST  = my-central-manager.wisc.edu
ALLOW_READ = *
ALLOW_DAEMON = $(CONDOR_HOST), submit*.wisc.edu, worker*.wisc.edu
ALLOW_NEGOTIATOR = $(CONDOR_HOST)
ALLOW_ADMINISTRATOR = $(CONDOR_HOST)
```

Create a pool password file and copy to all machines in the pool

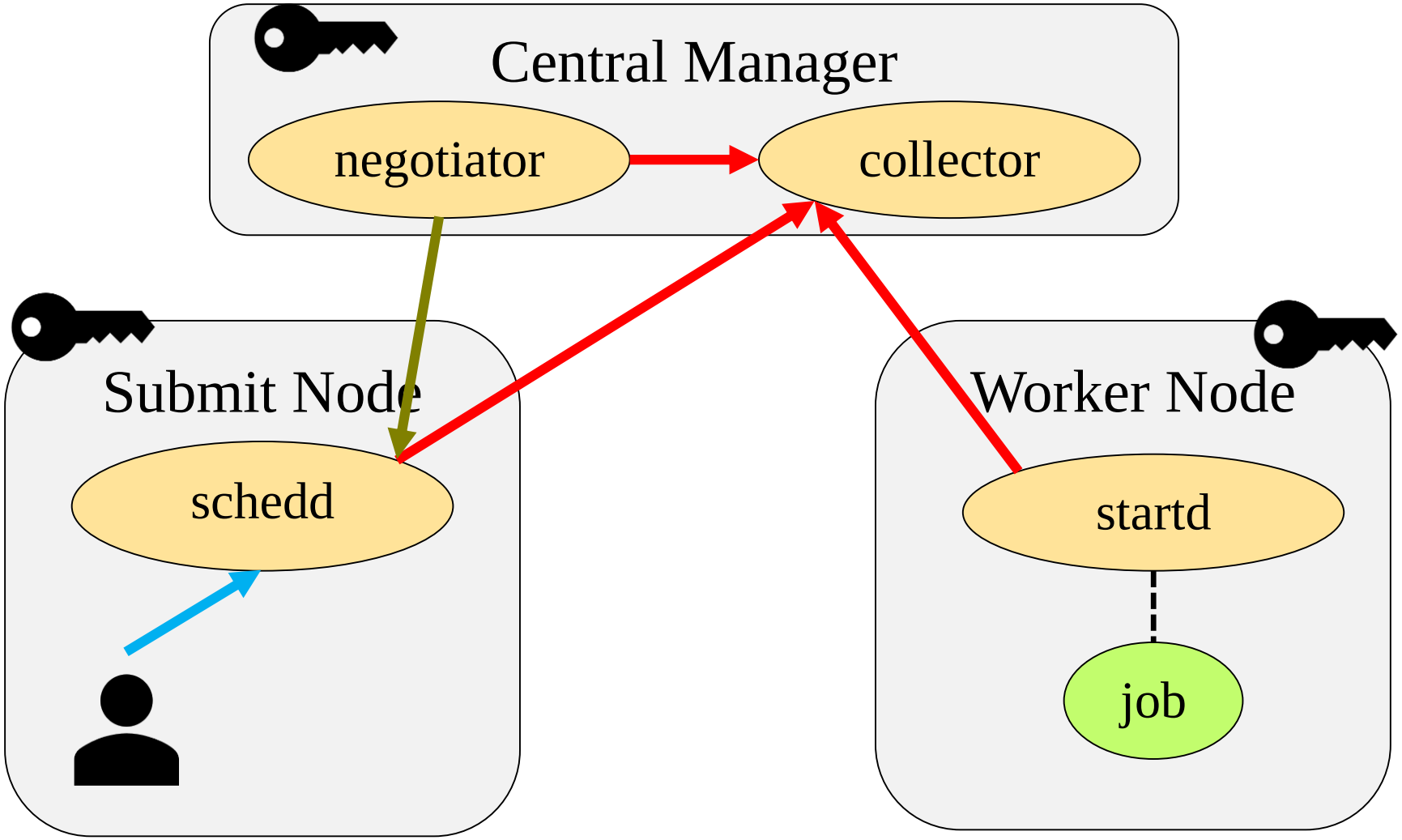


```
# require authentication and integrity for everything...
SEC_DEFAULT_AUTHENTICATION=REQUIRED
SEC_DEFAULT_INTEGRITY=REQUIRED
# ...except read access...
SEC_READ_AUTHENTICATION=OPTIONAL
SEC_READ_INTEGRITY=OPTIONAL
```

See security HOWTO Recipes at htcondor.org

```
# this will require PASSWORD authentications for daemon-to-daemon, and
# allow FS authentication for submitting jobs and administrator commands
SEC_PASSWORD_FILE = /etc/condor/passwords.d/POOL
SEC_DEFAULT_AUTHENTICATION_METHODS = FS, PASSWORD
SEC_DAEMON_AUTHENTICATION_METHODS = PASSWORD
SEC_NEGOTIATOR_AUTHENTICATION_METHODS = PASSWORD

#### AUTHORIZATION SECTION  (eg ALLOW_*, DENY_*)
# allow any process that can read the pool password to act as a daemon
ALLOW_DAEMON = condor_pool@*
# allow admin commands from root or tannenba on the central manager
ALLOW_ADMINISTRATOR = root@*/$(CONDOR_HOST),  \
        tannenba@*/$(CONDOR_HOST)
# only the condor daemons on the central manager should be negotiating
ALLOW_NEGOTIATOR = condor_pool@*/$(CONDOR_HOST)
```

Pretty good… any "bad news"?



Could use Puppet SSL certs…

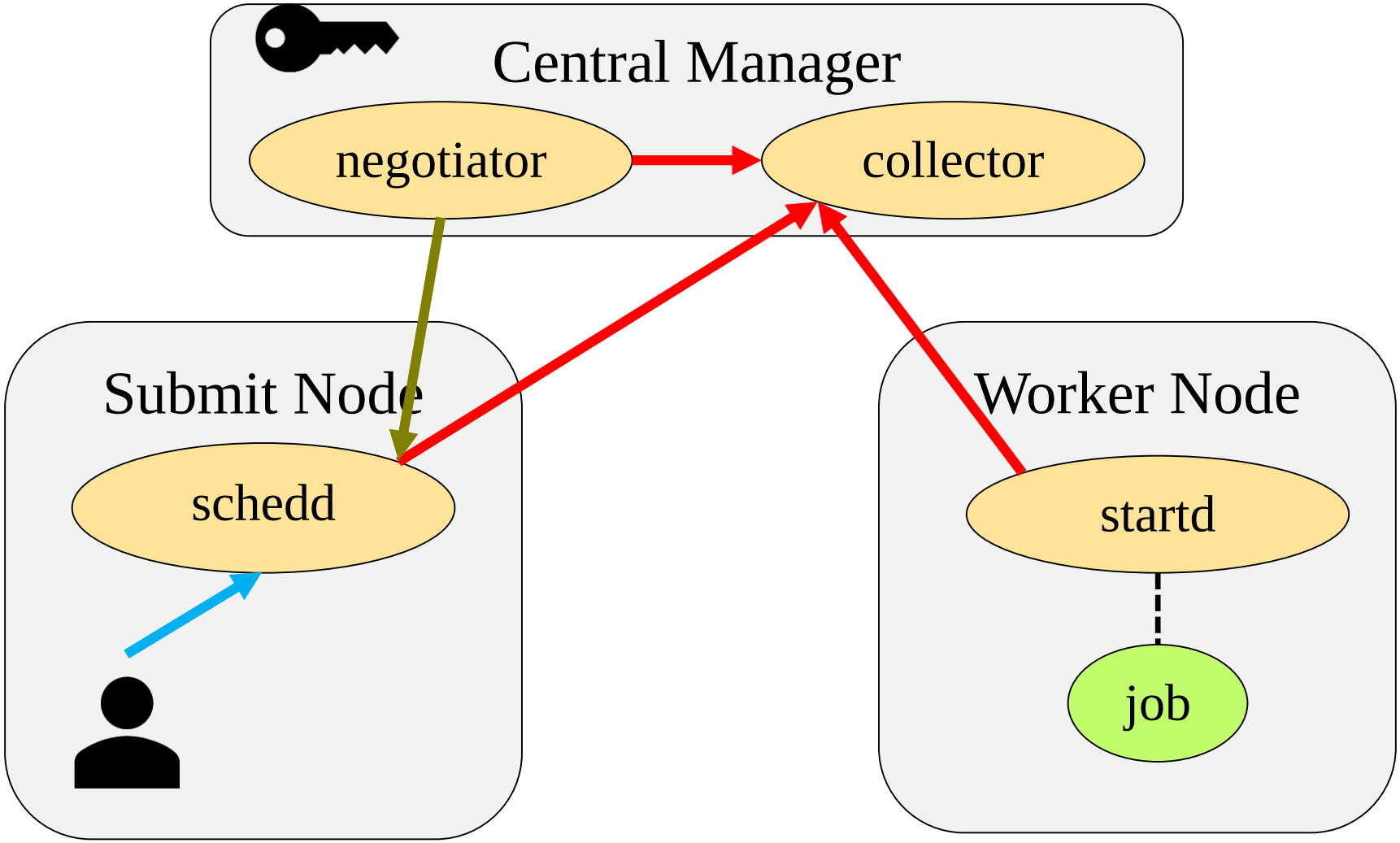
```
# Require SSL for daemon-to-daemon communications
SEC_DAEMON_INTEGRITY = REQUIRED
SEC_DAEMON_AUTHENTICATION = REQUIRED
SEC_DAEMON_AUTHENTICATION_METHODS = SSL
SEC_NEGOTIATOR_INTEGRITY = REQUIRED
SEC_NEGOTIATOR_AUTHENTICATION = REQUIRED
SEC_NEGOTIATOR_AUTHENTICATION_METHODS = SSL

# If you have a mapfile, set this to the HTCondor canonical name instead
ALLOW_DAEMON = ssl@unmapped

# SSL cert and key locations
SSL_DIR = /var/lib/puppet/ssl
AUTH_SSL_CLIENT_CAFILE = $(SSL_DIR)/certs/ca.pem
AUTH_SSL_CLIENT_CERTFILE = $(SSL_DIR)/certs/$(FULL_HOSTNAME).pem
AUTH_SSL_CLIENT_KEYFILE = $(SSL_DIR)/private_keys/$(FULL_HOSTNAME).pem
AUTH_SSL_SERVER_CAFILE = $(SSL_DIR)/certs/ca.pem
AUTH_SSL_SERVER_CERTFILE = $(SSL_DIR)/certs/$(FULL_HOSTNAME).pem
AUTH_SSL_SERVER_KEYFILE = $(SSL_DIR)/private_keys/$(FULL_HOSTNAME).pem
```

See security HOWTO Recipes at htcondor.org

Or could use new TOKEN authentication method

- New in HTCondor v8.9
- A token is signed by a symmetric private key (e.g. the pool password!) and contains
  - An identity
    - For use in ALLOW_XXX and DENY_XXX authorization lists
  - An expiration time
  - A bounding set of permitted actions

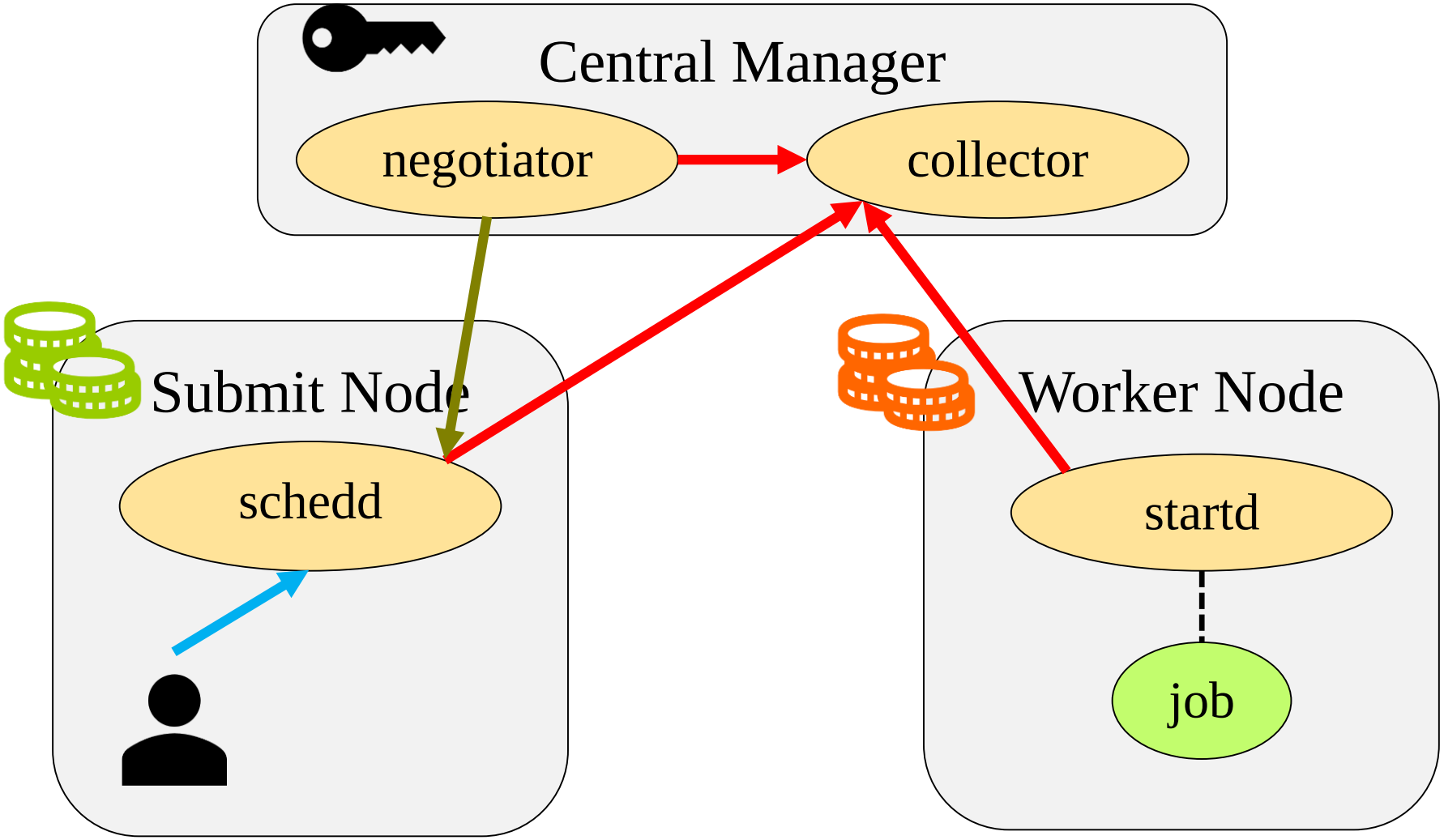
Keep pool password on CM…



Create some tokens…

```
condor_token_create -identity node1@pool.example.com \
    -lifetime 160000000 \
    -authz ADVERTISE_STARTD
condor_token_create -identity node2@pool.example.com \
    -lifetime 160000000 \
    -authz ADVERTISE_STARTD
condor_token_create -identity submit1@pool.example.com \
    -lifetime 160000000 \
    -authz ADVERTISE_SCHEDD
….
```

And distribute tokens….



Or just use v8.9 security "Quick Configuration" for a new pool!

When installing a new pool, assuming you are on a trusted network and there are no unprivileged users logged in to the submit hosts:

1. Start HTCondor on your central manager host (containing the *condor_collector* daemon) first. For a fresh install, this will automatically generate a random key in the file specified by `SEC_PASSWORD_FILE` (defaulting to `/etc/condor/passwords.d/POOL` on Linux).

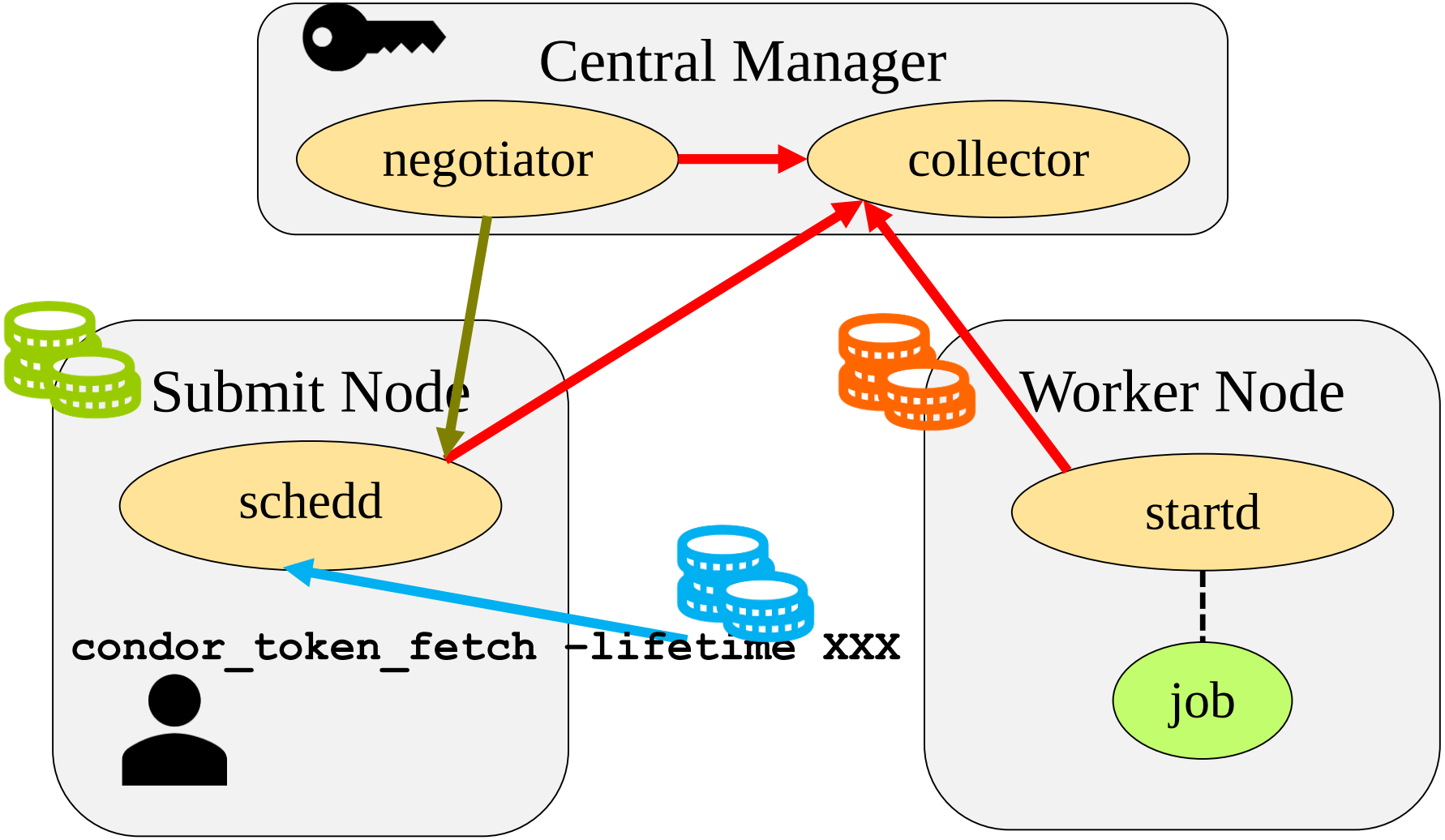
2. Install an auto-approval rule on the central manager using `condor_token_request_auto_approve`. This automatically approves any daemons starting on a specified network for a fixed period of time. For example, to auto-authorize any daemon on the network `192.168.0.0/24` for the next hour (3600 seconds), run the following command from the central manager:

```
condor_token_request_auto_approve -netblock 192.168.0.0/24 -lifetime 3600
```

3. Within the auto-approval rule's lifetime, start the *condor_schedd* and *condor_startd* hosts inside the appropriate network. The token requests for these daemons will be automatically approved and installed into `/etc/condor/tokens.d/`; this will authorize the daemon to advertise to the collector. By default, auto-generated tokens do not have an expiration.

This quick-configuration requires no configuration changes beyond the default settings. More complex cases, such as those where the network is not trusted, are covered in the *Token Authentication* section.

What about user submit from a different node? Or Jupyter NB?



Configuration Security

- Are your condor_config files secured?
- They should be owned and only modifiable by root.
- If you use a config directory, make sure only root can create files in it

Configuration Security

- HTCondor can allow configuration changes using a command-line tool:
  - condor_config_val –set Name Value

- However, this behavior is off by default and needs to be enabled on a case-by-case basis for each config parameter… use carefully only if you really need it

HTCondor Privilege

- HTCondor typically runs “as root”
- Why?
  - Impersonating users
  - Process isolation
  - Reading secure credentials
- When it isn’t actively using root, it switches effective UID to another user (“condor”)

HTCondor Privilege

- HTCondor will never launch a user job as root. There is a “circuit breaker” at the lowest level to prevent it.
- If not using system credentials, the Central Manager can run without root priv
- Let’s examine some different Startd configurations

StartD Configurations

Startds have a few different options for running jobs by comparing UID_DOMAIN:

- Run jobs as the submitting user
- Run jobs as a dedicated user per slot
  - Keeps jobs running as a low-privilege user
  - Isolates jobs from one another
  - Makes it easy to clean up after a job
- Run jobs as the user “nobody”
  - May allow jobs to interfere with one another
  - This helps: `USE_PID_NAMESPACES = True`

Encrypted File Transfer

- Even if that admin has not required encryption for all network connections, user jobs can specify per-file for both input and output if the files should be encrypted:
  - Encrypt_Input_Files = file1, *.dat
  - Encrypt_Output_Files = data.private

Encrypt Execute Directory

- If you are using Linux with *ecryptfs* installed, you can have HTCondor encrypt the execute directory on disk, offering extra protection of sensitive data.
- Can be enabled pool-wide by the admin:
  - ENCRYPT_EXECUTE_DIRECTORY = True
- Per-job in the submit file:
  - Encrypt_Execute_Directory = True

Restricting Users

- SUBMIT_REQUIREMENT allows the administrator to restrict what jobs are able to enter the queue
- Can be used to prevent users from lying about what groups they belong to:

```
SUBMIT_REQUIREMENT_NAMES = GROUP1

SUBMIT_REQUIREMENT_GROUP1= (AcctGroup =!= “group1”) ||
   (AcctGroup =?= “group1” && (Owner==“zmiller” || Owner==“tannenba”))

SUBMIT_REQUIREMENT_GROUP1_REASON=“User not in group1”
```

Restricting Users

- SUBMIT_REQUIREMENT allows the administrator to restrict what jobs are able to enter the queue
- Can be used to allow only certain executable files, number of CPUs requested for a job, anything else that is part of the Job ClassAd

Vulnerabilities

- HTCondor is periodically assessed by an independent research group.

- Our vulnerability reporting process is documented and vulnerability reports publicly available:
  - http://research.cs.wisc.edu/htcondor/security/

Thank you and Questions?

- Tip: Try emailing the htcondor-users mailing list:

  https://lists.cs.wisc.edu/mailman/listinfo/htcondor-users