Administrating HTCondor

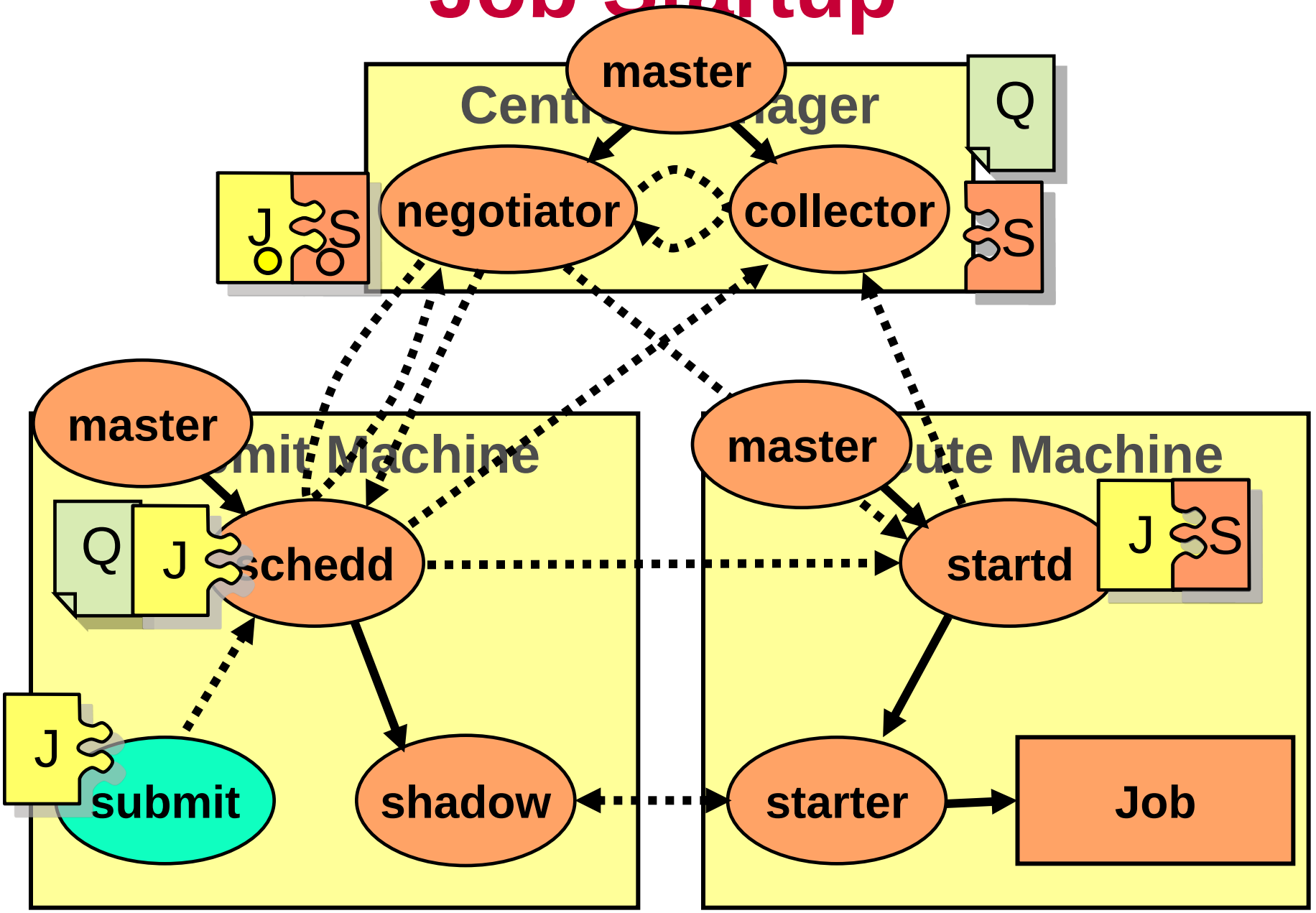
Alan De Smet
Center for High Throughput Computing
adesmet@cs.wisc.edu
http://research.cs.wisc.edu/htcondor

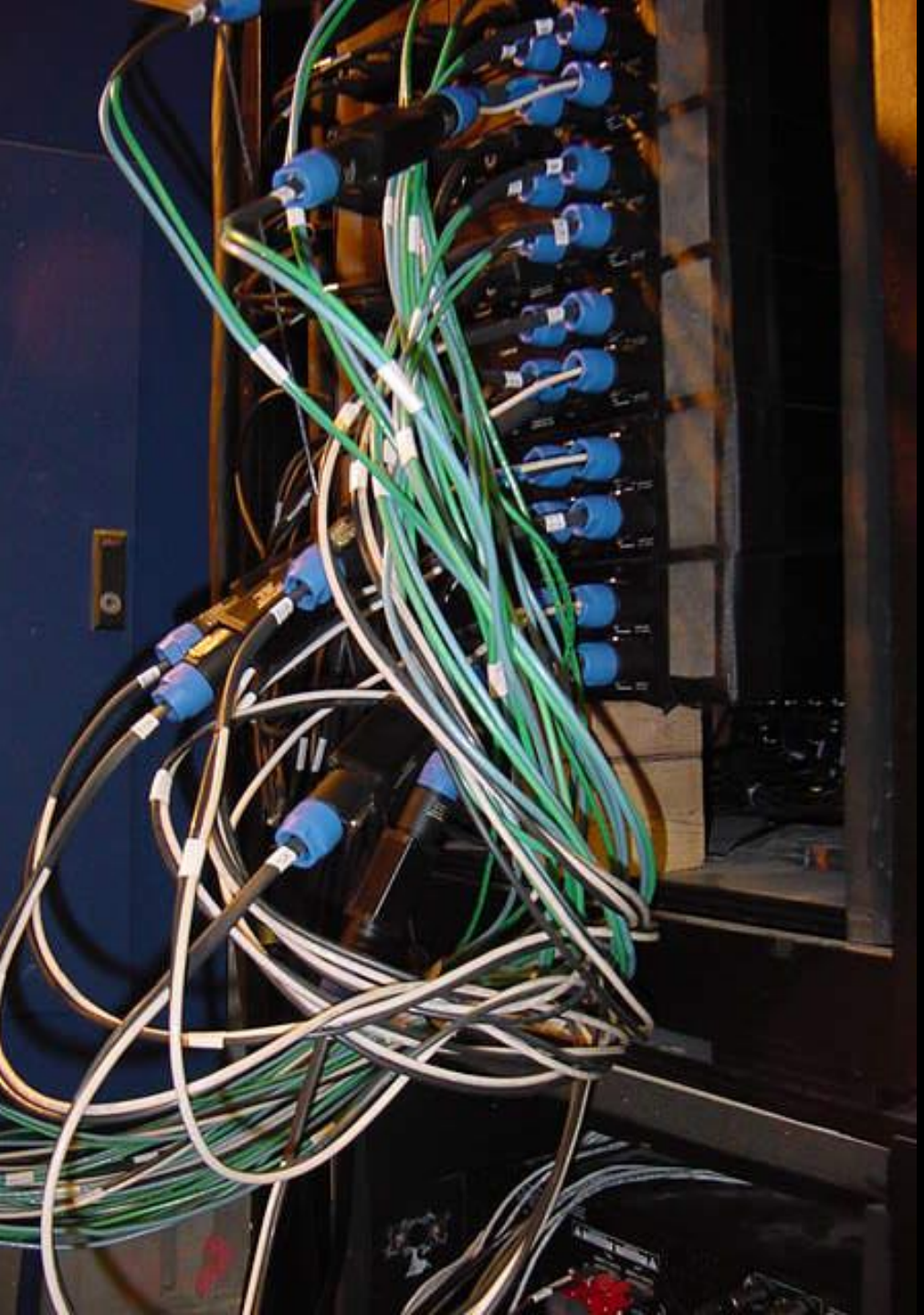
The next 70 minutes…

- HTCondor Daemons & Job Startup
- Configuration Files
- Security, briefly
- Policy Expressions
  - Startd (Machine)
  - Negotiator
- Priorities
- Useful Tools
- Log Files
- Debugging Jobs

Daemons & Job Startup

Job Startup


master
Centi lager
Q
negotiator
collector
J
S
S
master
mit Machine
master
ute Machine
Q
J
schedd
startd
J
S
J
submit
shadow
starter
Job



Configuration Files

Configuration File

- **`CONDOR_CONFIG`** environment variable, **`/etc/condor/condor_config`**, **`~condor/condor_config`**
- All settings can be in this one file
- Might want to share between all machines (NFS, automated copies, Wallaby, etc)

Other Configuration Files

- **LOCAL_CONFIG_FILE**
  - Comma separated, processed in order

```
LOCAL_CONFIG_FILE = \
   /var/condor/config.local,\
   /var/condor/policy.local,\
   /shared/condor/config.$(HOSTNAME),\
   /shared/condor/config.$(OPSYS)
```

- **LOCAL_CONFIG_DIR**

```
LOCAL_CONFIG_DIR = \
   /var/condor/config.d/,\
   /var/condor/$(OPSYS).d/
```

Configuration File Syntax

```
# I'm a comment!
CREATE_CORE_FILES=TRUE
MAX_JOBS_RUNNING = 50
# HTCondor ignores case:
log=/var/log/condor
# Long entries:
collector_host=condor.cs.wisc.edu,\
    secondary.cs.wisc.edu
```

Configuration File Macros

- You reference other macros (settings) with:
  - `A = $(B)`
  - `SCHEDD = $(SBIN)/condor_schedd`
- Can create additional macros for organizational purposes

Configuration File Macros

- Can append to macros:

```
A=abc
A=$(A),def
```

- Don't let macros recursively define each other!

```
A=$(B)
B=$(A)
```

Configuration File Macros

- Later macros in a file overwrite earlier ones
  - B will evaluate to 2:

```
A=1
B=$(A)
A=2
```

Macros and Expressions Gotcha

- These are simple replacement macros
- Put parentheses around expressions

```
TEN=5+5
HUNDRED=$(TEN)*$(TEN)
```

  - HUNDRED becomes 5+5*5+5 or 35!

```
TEN=(5+5)
HUNDRED=($(TEN)*$(TEN))
```

  - ((5+5)*(5+5)) = 100

Security, briefly

HTCondor Security

- Strong authentication of users and daemons
- Encryption over the network
- Integrity checking over the network

"locks-masterlocks.jpg" by Brian De Smet, © 2005
Used with permission.
http://www.fief.org/sysadmin/blosxom.cgi/2005/07/21#locks

Minimal Security Settings

- You *must* set **ALLOW_WRITE**, or nothing works
- Simplest setting:

```
ALLOW_WRITE=*
```

  - ***Extremely insecure!***

- A bit better:

```
ALLOW_WRITE= \
        *.cs.wisc.edu
```

More on Security

- Chapter 3.6, “Security,” in the HTCondor Manual
- htcondor-admin@cs.wisc.edu

Policy

Policy

- Who gets to run jobs, when?

Policy Expressions

- Specified in **`condor_config`**
  - Ends up slot ClassAd
- Policy evaluates both a slot ClassAd and a job ClassAd together
  - Policy can reference items in either ClassAd (See manual for list)
- Can reference **`condor_config`** macros:
  `$(MACRONAME)`

Slots vs Machines

- Machine – An individual computer, managed by one startd
- Slot – A place to run a job, managed by one starter.
  - A machine may have many slots
  - Partionable slots create more slots on the fly
- The start advertises each slot
  - The ClassAd is a “Machine” ad for historical reasons

Slot Policy Expressions

- `START`
- `RANK`
- `SUSPEND`
- `CONTINUE`
- `PREEMPT`
- `KILL`

START

- START is the primary policy
- When FALSE the slot enters the Owner state and will not run jobs
- Acts as the Requirements expression for the slot, the job must satisfy START
  - Can reference job ClassAd values including Owner and ImageSize

RANK

- Indicates which jobs a slot prefers
  - Jobs can also specify a rank
- Floating point number
  - Larger numbers are higher ranked
  - Typically evaluate attributes in the Job ClassAd
  - Typically use + instead of &&

RANK

- Often used to give priority to owner of a particular group of machines
- Claimed slots still advertise looking for higher ranked job to preempt the current job
  - *RANK causes preemption!*

SUSPEND and CONTINUE

- When SUSPEND becomes true, the job is suspended
- When CONTINUE becomes true a suspended job is released

PREEMPT and KILL

- When PREEMPT becomes true, the job will be politely shut down
  - Vanilla universe jobs get SIGTERM
    - Or user requested signal
  - Standard universe jobs checkpoint
- When KILL becomes true, the job is SIGKILLed
  - Checkpointing is aborted if started

Minimal / Default Settings

- Always runs jobs

```
START = True
RANK  = 0
SUSPEND  = False
CONTINUE  = True
PREEMPT = False
KILL  = False
```

Policy Configuration

- I am adding nodes to the Cluster… *but the Chemistry Department has priority on these nodes*

New Settings for the Chemistry nodes

- Prefer Chemistry jobs

```
START = True
RANK = Department == "Chemistry"
SUSPEND = False
CONTINUE = True
PREEMPT = False
KILL = False
```

Submit file with Custom Attribute

- Prefix an entry with “+” to add to job ClassAd

```
Executable = charm-run
Universe = standard
+Department = "Chemistry"
queue
```

What if “Department” not specified?

```
START = True
RANK  = Department =?= "Chemistry"
SUSPEND = False
CONTINUE = True
PREEMPT = False
KILL = False
```

More Complex RANK

- Give the machine's owners (adesmet and roy) highest priority, followed by the Chemistry department, followed by the Physics department, followed by everyone else.
  - Can use automatic **`Owner`** attribute in job attribute to identify adesmet and roy

More Complex RANK

```
IsOwner = (Owner == "adesmet" \
   || Owner == "roy")
IsChem =(Department =?= "Chemistry")
IsPhys =(Department =?= "Physics")
RANK = $(IsOwner)*20 + $(IsChem)*10 \
  + $(IsPhys)
```

Policy Configuration

- I have an unhealthy fixation with PBS so… *kill jobs after 12 hours, except Physics jobs get 24 hours.*

Useful Attributes

- **`CurrentTime`**
  - Current time, in Unix epoch time (seconds since midnight Jan 1, 1970)
- **`EnteredCurrentActivity`**
  - When did HTCondor enter the current activity, in Unix epoch time

Configuration

```
ActivityTimer = \
     (CurrentTime - EnteredCurrentActivity)
HOUR = (60*60)
HALFDAY = ($(HOUR)*12)
FULLDAY = ($(HOUR)*24)
PREEMPT = \
  ($(IsPhys) && ($(ActivityTimer) > $FULLDAY)) \
  || \
  (!$(IsPhys) && ($(ActivityTimer) > $HALFDAY))
KILL = $(PREEMPT)
```

Policy Configuration

- The cluster is okay, but... *HTCondor can only use the desktops when they would otherwise be idle*

Defining Idle

- One possible definition:
  - No keyboard or mouse activity for 5 minutes
  - Load average below 0.3

Desktops should

- **`START`** jobs when the machine becomes idle
- **`SUSPEND`** jobs as soon as activity is detected
- **`PREEMPT`** jobs if the activity continues for 5 minutes or more
- **`KILL`** jobs if they take more than 5 minutes to preempt

Useful Attributes

- **`LoadAvg`**
  - Current load average
- **`CondorLoadAvg`**
  - Current load average generated by HTCondor
- **`KeyboardIdle`**
  - Seconds since last keyboard or mouse activity

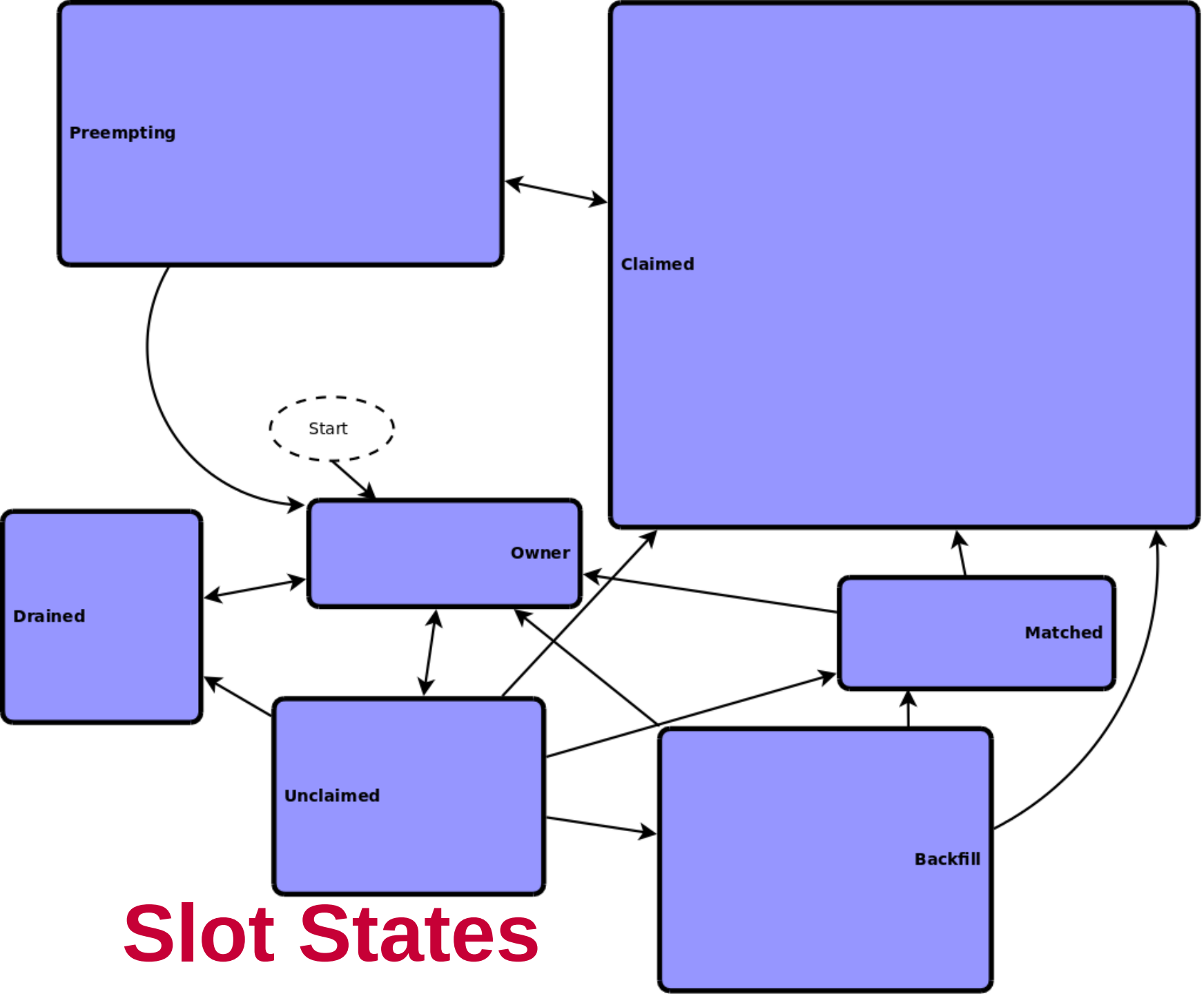
Macros in Configuration Files

```
NonCondorLoadAvg = (LoadAvg - CondorLoadAvg)
BgndLoad = 0.3
CPU_Busy = ($(NonCondorLoadAvg) >= $(BgndLoad))
CPU_Idle = (!$(CPU_Busy))
KeyboardBusy = (KeyboardIdle < 10)
KeyboardIsIdle = (KeyboardIdle > 300)
MachineBusy = ($(CPU_Busy) || $(KeyboardBusy))
```

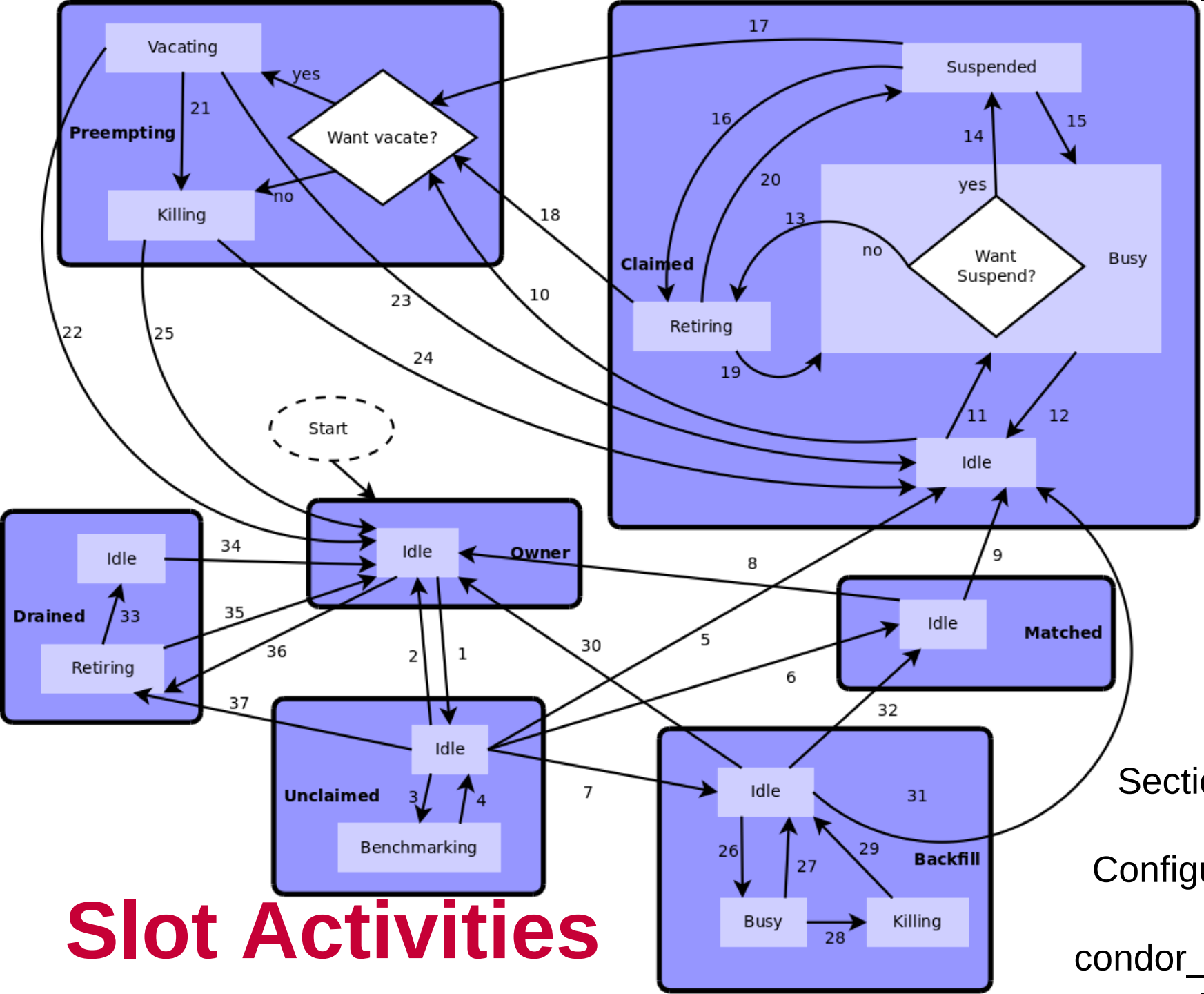
Desktop Machine Policy

```
START = $(CPU_Idle) && $(KeyboardIsIdle)
SUSPEND    = $(MachineBusy)
CONTINUE = $(CPU_Idle) && KeyboardIdle > 120
PREEMPT    = (Activity == "Suspended") && \
             $(ActivityTimer) > 300
KILL  = $(ActivityTimer) > 300
```

Mission Accomplished


Preempting
Claimed
Start
Owner
Drained
Matched
Unclaimed
Backfill

Slot States



Slot Activities

Section 3.5: Policy Configuration for the condor_startd)

Custom Slot Attributes

- Can add attributes to a slot's ClassAd, typically done in the local configuration file

```
INSTRUCTIONAL=TRUE
NETWORK_SPEED=1000
STARTD_EXPRS=INSTRUCTIONAL,
  NETWORK_SPEED
```

Custom Slot Attributes

- Jobs can now specify Rank and Requirements using new attributes:

```
Requirements = INSTRUCTIONAL=!=TRUE
Rank = NETWORK_SPEED
```

- Dynamic attributes are available; see **`STARTD_CRON_*`** in the manual

Further Machine Policy Information

- For further information, see section 3.5 “Policy Configuration for the *condor_startd*” in the HTCondor manual
- htcondor-users mailing list

  http://research.cs.wisc.edu/htcondor/mail-lists/
- htcondor-admin@cs.wisc.edu

Priorities

Job Priority

- Set with **`condor_prio`**
- Users can set priority of their own jobs
- Integers, larger numbers are higher priority
- Only impacts order between jobs for a single user on a single schedd
- A tool for users to sort their own jobs

User Priority

- Determines allocation of machines to waiting users
- View with **`condor_userprio`**
- Inversely related to machines allocated (lower is better priority)
  - A user with priority of 10 will be able to claim twice as many machines as a user with priority 20

User Priority

- Effective User Priority is determined by multiplying two components
  - Real Priority
  - Priority Factor

Real Priority

- Based on actual usage
- Defaults to 0.5
- Approaches actual number of machines used over time
  - Configuration setting **`PRIORITY_HALFLIFE`**

Priority Factor

- Assigned by administrator
  - Set with **`condor_userprio`**
- Defaults to 1 (**`DEFAULT_PRIO_FACTOR`**)

Negotiator Policy Expressions

- **`PREEMPTION_REQUIREMENTS`** and **`PREEMPTION_RANK`**
- Evaluated when **`condor_negotiator`** considers replacing a lower priority job with a higher priority job
- *Completely unrelated to the **`PREEMPT`** expression*

PREEMPTION_REQUIREMENTS

- If false will not preempt machine
  - Typically used to avoid pool thrashing
  - Typically use:
    - **RemoteUserPrio** – Priority of user of currently running job (higher is worse)
    - **SubmittorPrio** – Priority of user of higher priority idle job (higher is worse)
- **PREEMPTION_REQUIREMENTS=FALSE**

PREEMPTION_REQUIREMENTS

- Only replace jobs running for at least one hour and 20% lower priority

```
StateTimer = \
  (CurrentTime - EnteredCurrentState)
HOUR = (60*60)
PREEMPTION_REQUIREMENTS = \
  $(StateTimer) > (1 * $(HOUR)) \
  && RemoteUserPrio > SubmittorPrio * 1.2
```

PREEMPTION_RANK

- Picks which already claimed machine to reclaim
- Strongly prefer preempting jobs with a large (bad) priority and a small image size

```
PREEMPTION_RANK = \
  (RemoteUserPrio * 1000000)\
  - ImageSize
```

Accounting Groups

- Manage priorities across groups of users and jobs
- Can guarantee minimum numbers of computers for groups (quotas)
- Supports hierarchies
- Anyone can join any group

Tools

condor_config_val

- Find current configuration values

```
% condor_config_val MASTER_LOG
/var/condor/logs/MasterLog
% cd `condor_config_val LOG`
```

condor_config_val -v

- Can identify source

```
% condor_config_val -v CONDOR_HOST
CONDOR_HOST: condor.cs.wisc.edu
   Defined in
   '/etc/condor_config.hosts', line 6
```

condor_config_val -config

- What configuration files are being used?

```
% condor_config_val -config
Config source:
        /var/home/condor/condor_config
Local config sources:
        /unsup/condor/etc/condor_config.hosts
        /unsup/condor/etc/condor_config.global
        /unsup/condor/etc/condor_config.policy
        /unsup/condor-test/etc/hosts/puffin.local
```

condor_fetchlog

- Retrieve logs remotely

```
condor_fetchlog beak.cs.wisc.edu
  Master
```

Checking the current status

- `condor_status`
- `condor_q`
- Greg's “How High Throughput was My Cluster?” this afternoon

Querying daemons `condor_status`

- Queries the collector for information about daemons in your pool
- Defaults to finding **`condor_startd`**s
  - **`condor_status -schedd`** summarizes all job queues
  - **`condor_status -master`** returns list of all **`condor_master`**s

condor_status

- `-long` displays the full ClassAd
- Optionally specify a machine name to limit results to a single host

```
condor_status -l
  node4.cs.wisc.edu
```

- Do not use in scripts/programs

condor_status -constraint

- Only return ClassAds that match an expression you specify
- Show me idle slots with 1GB or more memory
  - `condor_status -constraint 'Memory >= 1024 && Activity == "Idle"'`

condor_status -autoformat

- Report only fields you request
- Census of systems in your pool:

```
> condor_status -af Activity
  OpSys Arch | sort | uniq -c
       56 Busy LINUX X86_64
       35 Idle LINUX INTEL
     1515 Idle LINUX X86_64
      369 Idle WINDOWS X86_64
       31 Retiring LINUX X86_64
```

condor_status -autoformat

- Separate by tabs, commas, spaces, newlines
- Label each field by name
- Escape as a ClassAd value
- Add headers
- Several easy to parse options

condor_status -format

- Like autoformat, but with manual formatting
- Useful for writing simple reports
- Uses C printf style formats
  - One field per argument

condor_status -format

```
% condor_status -format '%-10s ' 
  Activity -format '%-7s ' OpSys -
  format '%s\n' Arch | sort | uniq -c
     54 Busy       LINUX   X86_64
     35 Idle       LINUX   INTEL
   1513 Idle       LINUX   X86_64
    369 Idle       WINDOWS X86_64
     31 Retiring   LINUX   X86_64
```

Examining Queues `condor_q`

- View the job queue
- The **`-long`** option is useful to see the entire ClassAd for a given job
- supports **`-constraint`**, **`-autoformat`**, and **`-format`**
- Can view job queues on remote machines with the **`-name`** option

condor_q -analyze and -better-analyze

- Why isn't this job running? default
- On this machine? **-machine**
- What does this machine hate my job?

  -better-analyse:reverse
- General reports **-analyze:sum**

  -analyze:sum,rev

Log Files

HTCondor's Log Files

- HTCondor maintains one log file per daemon
- Can increase verbosity of logs on a per daemon basis
  - SHADOW_DEBUG, SCHEDD_DEBUG, and others
  - Space separated list

Useful Debug Levels

- **`D_FULLDEBUG`** dramatically increases information logged
  - Does not include other debug levels!
- **`D_COMMAND`** adds information about about commands received

```
SHADOW_DEBUG = D_FULLDEBUG D_COMMAND
```

Log Rotation

- Log files are automatically rolled over when a size limit is reached
  - Only one old version is kept
  - Defaults to 10 megabytes
  - Rolls over quickly with **`D_FULLDEBUG`**
  - **`MAX_DEFAULT_LOG`**
  - Also per daemon settings
    - **`MAX_SHADOW_LOG`**, **`MAX_SCHEDD_LOG`**, and others

HTCondor's Log Files

- Many log files entries primarily useful to HTCondor developers
  - Especially if D_FULLDEBUG is on
  - Minor errors are often logged but corrected
  - Take them with a grain of salt
  - **`htcondor-admin@cs.wisc.edu`**

Debugging Jobs

Debugging Jobs: condor_q

- Examine the job with **`condor_q`**
  - especially the very powerful **`-analyze`** and **`-better-analyze`**

Debugging Jobs: User Log

- Examine the job's user log
  - Can find with:

    `condor_q -af UserLog` ***`17.0`***
  - Set with "log" in the submit file
  - You can set **`EVENT_LOG`** to get a unified log for all jobs under a schedd
- Contains the life history of the job
- Often contains details on problems

Debugging Jobs: ShadowLog

- Examine **`ShadowLog`** on the submit machine
  - Note any machines the job tried to execute on
  - There is often an “ERROR” entry that can give a good indication of what failed

Debugging Jobs: Matching Problems

- No **`ShadowLog`** entries? Possible problem matching the job.
  - Examine **`ScheddLog`** on the submit machine
  - Examine **`NegotiatorLog`** on the central manager

Debugging Jobs: Remote Problems

- **`ShadowLog`** entries suggest an error but aren't specific?
  - Examine **`StartLog`** and **`StarterLog`** on the execute machine

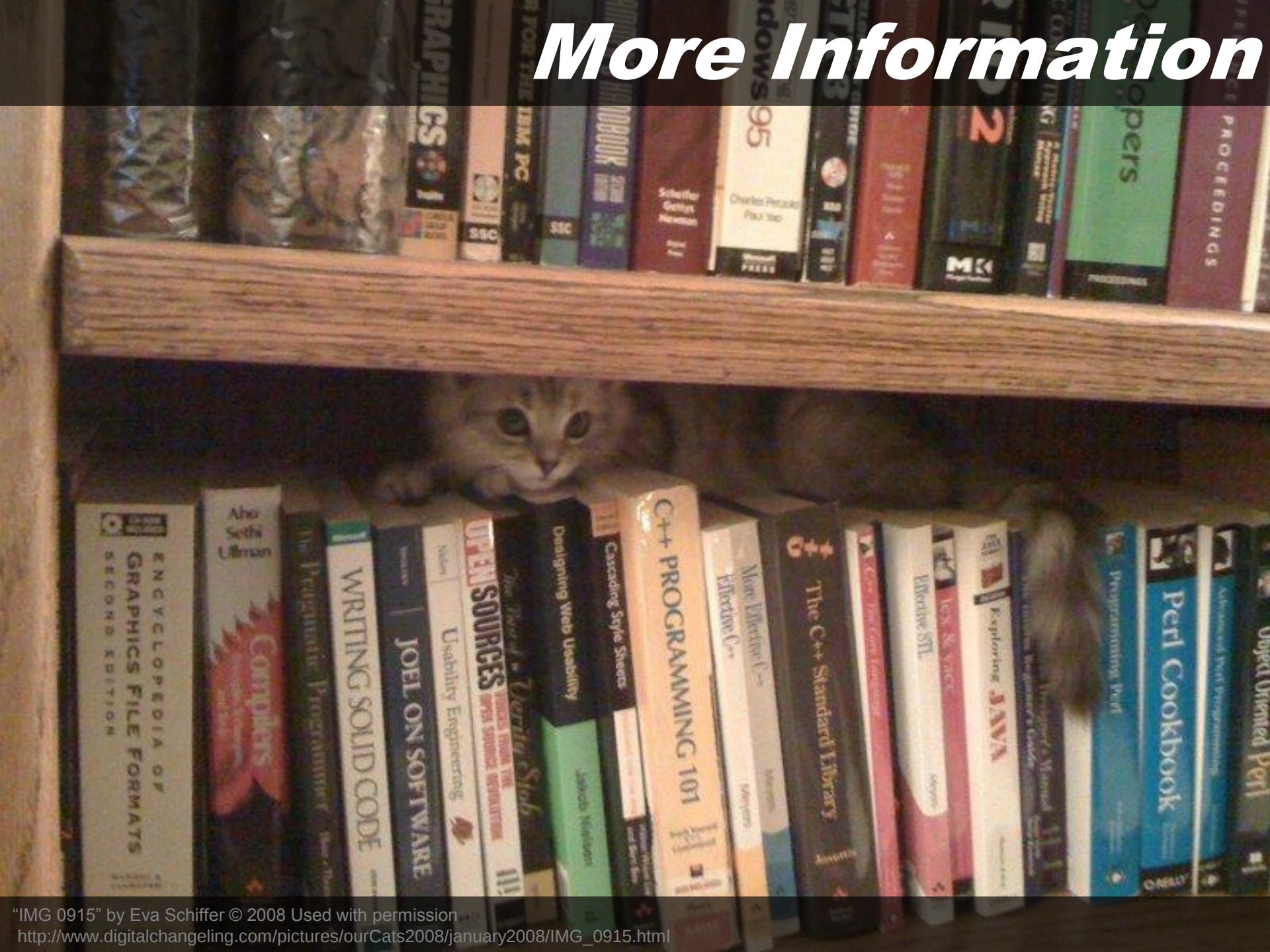
Debugging Jobs: Reading Log Files

- HTCondor logs will note the job ID each entry is for
  - Useful if multiple jobs are being processed simultaneously
  - grepping for the job ID will make it easy to find relevant entries
- Occasionally HTCondor doesn't know yet…

Debugging Jobs: What Next?

- If necessary add "**`D_FULLDEBUG D_COMMAND`**" to **`DEBUG_`*`DAEMONNAME`*** setting for additional log information
- Increase **`MAX_`*`DAEMONNAME`*`_LOG`** if logs are rolling over too quickly
- If all else fails, email us
  - htcondor-admin@cs.wisc.edu

More Information



More Information

- Staff here at HTCondor Week
- HTCondor Manual
- htcondor-users mailing list

  http://research.cs.wisc.edu/htcondor/mail-lists/
- htcondor-admin

  htcondor-admin@cs.wisc.edu

"Condor Manual" by Alan De Smet
(Actual first page of the 7.0.1 manual on about 700 pages of other output. The actual 7.0.1 manual is about 860 pages.)

Thank You!

Any questions?