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http://www.flickr.com/photos/7428244@N06/427485954/ http://www.webcitation.org/5g6wqrJPx

# The next 70 minutes…

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

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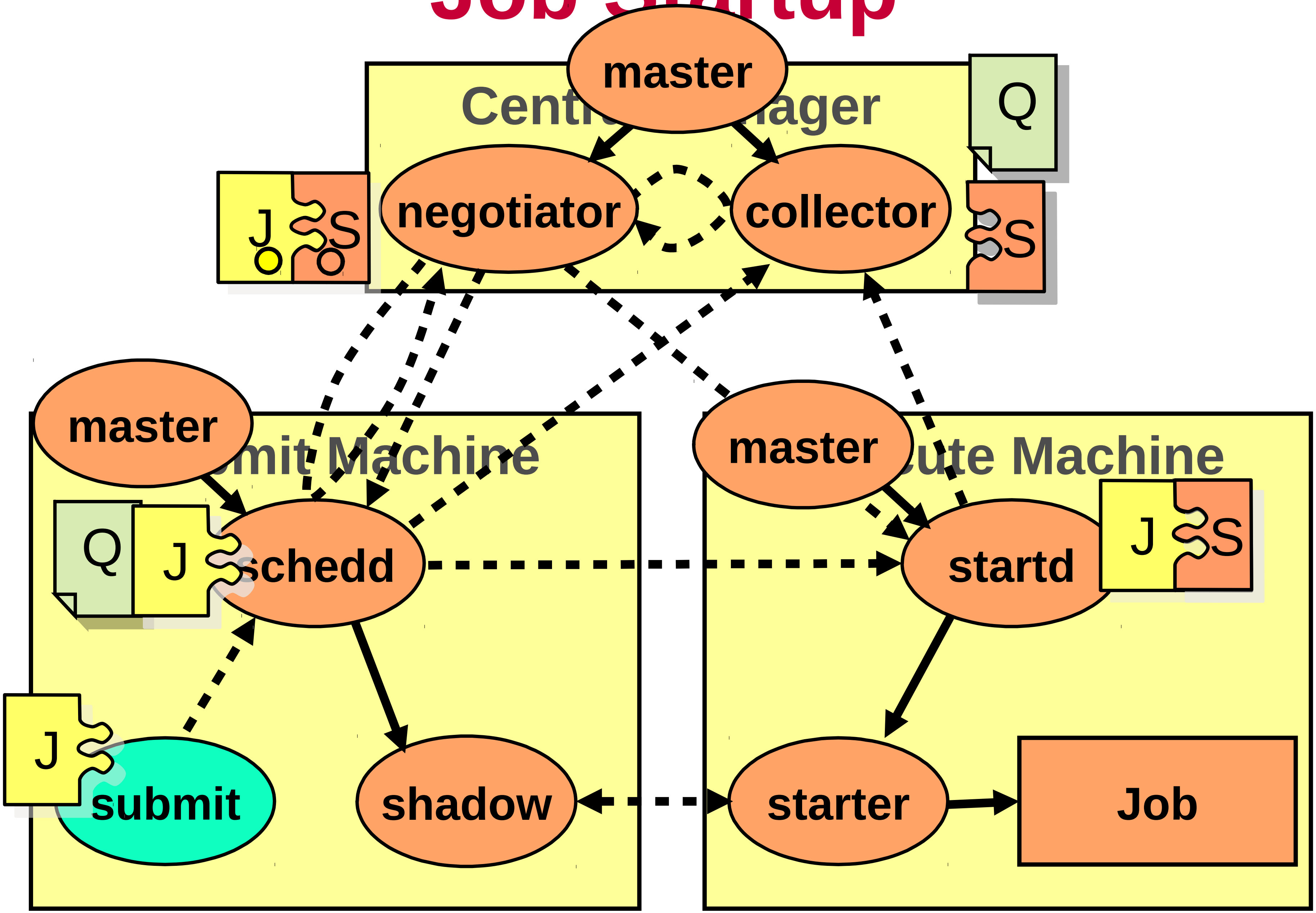
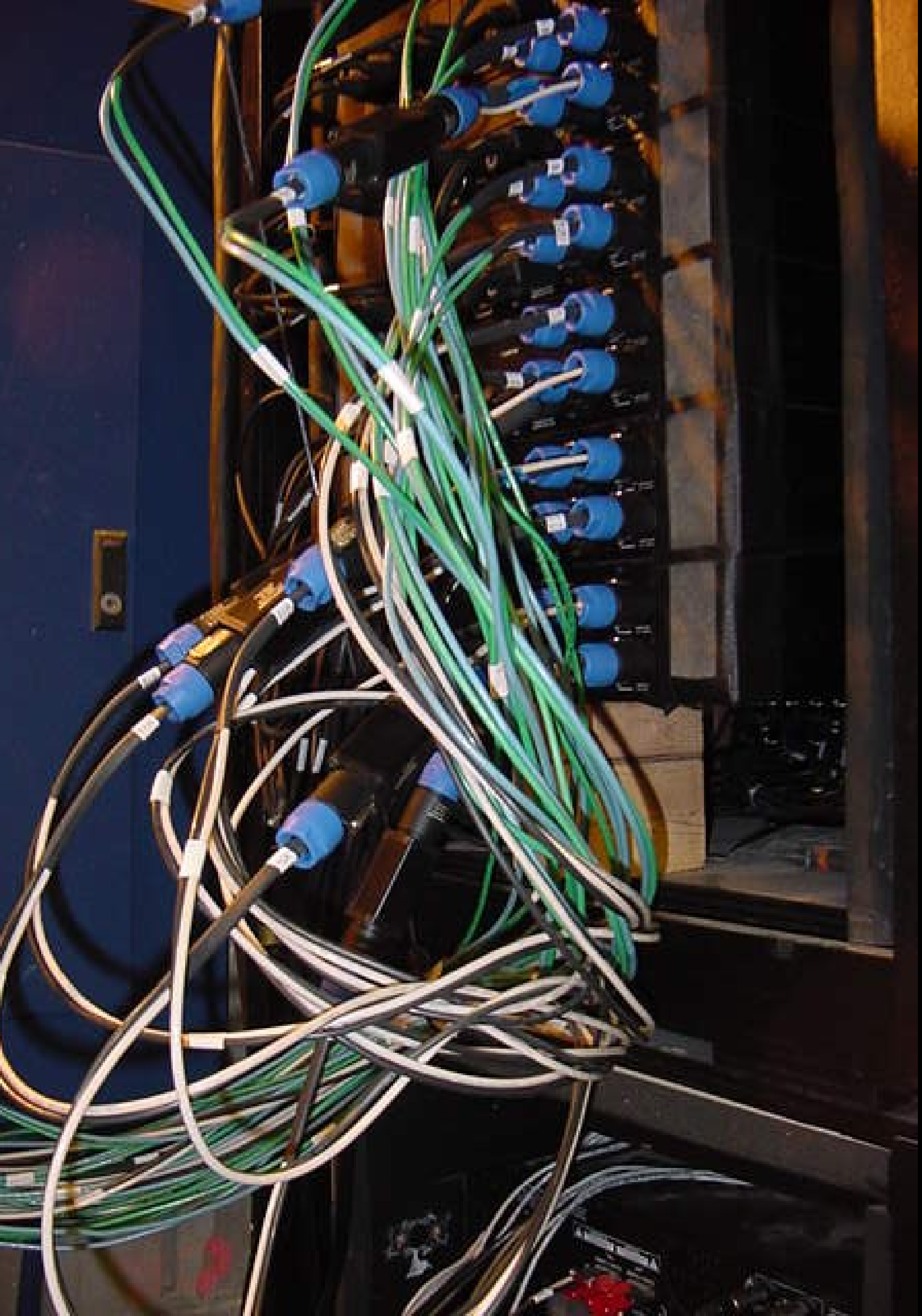
http://www.webcitation.org/5XIfTl6tX

# Job Startup


master
Centr
nager
Q
J
S
negotiator
collector
S
master
mit Machine
Q
J
schedd
J
submit
shadow
master
cute Machine
startd
J
S
starter
Job



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# Configuration File

- **CONDOR_CONFIG** environment variable, **/etc/condor/condor_config**, **~condor/condor_config**
- All settings can be in this one file
  - Some must be (**ENABLE_IPV6**)
- 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
  - h 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)
```

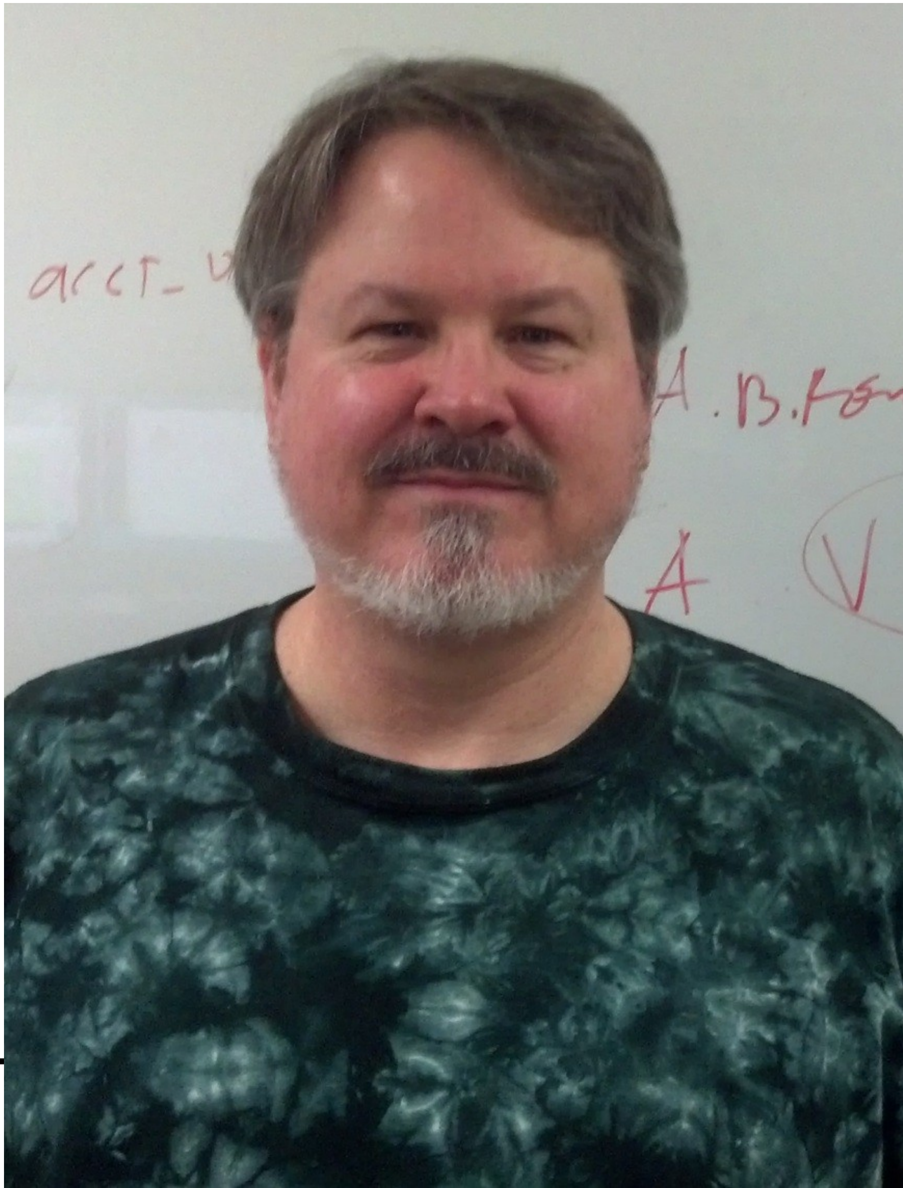
  - HUNDRED becomes 5+5*5+5 or 35!

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

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

# 8.1,8.2 configuration

- Simplified
- More powerful
- Goal: <20 line configuration files
- “Improvements to Configuration” by TJ on Wednesday



“Padlock” by Peter Ford © 2005

http://www.flickr.com/photos/peterf/72583027/

http://www.webcitation.org/5XIiBcsUg

# 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
```

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http://www.flickr.com/photos/madaboutshanghai/184665954/ http://www.webcitation.org/5XIhUAfuY

# More on Security

- Zach’s talk, Wednesday!
- Chapter 3.6, “Security,” in the HTCondor Manual
- htcondor-admin@cs.wisc.edu

“Zach Miller” by Alan De Smet

“Don't even think about it” by Kat “tyger_lyllie” © 2005
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http://www.webcitation.org/5XIh5mYGS

# 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
- 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

# SUSPEND and CONTINUE

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

“DSC03753” by Eva Schiffer © 2008 Used with permission
http://www.digitalchangeling.com/pictures/ourCats2008/january2008/DSC03753.html

# 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 Settings

- Always runs jobs

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

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http://www.flickr.com/photos/gumuz/7340411/ http://www.webcitation.org/5XIh8s0kI

# Policy Configuration

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

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http://www.flickr.com/photos/vmos/2078227291/ http://www.webcitation.org/5XIff1deZ

# 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.*

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# 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*

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http://www.flickr.com/photos/vmos/2078227291/ http://www.webcitation.org/5XIff1deZ

# 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.

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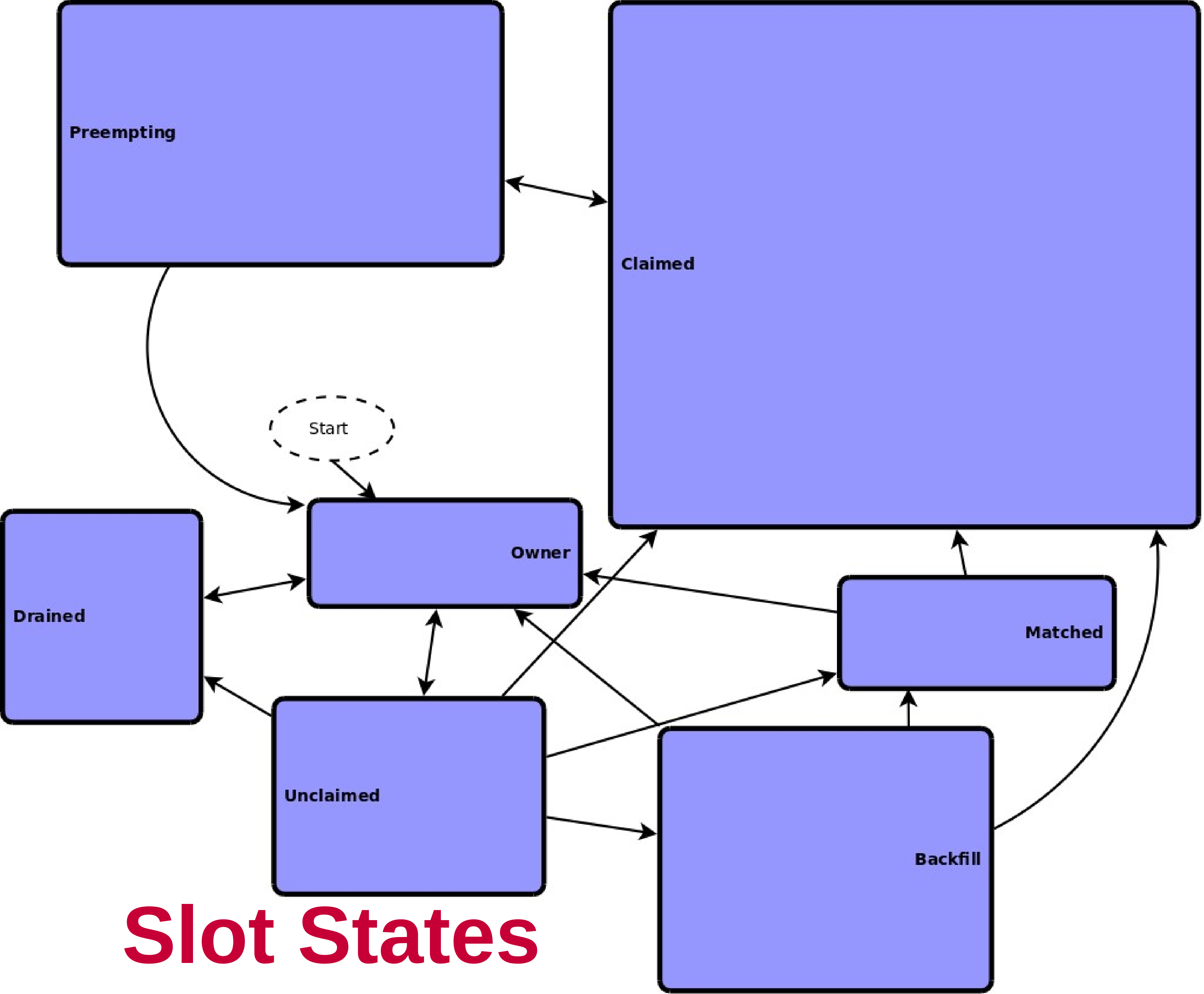
http://www.flickr.com/photos/pjlewis/46134047/ http://www.webcitation.org/5XIhBzDR2

# Slot States



Preempting

Claimed

Start

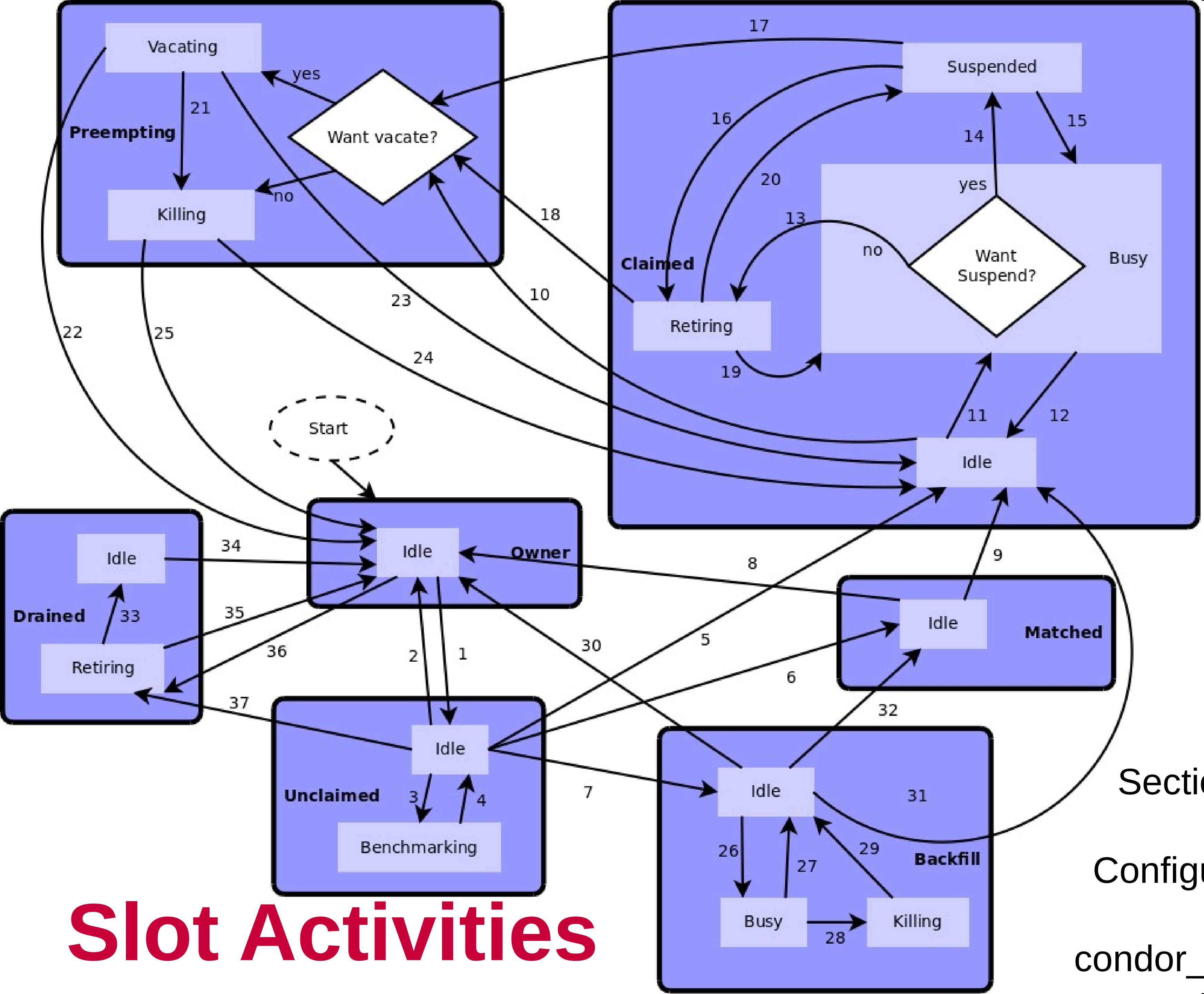
Owner

Drained

Matched

Unclaimed

Backfill



# 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*

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http://www.flickr.com/photos/joanne_matt/97737986/ http://www.webcitation.org/5XIieCxq4

# 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*

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http://www.flickr.com/photos/batega/1596898776/ http://www.webcitation.org/5XIj1E1Y1

# 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
```

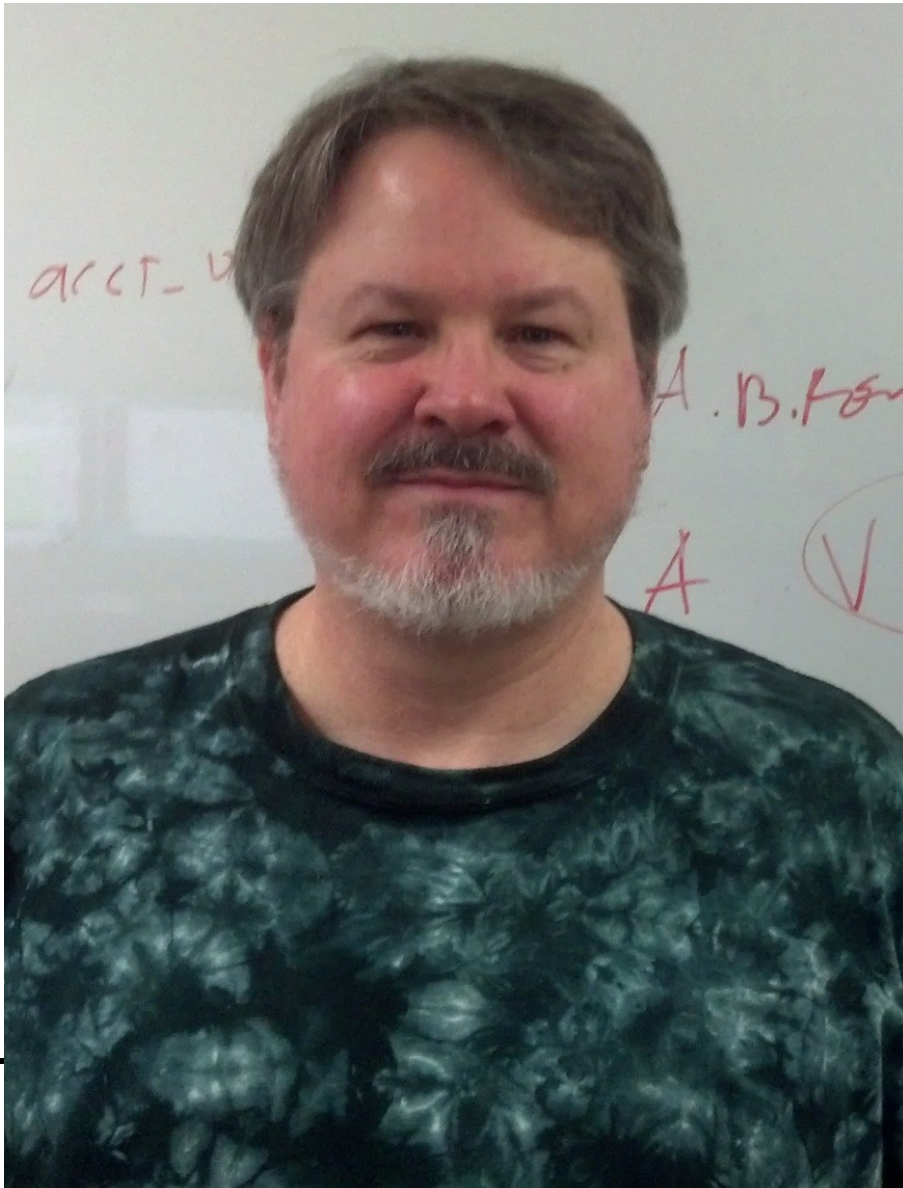
# condor_config_val -config

- 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_config_val

- Neat new stuff in 8.2
- "Improvements to Configuration" by TJ on Wednesday



# 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
```

# 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

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http://www.flickr.com/photos/fazen/17200735/
http://www.webcitation.org/5XIhNWC7Y

# 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*

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http://www.flickr.com/photos/bcmom/59207805/ http://www.webcitation.org/5XIhRO8L8

# 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 1,000,000 bytes
    - 10 MB in 8.1 and later
  - Rolls over quickly with **D_FULLDEBUG**
  - **MAX_*_LOG**, one setting per daemon
    - **MAX_SHADOW_LOG**, **MAX_SCHEDD_LOG**, and others
    - **MAX_DEFAULT_LOG** in 8.1 and later

# 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

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http://www.flickr.com/photos/kevincollins/89538633/ http://www.webcitation.org/5XIiMyhpp

# 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

"IMG 0915" by Eva Schiffer © 2008 Used with permission
http://www.digitalchangeling.com/pictures/ourCats2008/january2008/IMG_0915.html

# 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?

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http://www.flickr.com/photos/mysteryfaery/294253525/ http://www.webcitation.org/5XIi6HRCM