uFleetManager Guide

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1 Purpose

This guide is intended to explain to a member of the PAVLAB how to use and improve the fleet manager app. Those members are expected to have a basic familiarity with MOOS-IvP, C++, and Bash.

2 Usage

2.1 Dependencies

`uFleetManager` was developed for Mac. It is in principle compatible with Linux, but that has never been demonstrated.

Currently, the only dependency is `ncurses`. On a Mac, get it with either Macports or Homebrew;
`port install ncurses`
The usage is slightly more complicated on Linux. Without having gotten it working, it's hard to say for sure, but it looks like `libncurses5-dev` is the correct version. So on Ubuntu, get it with
`apt-get install libncurses5-dev`

2.2 Installation

`uFleetManager` is bundled in the `moos-ivp-aquaticus` tree. Assuming you haven't already, install `moos-ivp-aquaticus` in your home directory.

2.2.1 Download ARO

Most users will use the Anonymous Read Only version of `moos-ivp-aquaticus`:
`svn co https://oceanai.mit.edu/svn/moos-ivp-aquaticus-aro-trunk/trunk moos-ivp-aquaticus`

2.2.2 Download for Editing

A few users will have edit and commit privileges; speak to Dr. Benjamin. Then get the codebase with

```
svn co svn+ssh://[YOUR_USERNAME]@oceanai.mit.edu/home/svn/repos/moos-ivp-aquaticus/trunk
moos-ivp-aquaticus
```

2.2.3 Enable

At the time of writing, this code is considered experimental and therefore disabled by default.

Open ∼/moos-ivp-aquaticus/src/CMakeLists.txt and in the BUILD_ALL section, find the line ADD_SUBDIRECTORY(uFleetManager) and uncomment it. Remember to recomment it before committing code, and check it after pulling down new code.

2.3 Starting the Fleet Manager

Build the fleet manager with the normal aquaticus build script, e.g.:

∼/moos-ivp-aquaticus/build.sh

You'll be looking for the uFleetManager executable in ∼/moos-ivp-aquaticus/bin

There are two use cases; with or without a config file. You can run uFleetManager with no arguments, e.g.

∼/moos-ivp-aquaticus/bin/uFleetManager

and that will let you observe all the lab vehicles but wont let you launch a MOOS-IvP mission.

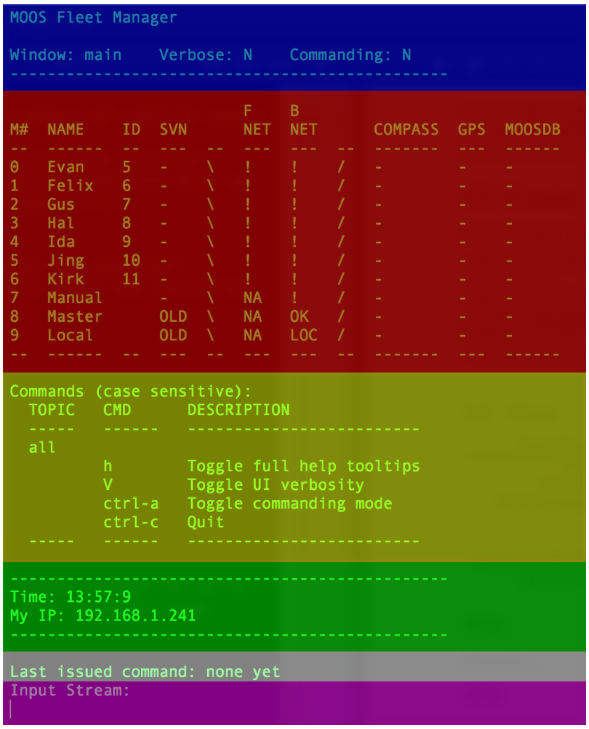
To only observe specific vehicles, and to run a particular MOOS-IvP mission, you'll want to run it with a config file;

∼/moos-ivp-aquaticus/bin/uFleetManager --file /path/to/my_config_file.moos

Refer to the Config Files section for how to write a configuration file.

2.4 Fleet Maanger Layout

Once you start the Fleet Manager, you should see something like this, without the highlight colors.



Blue Header; displays the state of the app

Red Window; displays the view indicated in the header (see below for details on each view).

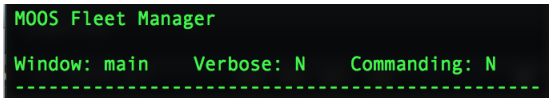
Yellow Help; displays the currently available command set.

Green My Machine; displays own computer information. 'Time' is the one topic that is expected to change frequently and consistently, and therefore can be used to determine if the app has crashed.

Grey Last command; displays the last command issued.

Purple Input; shows currently input characters

2.4.1 Header



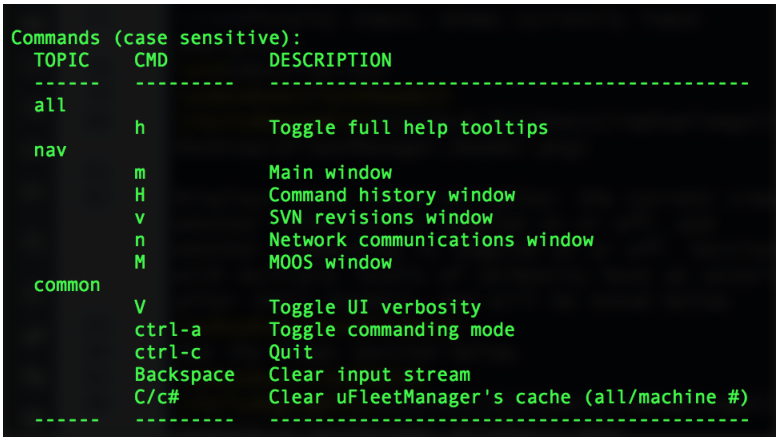
Displays three state variables: the current view, whether verbosity is toggled on or off, and whether commanding is toggled on or off. Sections with multiple levels of verbosity have an asterisk after their headers, and will be noted below.

2.4.2 Windows

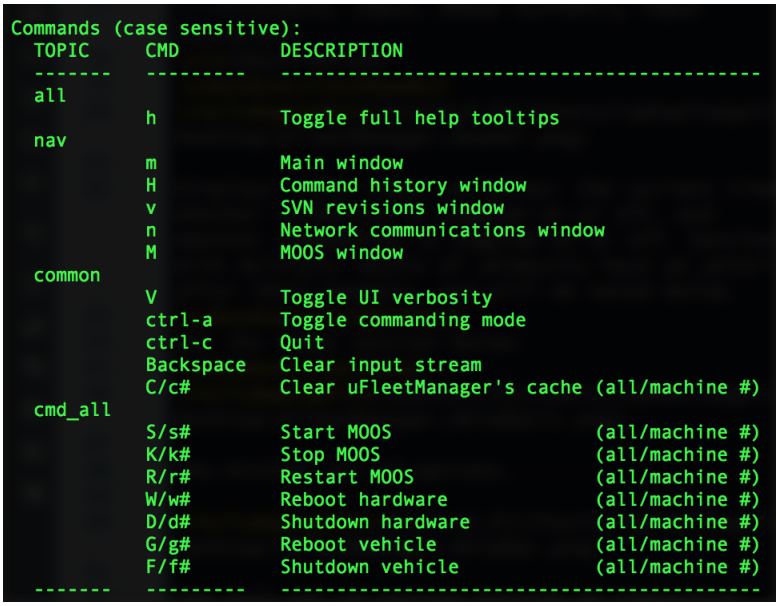
See the Views section below.

2.4.3 Help

The minimal set of options.

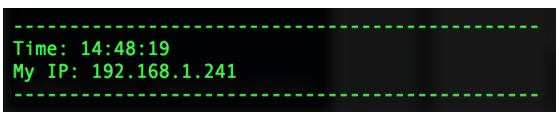


The full set of options outside of commanding mode; contains the common set, navigation commands, and the command to clear the local cache of information requests.



The full set of options, including those in commanding mode.

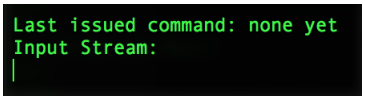
2.4.4 My Machine



Stats about your own machine. `Time` serves as a responsive UI element, demonstrating that the app

is actually refreshing. `MY IP` is helpful if you're running the shoreside on your computer and need to update the machine's UI, but it also indicates which wifi network you're on; if the first block is 10 you're probably on MIT-GUEST, if the wifi is 192.168.1.X, you're probably on kayak-local. You will only be able to talk to the robots on kayak-local.

2.4.5 Footer

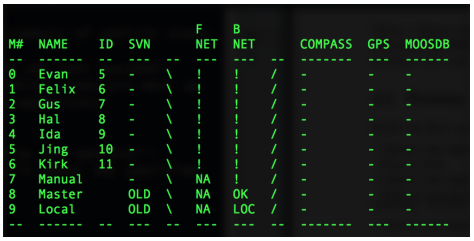


Information about keys you're currently inputting, and the executive summary of the command you've most recently input.

2.5 Views

View Name	Nav Key	Description
Main	m	Main window, provides a ready/not ready summary of vehicle state.
Network	n	Vehicle addresses and whether ping and ssh test succeed
SVN Revisions	v	Lists revisions and summarizes which trees are most up-to-date for `moos-ivp`, `moos-ivp-aquaticus`, `moos-ivp-colregs`, `pablo-common`, and `mokai-common`
Command History	H	Lists the commands dispatched by the operator
MOOS-IvP	M	Lists mission configuration and details about the specified mission
Previous	p	Go to previous view

2.5.1 Main



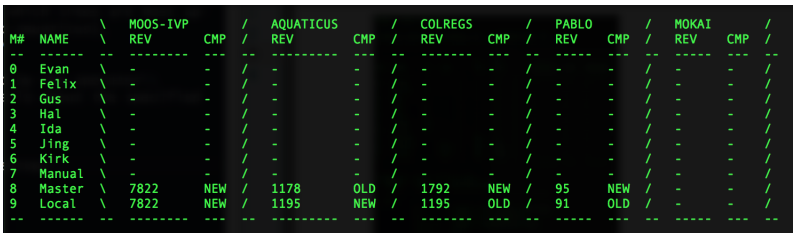
Topic	Explanation	Comments
M#	Machine #; the # in the Commands section	Limited to $0 <= M\# < 10$
Name	Vehicle Name	List hard coded in Configuration class
ID	Lab vehicle id system, alpha=1, bravo=2, ...	
SVN	Summary; worst status from all its svn trees	OLD and NEW are relative amongst vehicles e.g. if even one of your trees is out of date, then your summary will be OLD. See SVN view for more detail
F NET	Front Seat network summary	ssh and ping; see Network view for more detail
B NET	Back Seat network summary	same as F NET. Single-computer robots are back seats
COMPASS	Reports if vehicle's compass is up	M300 common failure mode is NaNs Mokai common failure mode is disconnects
GPS	Reports GPS status	M300 reports PDOP Mokai only reports connectedness
MOOSDB	Counts the MOOSDB processes running	1 is the only sane value Also lists the vehicle's team, if one is given; see the MOOS-IvP section

2.5.2 Network

			F					B				
M#	NAME	ID		PING	SSH	USER	ADDR		PING	SSH	USER	ADDR
0	Evan	5	/	!	!	student	192.168.5.1	/	!	!	student2680	192.168.5.100
1	Felix	6	/	!	!	student	192.168.6.1	/	!	!	student2680	192.168.6.100
2	Gus	7	/	!	!	student	192.168.7.1	/	!	!	student2680	192.168.7.100
3	Hal	8	/	!	!	student	192.168.8.1	/	!	!	student2680	192.168.8.100
4	Ida	9	/	!	!	student	192.168.9.1	/	!	!	student2680	192.168.9.100
5	Jing	10	/	!	!	student	192.168.10.1	/	!	!	student2680	192.168.10.100
6	Kirk	11	/	!	!	student	192.168.11.1	/	!	!	student2680	192.168.11.100
7	Manual		/	NA	NA			/	!	!	student	192.168.1.192
8	Master		/	NA	NA			/	OK	OK	student2680	pablo-master.csail.mit.edu
9	Local		/	NA	NA			/	LOC	LOC		localhost

Topic	Explanation	Comments
M#		See the Main view
Name		See the Main view
ID		See the Main view
F	Front Seat block	
PING	Is ADDR reachable by ping	NA indicates no front seat expected
SSH	If USER@ADDR can run a simple test command	NA indicates no front seat expected
USER	The front seat username	
ADDR	The front seat address	
B	Back Seat block	Single-computer vehicles are considered back seats
PING	Is ADDR reachable by ping	
SSH	If USER@ADDR can run a simple test command	
USER	The back seat username	
ADDR	The back seat address	

2.5.3 SVN

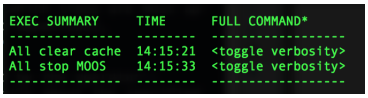


M#	NAME	MOOS-IVP REV	MOOS-IVP CMP	AQUATICUS REV	AQUATICUS CMP	COLREGS REV	COLREGS CMP	PABLO REV	PABLO CMP	MOKAI REV	MOKAI CMP
0	Evan	-	-	-	-	-	-	-	-	-	-
1	Felix	-	-	-	-	-	-	-	-	-	-
2	Gus	-	-	-	-	-	-	-	-	-	-
3	Hal	-	-	-	-	-	-	-	-	-	-
4	Ida	-	-	-	-	-	-	-	-	-	-
5	Jing	-	-	-	-	-	-	-	-	-	-
6	Kirk	-	-	-	-	-	-	-	-	-	-
7	Manual	-	-	-	-	-	-	-	-	-	-
8	Master	7822	NEW	1178	OLD	1792	NEW	95	NEW	-	-
9	Local	7822	NEW	1195	NEW	1195	OLD	91	OLD	-	-

Topic	Explanation	Comments
M#		See the Main view
Name		See the Main view
ABC REV	Revision number of the copy of ABC	
ABC CMP	ABC tree is comparatively OLD or NEW(est)	Contacting a new machine may change who is newest

The tracked trees are `moos-ivp`, `moos-ivp-aquaticus`, `moos-ivp-colregs`, `pablo-common` and `mokai-common`. The PABLO and Mokai trees tend to not coexist, so they are special cased on the Main view such that having one but not the other will not bubble up an error.

2.5.4 History



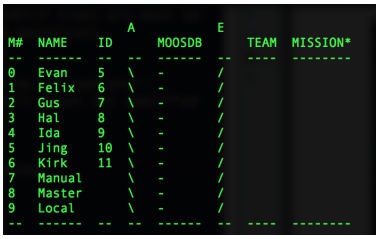
EXEC SUMMARY	TIME	FULL COMMAND*
All clear cache	14:15:21	<toggle verbosity>
All stop MOOS	14:15:33	<toggle verbosity>

Topic	Explanation	Comments
EXEC SUMMARY	Explains the command	Most recent is is displayed in the footer
TIME	Time command was dispatched	Local computer time
Full Command	Full command as sent over the wire	Often very large; toggle verbosity to read

Only the last ten commands are displayed.

Note: the astersik in the header indicates that the topic has multiple verbosity modes.

2.5.5 MOOS-IvP



M#	NAME	ID	A MOOSDB	E TEAM	MISSION*
0	Evan	5	-		
1	Felix	6	-		
2	Gus	7	-		
3	Hal	8	-		
4	Ida	9	-		
5	Jing	10	-		
6	Kirk	11	-		
7	Manual		-		
8	Master		-		
9	Local		-		

Topic	Explanation	Comments
M#		See the Main view
Name		See the Main view
ID		See the Main view
A	Actual results block	Values here read off the target machine
MOOSDB		See the Main view
		Note that team isn't included here, unlike in the Main view
E	Expected results block	Values here are what uFleetManager would dispatch
Team	Team that the machine is on	Read from config
Mission	Launch file and args	If this is blank, startMOOS doesn't dispatch anything
		Toggle verbosity to see full path

Note: the astersik in the header indicates that the topic has multiple verbosity modes.

2.6 Commands

Many of these commands require the operator's fleet manager to be in "commanding mode"; they will be indicated by a * next to their name in this list. Some of these commands require confirmation; they will be indicated with a $ next to their name in this list.

Command	Key Feed	Description
Quit	ctrl-c	Close uFleetManager
Help	ctrl-h	Toggle help text; default is most hidden
CMD mode	ctrl-a	Toggle command mode; default is not in command
Verbose mode	V	Toggle verbose mode; default is terse
Clear	Backspace	Clear key feed
Start MOOS*	S	Start MOOS on each available machine, if possible
	s#	Start MOOS on machine #, if possible
Stop MOOS*$	K	Stop MOOS on all available machines (aka `ktm`)
	k#	Stop MOOS on machine #
Restart MOOS*$	R	Equivalent to the sequence `K S`
	r#	Equivalent to the sequence `k# s#`
Reboot Machine*$	W	Reboot all the machines (back seats)
	w#	Reboot machine #'s back seat
Shutdown Machine*$	D	Shutdown all the machines (back seats)
	d#	Shutdown machine #'s back seat
Reboot Vehicle*$	G	Reboot each of the machines' front seats, if they have them
	g#	Reboot machine #'s front seat, if it has one
Shutdown Vehicle*$	F	Shutdown each of the machines' front seats, if they have them
	f#	Shutdown machine #'s front seat, if it has one

2.7 Config files

Config files use standard `.moos` file syntax. The minimal config file looks like this

```
ProcessConfig = uFleetManager

{
```

```
 machines = alpha bravo charlie

}
```

and this would direct the Fleet Manager to watch three known vehicles; `Alpha`, `Bravo`, and `Charlie`, without specifying their mission or team.

To specify their team, add team variables like so:

```
ProcessConfig = uFleetManager

{

 machines = alpha bravo charlie

 red = alpha

 blue = bravo delta

}
```

This will result in `Alpha` and `Bravo` being assigned teams (which will show up in the `main` and `MOOS` views), `Charlie` will not have a team, and `Delta`'s team would be ignored because `Delta` isn't called out in `machines`.

To specify a mission directory, add the full path;

```
 all_mission_dir = ~/some/fully/qualified/path/
```

To specify vehicle-specific arguments for vehicle `foobar`, add a variable with its name;

```
 foobar = launch:launch.sh, dir:some/other/path, dir_rel:true, args:-s
```

Which would instruct `foobar` to use the `launch.sh` launch file when given the command to launch MOOS-IvP by the Fleet Manager, and to look for it at `~/some/fully/qualified/path/some/other/path`, and pass it the argument `-s`. If `dir_rel` was given `false`, then the Fleet Manager would go instead to `some/other/path` and look for `launch.sh` there.

As before, specifying the arguments for `foobar` will be ignored if `foobar` isn't in the `machines` list.

Comments are `//`.

3 Modifying the Fleet Manager

3.1 Adding Views

There are four places in `ui.cpp` that need to be modified to add a view; the help text, the table formatting, the navigation character handlers, and the view render block.

Help Text Find the block in `UI::setTableFormats()` of additions to `m_help["nav"]`; the syntax is a struct of three strings;

{`view name, navigation character, help text description`}

Table Formats Find the blocks in `UI::setTableFormats()` like

```
foo.push_back("BLAH")

foo.push_back("BLAH BLAH")

m_headers["foobar"].push_back(foo)
```

The map `m_headers` stores the headers for each view. A header is a vector of vectors of strings; the outer vector stores rows to feed to ACTables, and the inner vector stores the strings to put in each column of the table. Sections that have multiple header rows should be specified as

```
foo1.push_back("BLAH"); foo2.push_back("DUH")

foo1.push_back("BLAH BLAH"); foo2.push_back("DUH DUH")

m_headers["foobar"].push_back(foo1);

m_headers["foobar"].push_back(foo2);
```

the first block would result in a table formatted like

BLAH	BLAH BLAH
...	...

while the second block would result in a table formatted like

BLAH	BLAH BLAH
DUH	DUH DUH
...	...

Usually one or two lines is sufficient; the first line to delineate sections and the second line for column headers. Add your own section, consistent with what you put in the Help Text section. You will revisit this in Adding Topics to a View.

Character Handlers Find the block in `UI::actOnKeyPress()` with sequences like

```
else if (m_key_feed=="M") {

 m_view = "MOOS";

 command_match = true;

}
```

and add you own, consistent with the information you put in the Help Text section

View Render Find the block in `UI::printWindow()` that looks like

```
if (m_view=="FOO") {

 view_table << something

}

else if (m_view=="BAR") {

 view_table << something else

}

...
```

and add a similar block checking for your new view. See the next section for how to fill out that block.

3.2 Adding Topics to a View

There are two places in `ui.cpp` that need to be modified to add a column to a view; the table formatting block and the view rendering block.

Table Formats Find your block in `UI::setTableFormats()`, the same as your Table Formats block from Adding Views. Add a string to all the inner vectors. Disallowed[1] strings include "\n" and "|", and allowable strings include "", "\", "/", and "#".

View Render Find your block in `UI::printWindow()`, the same as your View Render block from Adding Views. The `n`th line such as `view_table << something` will fill the `n`th column of the table as ordered in Table Formats.

3.3 Adding Commands

The interface for the UI to call vehicle commands, to get information or to take action, is public `ManagedMoosMachine` methods.

Commands are fired off into the void, with a file to write results back to. These files are opened and read synchronously with the local machine, with a small proability[2] of reading partially written data[3]. This architecture approximates threading[4], but does not require maintainers to understand threading per se.

3.3.1 Dispatching

At the high level, the fleet manager is a big wrapper for sending commands over `ssh`;

[1] Used by ACTables for formatting.

[2] Determined by the duty cycle of file IO

[3] uFleetManager's networking layer is written such that in that case, the message ID is the last thing written, and only once it is complete will the app do anything with that data. In formal terms, this satisfies only the Consistency pillar of CAP. If the user clears the cache agggressively, it also weakly satisfies Partition Tolerance.

[4] This architecture was selected in keeping with Dr. Benjamin's standing instructions that any user with basic C++ and Bash experience should be able to understand any code in the lab. The PAVLAB considers threading a non-basic feature.

```
ssh ADDR "remote_cmd"
```

The complexity in sending commands is in letting go of it so the app can return to its thread of execution. The normal way to execute commands from `C++` is with the `system_call()` function[5], which is fine for local, synchronous commands. However, that naive approach is not sufficient to have many asynchronous commands in flight at the same time. The solution involves `nohup` (no hangup) and `&`, and is implemented in the `_dispatch()` function in `system_call.cpp`[6].

The robust interface from `system_call.cpp` is two functions, `system_call_dispatch_pipe()` and `system_call_dispatch_return()`. Both of them dispatch commands and capture an output from the script via `ssh` and write it to a named mailbox; `_pipe()` captures from `stdout`, where `_return()` captures the script's return value.

When you're adding a new public method to `ManagedMoosMachine`, it will be essentially a wrapper around either `system_call_dispatch_pipe()` or `system_call_dispatch_return()`. There are two common ways to do so; standard PAVLAB commands, and one-off commands. All else being equal, standard commands are preferable.

3.3.2 Standard PAVLAB Commands

The standard PAVLAB way of interfacing with lab machines outside of MOOS-IvP itself is via a *machine*-common directory. Currently we are maintaining two lab `svn` repos, `pablo-common` and `mokai-common`, and they each contain a directory called FleetManagerScripts with the lab's standard scripts. Commands have a simple naming scheme: "pav_*action_object*.sh". Some examples are

```
pav_test_ssh.sh

pav_get_svn_rev_moos.sh

pav_up_svn_moos.sh

pav_reboot_computer.sh
```

The sole exception is `pav_not_implemented.sh`, the placeholder implementation, which lacks a verb (such as "is").

All machines should have their relevant kind of *machine*-common tree, but they will have the Anonymous Read Only version, *machine*-common-aro[7].

There is a special helper function in `ManagedMoosMachine` to streamline calling those standard PAVLAB commands, `_dispatchPavCmd()`. There are several good examples of its usage in the `ManagedMoosMachine` class.

[5] system_call() has known security issues, be very careful using it unless you're absolutely sure you know the pedigree of the scripts you're calling with it.

[6] Note, I left some vestigal code about timeouts - I was leaking background processes, and attempting to solve that by sending out the scripts with a kill switch on a timer. Instead, the eventual solution was to use message indices and only send out a new request once the old one returned, I just haven't had time to clean up that bit of code.

[7] This allows anyone to call update and to use the scripts, but not to push changes. To push changes, talk to Dr. Benjamin about getting access to the *machine*-common repos

3.3.3 Special Commands

Some commands do not lend themselves to the common and standardized system. For example, `ping` makes no sense to be hosted remotely. Rebooting computers can be configured to run without a password on some operating systems (e.g. Raspian) but it's not clear on others (e.g. Ubuntu) so one-off versions are sometimes needed.

In that case, compose the script in code and use the appropriate dispatcher (`system_call_dispatch_pipe()` or `system_call_dispatch_return()`) to run it.

One interesting caveat is that unlike normal scripts, where instructions are separated by semicolons, in these scripts the instructions must be separated by newlines.

3.3.4 Reading Mail

Dispatched commands will, once they conclude, yield a result to a mailbox file. Mailbox files are files in the directory `/tmp/MOOSMAIL`. The usual naming is `/tmp/MOOSMAIL/`*Machine_commandName*`.mailbox`. For ease of use, use the `ManagedMoosMachine` helper function `serviceMailboxName()`.

Once that result is put in the mailbox, you'll want to read it. At its core, we're just reading lines out of the mailbox and parsing them. By checking for message indices, this step also serves as a caching and synchronizing step.

Consider a new `ManagedMoosMachine` public method, `checkFooServiceMail()`; its implementation might look something like this:

```
vector<string> mail_list = readServiceMailbox(m_mailboxes["fooService"]);

index_t index = grabIndex(mail_list);

if (receiveUpdate(m_mail["fooService"], index)) {

 // do parsing here...

 m_mail["fooService"].data = /* a result string */

}

return(get_data_and_staleness(m_mail["fooService"]));
```

When returning a status, consider looking in the `Status` namespace in `Constants.h`. These statuses are shared throughout the app, allowing them to be reasoned over in the UI.

3.3.5 Required Variables and Caching

3.4 Miscellaneous

3.4.1 Tips and Tricks

4 Configuring Machines to work with the Fleet Manager

4.1 SSH Keys

4.2 Shell Startup and Sources

4.3 Software

4.4 Permissions

5 Debugging

Symptom	Issue	Resolution
Semicolons in command (see History)	Needs to be \n	Replace in relevant ManagedMoosMachine dispatcher function.
App responds slowly	Resource starved	Check CPU usage Check process count Try closing Google Chrome or other resource-hogging programs.