Private Dropbox
Final Report
COSC480

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Abstract

I have written a program in Python which reads user settings from a file, and synchronises the appropriate files to the appropriate machines when they have been modified. It does this using an efficient two way file synchronising tool called Unison. I will discuss in this dissertation what I have done and how I have tested my program.

Contents

1 Introduction

1.1 Project goals

The aim of this project was to develop a file synchronisation tool. Similar to Dropbox (and others) its main function should be to keep data synchronised between multiple devices. What makes it different however is it should:

- Support decentralised operation. It will not necessarily need to communicate with 'the cloud'. The program should not require a centralised server. However it should be possible to configure the system to behave like a centralised system if the user wants to. The system should be flexible in this regard.
- Allow file synchronisation between multiple clients not just point-to-point between two clients. Synchronisation between two clients however is the basis for multiple client synchronisation. Clients may be running different operating systems. Clients may be connected to different networks, with different costs of access, including being disconnected from the Internet at times.
- The user should be able to choose what to replicate and how often to do it within different sets of files. Choosing what to replicate could be done based on file name, file types, file size *etc.* They system should allow for fine-grained user control for the majority of the program's functionality.
- Show statistics about which files are being replicated, efficiency (time taken for the files to become fully up to date), cost (bandwidth, disk space used). These statistics could also possibly lead to a heuristic for when to synchronise a given file. For example if a file is updated and a node has many neighbours to potentially send the file too. Perhaps choosing the neighbour whose links has the lowest cost would be a good choice to send the data to first.
- Operate automatically, without the user having to initiate a file synchronisation themselves. The system's autonomous operation should be influenced by the users choices on how often to sync and what files should be synced, this relates to the fine-grained controls mentioned above.

1.2 Background

There are already many services available that can synchronize your files between different devices. Dropbox, Google Drive, Microsoft SkyDrive, Apple iCloud are all examples of cloud based solutions for distributing your files across your devices. The problems with these services is privacy and availability. Storing your data with a third party gives them access to your documents. If you are a commercial organisation with sensitive information this might be concerning. You could of course choose to encrypt your files. Encrypting your files adds two slow extra steps, encrypting them before you upload

and decrypting files before you can use them, this is less than ideal. You also cannot guarantee that you will always be able to access your data, if the company that hosts your data goes bankrupt or decides to shutdown their service you could lose all of your data with little or no warning.

For example Megaupload, a file hosting service, has recently been shut down by the United States Department of Justice for alleged copyright infringement. According to its founder, 100 million users lost access to 12 billion unique files[1].

There are other possible approaches to replicating files across multiple computers. For example you could use version control systems like Subversion, Mercurial, and CVS. One problem with these is that they are centralised (they rely on a central server), should that server fail the replication will break. Not only that, they create a bottleneck at the server which can slow replication down. Cloud based solutions are often centralised. Another problem is that even if they are decentralised like git, they will not automatically push updates to other working sets. This could be accomplished with some cron scripts or a post-commit hook to get git to propagate data onwards. Git might have made a promising base to build my application on top of, the only real problem was the version control overhead that comes with it. Old revisions would take up space on the hard disk and require more data to be transmitted across network links. I decided that as a file synchronisation program, revision history was out off scope and that my program would deal with just keeping files in sync. Using git would be an interesting extension to my program and could easily be integrated into my current system.

1.3 Example use case

Here is an example use case demonstrating why I find my program useful.

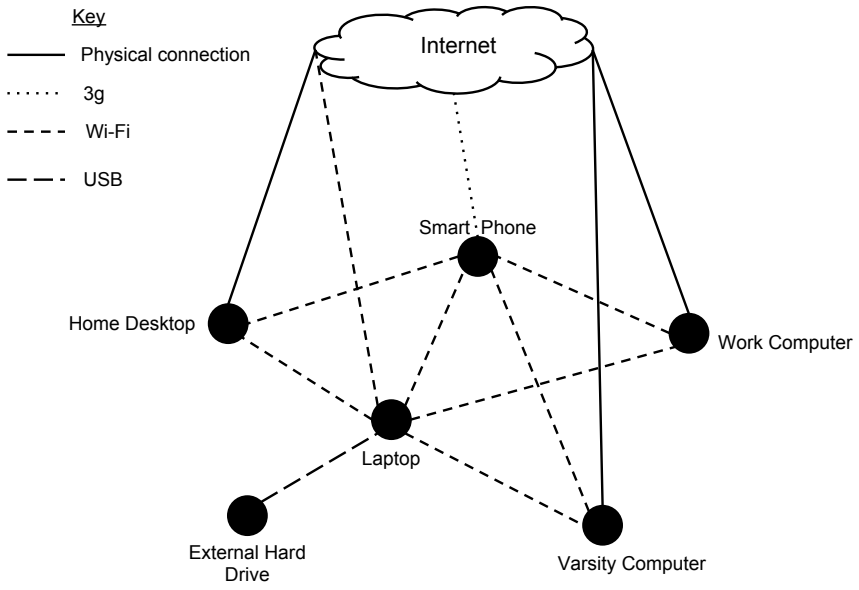
I like to keep all of the data on my laptop backed up to an external hard drive. The data on my computer that I wish to back up falls into three main categories: documents, music, and movies. Documents are mostly scripts and programs that I am writing for University or work projects. Documents also include reports for assessment. These documents change very frequently and are very important to me. Often these are small files (but not always). My music collection changes relatively infrequently, files are around $\approx$5MB and I like to have a relatively current backup of this collection. My movie collection contains fairly large files but I do not need it to be backed up very often as it does not change very much and I do not care if I loose some of these movies. Files that I work on at University would be very useful to have on my laptop at home. Files that I work on at work mostly stay at work but occasionally I might want to bring something home to work on. The other device I always have with me and may be on one of any given (Wi-Fi or 3G) network at a certain time is my smart phone. I would like to have photos taken on this backed up to either (or both) my laptop and external hard drive.

[1] http://computerworld.co.nz/news.nsf/news/kim-dotcom-wants-his-money-back

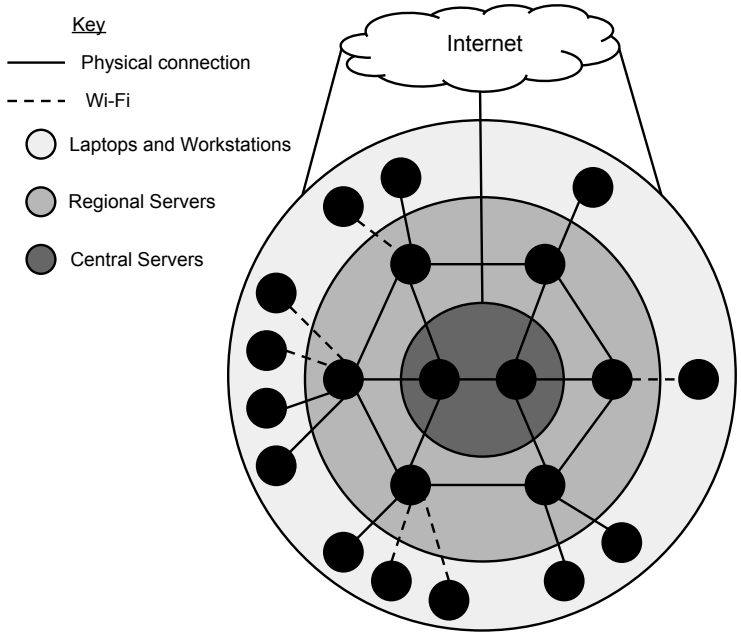
Some of the files that I move around are of a sensitive or personal nature and I would prefer not to store them with a third party vendor. I also have different synchronisation requirements for different types of data. For example my collection of large video files does not change that often and will chew up valuable network bandwidth whenever it has to transfer a new file. I like this to be replicated only occasionally as I do not use it that much. On the other hand my document collection which I use for work and coursework changes very often, is very important, and is fairly small. I would like this to be as up to date as possible.

Existing file synchronisation tools do not do enough for me. I do not have enough control over my data. I want to know which machines my files are going to and when. I want to feel confident that I will always be able to access my data even if the service closes down or my internet connection fails. My program is aimed at addressing these issues.

I have already described the personal network shown in Figure 1a. Figure 1b shows a graph of a corporate network, this is another example use case. It will have many of the same basic needs as the personal graph. The coloured rings represent the need for different policies for different machines in a network. Something which Dropbox will not provide but my system does.



(a) Personal Network



(b) Corporate Network

Figure 1: Example use cases

2 Supporting architecture and program development

2.1 Virtual Machines, Node networks

For testing my program I needed to have a network of computers that can be linked together in different arrangements easily. I decided to use virtual machines for this job since it means I do not need to have a large number of physical machines. I can create new machines very easily, and manipulate the links between them.

I have used Oracle's VirtualBox software. I chose VirtualBox because of its easy to use command line interface. My program should be able to run across any network of nodes. So I wanted to test as many different arrangements as possible. I decided that I needed to be able change network topologies easily without having to re-write my scripts. I built some bash scripts to run on top of a program called Graphviz[2].

Graphviz is open source software for generating graphs. I used Graphviz to generate graphs of all the topologies I worked with. This made it easy to keep track of what a topology looked like which was useful for debugging. It was also useful to display results alongside an image of what the topology looks like. Building my program on top of Graphviz meant that I could couple the production of the topology graph and the configuration of the virtual machines together. I never wanted one without the other so this was very useful.

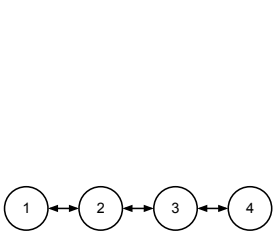
Graphviz takes input from scripts written in DOT language[3]. DOT language is a simple graph description language. I have written a script to read in these DOT files and interpret the graph to set up my virtual machines[4]. My script also calls a program called `neato` (part of Graphviz) to generate graphs. This means I only have to write one DOT file to get a graph of my network topology and set up my virtual machines.

My Bash script enables the appropriate network adaptors on each virtual machine[5]. It does this by calling the `VboxManage` command which provides a command line interface to virtual box's functionality and allows me to configure the virtual machines to my liking. Then it sets an internal network and attach's these adaptors to use that network. I chose to use an internal network as the link between any given machines because this way I could guarantee my program and programs that I called (like Unison) were the only programs using the interface. This helped me monitor the network traffic generated by my program (see Section 2.2). I sniffed network traffic using Wireshark[6] when nothing was running and also when my program was running to verify nothing unexpected was using the interface.

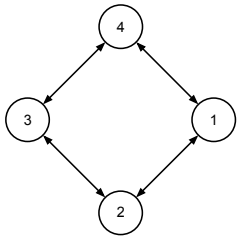
I started by writing some simple network topology DOT scripts. The reason I only choose to use simple topologies when testing my programs. I did this because it is easier to visualise how my program runs from the data if the topologies are simple. The other

[2] www.graphviz.org
[3] http://www.graphviz.org/doc/info/lang.html
[4] Appendix C line 125 onwards
[5] Appendix C line 60
[6] http://www.wireshark.org/

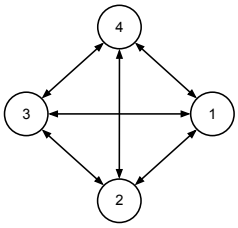
reason I chose to do this is because it is easy to extrapolate from a few simple topologies and generate a model of how more complicated topologies might behave.



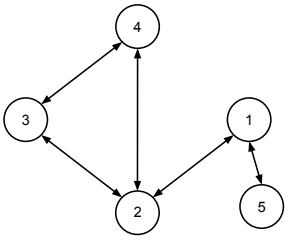
(a) Line topology



(b) Circle topology



(c) Connected mesh topology



(d) Other topology

Figure 2: Simple network topologies

2.2 Reading network statistics

In order to gather network traffic statistics I chose to monitor the upload and download data collected by the interfaces over time. Given that my program was to only program using these interfaces I did not have to differentiate between different processes using the network. I looked at the possibility of extending this to run on a network where other processes are using the network connection as you would expect in a real world application of my program. I found a tool called NetHogs[7]. NetHogs runs on Linux and monitors the amount of data sent over the network by any given process. I also looked at using Iotop[8]. Iotop provides data on files being written to disk which was useful information and relates closely to the amount of data sent over the network. However I decided that monitoring network traffic was a more useful statistic as I could also see the `ssh` overhead associated with a transfer. An interesting challenge I faced when I was trying to log network usage was what interface to log data for. Initially I logged the traffic of all of the interfaces on the machine[9]. The flaws in this approach became apparent very quickly, machines with an internet connection sometimes used large amounts of data which skewed the data. It also did not work with machines that were on more than one internal network as they might be sending/receiving data on

[7]http://nethogs.sourceforge.net/
[8]http://guichaz.free.fr/iotop/
[9]Appendix B line 92

both of the networks at the same time. I overcame this problem by using a built in Linux command `ip`. I always had an IP address to send data too, so all I needed to do was run `ip route get {IP address}` and examine the route information to see which interface was being used for communication to that IP address[10]. Once I had the interface name I would then record that data before and after a sync occurred for that given interface. I would also do this on the machine I was sending data too. This would give me timestamps of when data was

2.3 Getting my IP, networking

route etc.

2.4 settings and stored data

stores files sync time, how up to date all graph data could be utilised

2.5 Python

I have chosen to use Python to implement my program. Python appealed to me because it supports many different platforms (Windows, Linux, Mac OS X). This is useful because it means I will (hopefully) encounter fewer compatibility problems when running my program across different operating systems in the future.

2.6 User control

One of the main goals of my project is to allow the user to have a large amount of control over how the program behaves. I currently have the program reading from configuration files that allow the user to specify which directories they want to watch and where those directories should be synchronised to.

I chose to use directories as my granularity for replication as opposed to files because keeping track of a large list of files may become unwieldy, and because I replicate directories recursively, I can replicate large amounts of data without a cluttered configuration file.

Another reason I chose directories as my granularity was because it may be handy to have a directory full of symlinks pointing to other directories.

3 Program mechanics

3.1 Monitoring Directories

The application needs to monitor directories for changes (see section 4.4) so that it knows when to perform a sync. The reason I have chosen to do this is because syn-

[10] Appendix B line 38

chronising a directory that has not been changed is a waste of time. I do not however want to be continually polling the watched directories to see if there have been any changes made. This would be a significant waste of CPU time and the input/output time associated with checking the disk. Instead I have looked into ways of being notified of a change in the file system below the watched directory.

- Inotify
  - Inotify is a kernel feature that has been included in the Linux kernel since version 2.6. It is used to watch directories for changes and notify listeners when a change occurs. Inotify is inode based and replaced dnotify, an older system that provided the same functionality. Dnotify however was inefficient, it opened up the file descriptors for each directory it was watching which meant the backing device could not be unmounted. It also had a poor user-space interface which used SIGIO. Inotify only uses one file descriptor and returns events to the listener as they occur [11] There is a Python module called pyinotify[12] that provides a Python interface to inotify, which I have used in my program. Another reason I chose inotify was because different kinds of changes triggered different inotify events. So I can differentiate between a file being deleted, created or modified, *etc.*
- FSEvents
  - FSEvents is an API in MacOS X [13] It is similar to inotify in that it provides a notification to other applications when a directory is changed however it does not inform you which file in the directory was changed. This does not matter for my application since Unison is smart enough not to copy unchanged files in a directory. There is a Python module for FSEvents called MacFSEvents [14].

    I also looked at using the `kqueue` [15] system call that is supported by OS X and FreeBSD. It notifies the user when a kernel event occurs. I decided against using `kqueue` as the high level approach of FSEvents suits my application's needs.
- ReadDirectoryChangesW
  - Windows, like the other operating systems I have examined, provides a way of doing this too. There is a function called `ReadDirectoryChangesW`. There is a FileSystemWatcher Class in .NET version 4 and above. IronPython might prove to be a good choice for a Windows implementation as it is a

[11] www.kernel.org/pub/linux/kernel/people/rml/inotify/README
[12] http://pyinotify.sourceforge.net/
[13] https://developer.apple.com/library/mac/#documentation/Darwin/Conceptual/FSEvents_ProgGuide/Introduction/
[14] http://pypi.python.org/pypi/MacFSEvents/0.2.1
[15] http://developer.apple.com/library/mac/#documentation/Darwin/Reference/ManPages/man2/kqueue.2.html

version of Python integrated with the .NET framework. I have chosen only to implement my program on Linux because portability was not in the main scope of the project. I would have liked to look at it further but became too time consuming and not interesting from a research perspective.

3.2 Unison and temporary files

I noticed that when Unison ran it created temporary files in the directory and once these files had been fully copied it renamed them to their intended name. The problem with this was that my program was picking up these temporary files as they were created and trying to copy them to the next node, only to find that these files no longer existed. To get around this problem I decided to implement a filter on the files to be copied. The program filters out files that contain ".tmp" in the filename. Unison is not the only program that uses temporary files. I decided that this should be a user set preference given that users may want to filter out different files.

My program simply reads from a file with each file pattern to exclude listed on a new line. It is easy to add to/remove from. As I said above I added .tmp to the file as a default. This could easily be extended to allow a user to omit certain files from the replication by adding all files in my programs ignore file to Unisons ignore list. Or conversely by maintaining a white list of files to sync. This would allow for greater granularity when syncing nodes.

4 Program evaluation

4.1 Point-to-Point synchronisation

After looking for cross-platform, open source, file synchronisation tools, I have found a tool called Unison[16] to be a promising starting base for this project. Unison is an open source file synchronisation tool. It supports efficient (*i.e.,* it attempts to only send changes between file versions) file synchronisation between two directories (including sub-folders) between two "roots" that may or may not be on the same machine. Unison calls the directories it is synchronising, roots.

I decided to run some tests using Unison and two machines running on the same network to determine whether this would make a good base for my program or not.

I looked at three methods of file synchronisation across these two machines. Naïve copying; using Rsync, an application designed for efficiently copying files in one direction by looking at the differences in the files; and Unison described above.

Rsync and Unison performed significantly better than the naïve copy method (as expected). After the initial file transfer new files added to the directory resulted in much less data being transmitted over the network, which meant the node graph became up to date much more quickly.

[16]http://www.cis.upenn.edu/ bcpierce/unison/

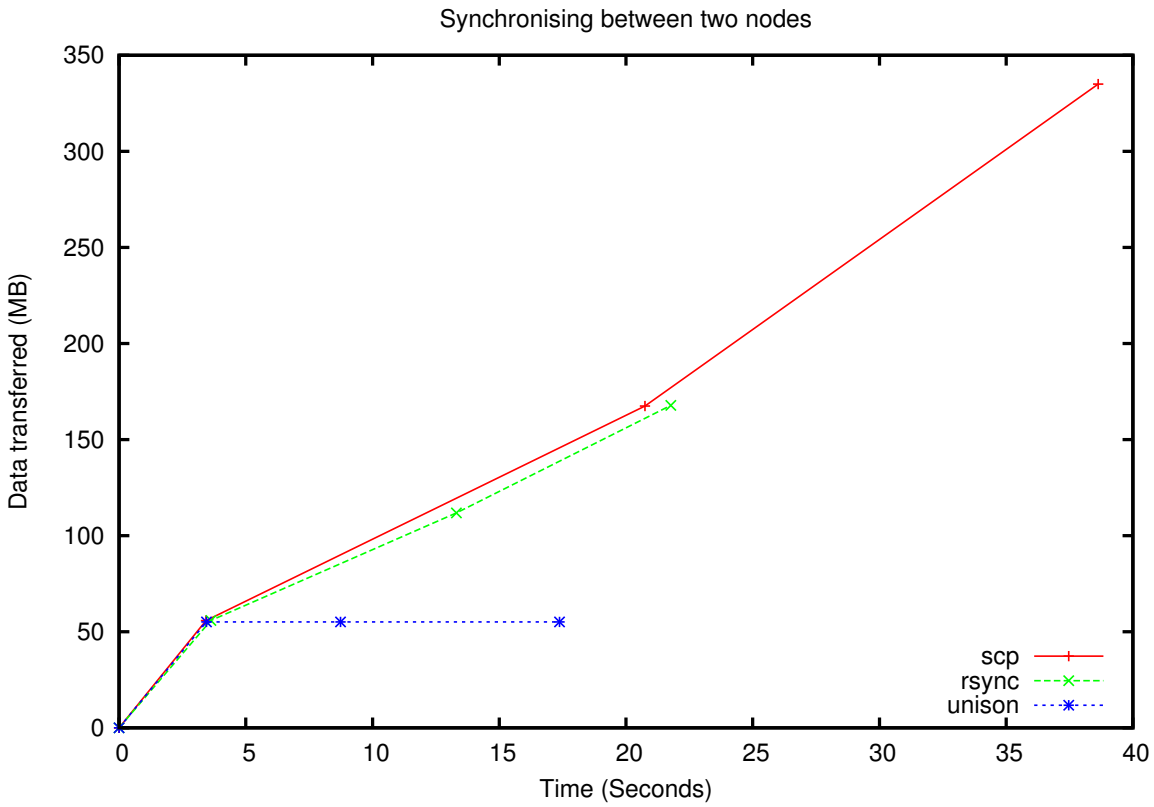


Figure 3: Comparison of SCP, Rsync, Unison. Three identical 50MB files with different names are being transfered between two nodes. Each point on the graph represents the start or end of a sync.

The reason naïve copy sent over 300MB of data to copy three 50MB files was because my implementation is deliberately naïve; it will copy the entire directory each time it is changed. Rsync and Unison were able to send less data because they work based on the differences between the files. However copy doesn't look at the files it just copies everything in the directory tree. Hence it will copy 50MB after file one is created, 100MB after the second file is added and finally 150MB when all three files are present for a total of 300MB.

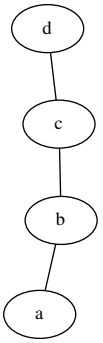
Rsync copies the expected 150MB for three 50MB files. Figure 3 illustrates another advantage of Unison over Rsync. The graph shows three zero filled binary files being copied from one node to another one after the other. Unison recognised that even though the files were named differently they were the same file. Another advantage of Unison is that it handles replication in two directions without overwriting the files on the other side.

Each of the three methods I trialled had some overhead associated with them. This overhead was due to the secure shell (SSH) tunnel between the machines that all three methods used. Unison and Rsync also incur some overhead when comparing the differences between the files in the directories. This is why the graph shows the three lines slightly above where you might expect them to be for the amount of data that was copied.

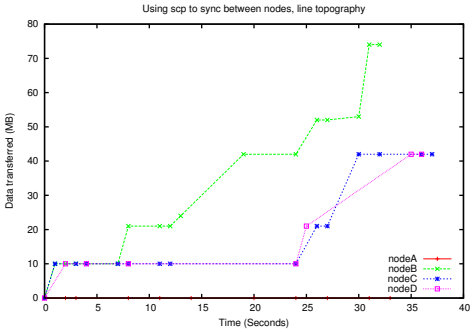
4.2 Full graph replication

As you can see Unison and Rsync outperformed SCP advantage of Unison is two-way sync

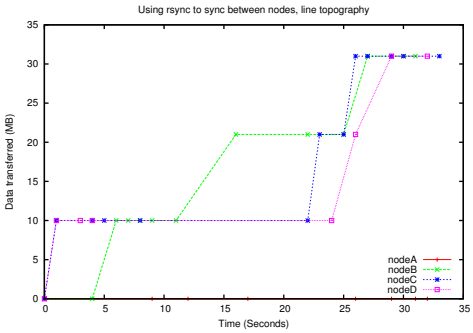
For next graphs I dropped SCP as not only is it inferior it is also completely wrong the programs behaviour is undefined for changes coming from two directions.



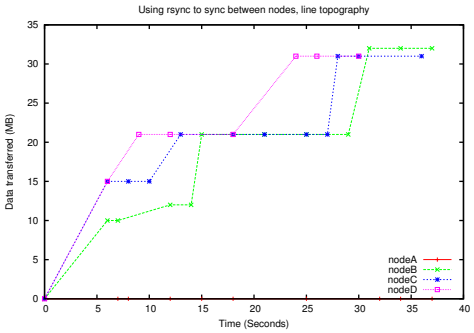
(a) Line - Generated Graph of Topology



(b) SCP

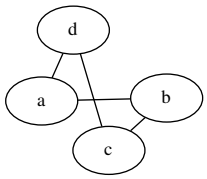


(c) Rsync

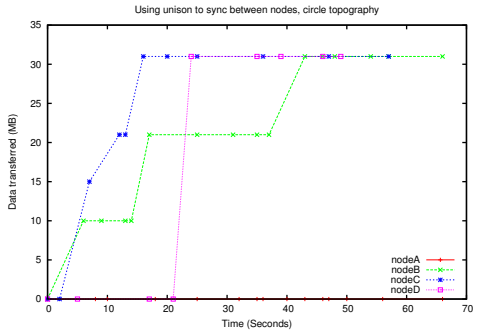


(d) Unison

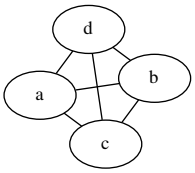
Figure 4: Comparison of methods over line topology



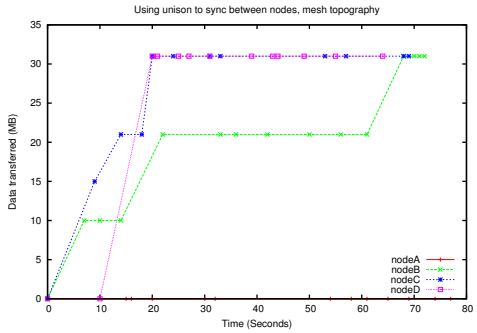
(a) Circle - generated graph of topology



(b) Unison running over circle topology



(c) Mesh - generated graph of topology



(d) Unison running over mesh topology

Figure 5: Comparison of different topologies

4.3 When to stop copying

They way my program works it that Each node notices when changes have occurred to a folder it is watching and when a change occurs, copy these changes to other nodes that it is connected to. After testing my program on some simple topologies one problem became clear. The problem was that if the changes came from one of its neighbour nodes this would cause an infinite loop of two nodes trying to copy changes to each other. This was particularly a problem when using SCP to copy. When using Unison this was not as much of a problem because it could detect that no changes had occurred between the nodes and would stop synchronising after one check (which had minimal overhead).

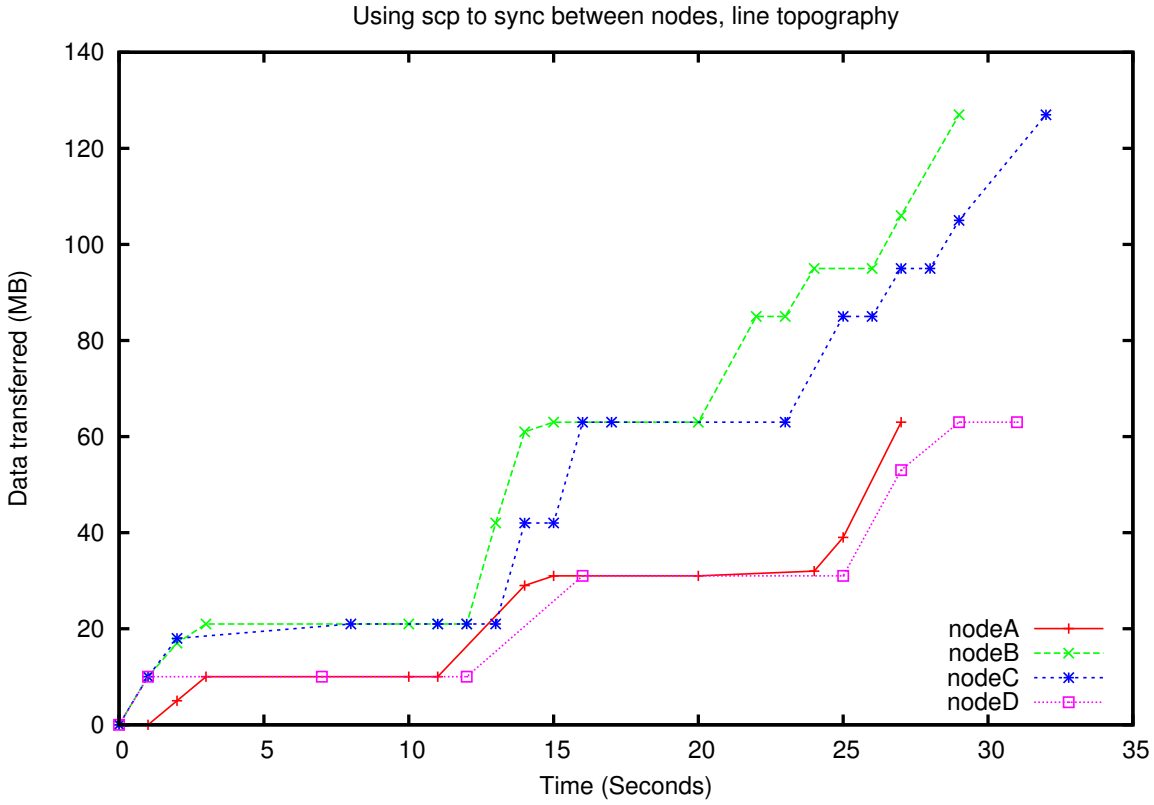


Figure 6: Line topology, using SCP, nodes copying data back and forth

Figure 6 shows three 10MB files being copied to nodeA in a line topology. The problem is that nodeB and nodeC continue to send data to each other even after every node has all of the files. NodeA receives a lot of data even though it was the source of the file changes.

The data points in Figure 7 show that when using Unison, although no extra data was sent, Unison still had to make checks to see whether there were any changes or not.

I used a control file to get around this problem. Each time a node synchronised with another node it would write out a control file telling the other node what files had

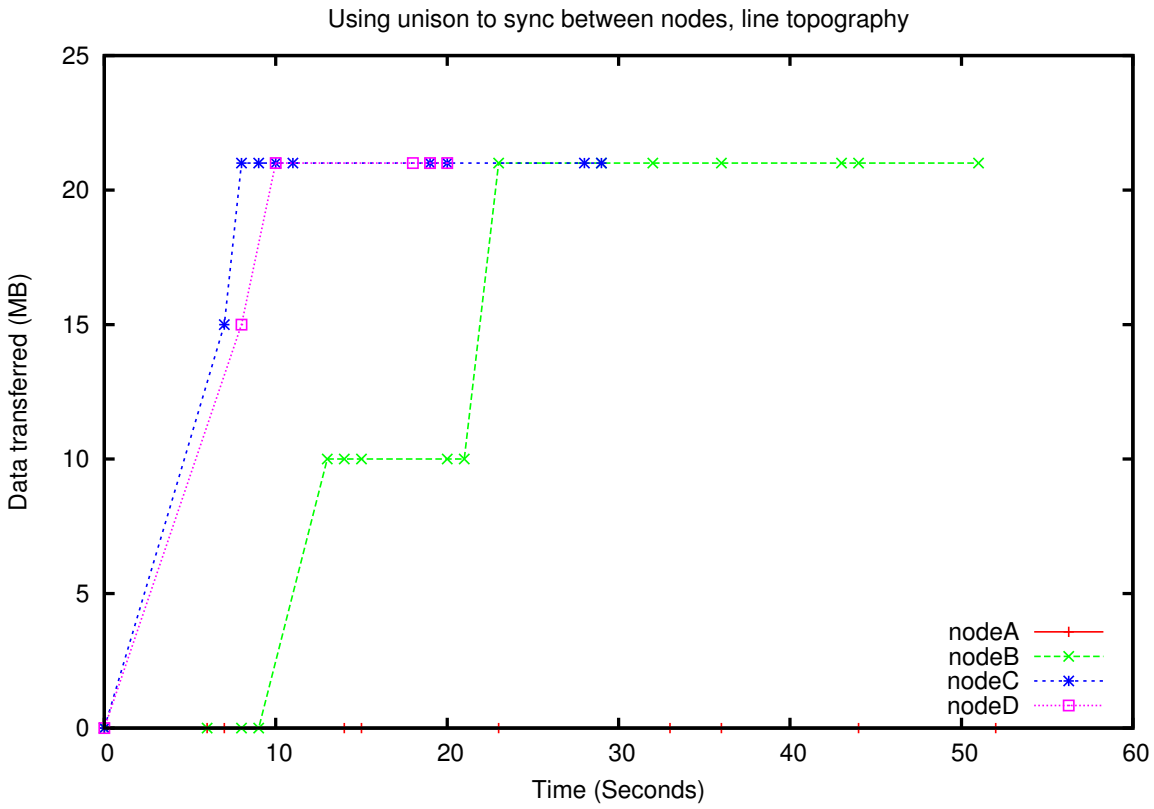


Figure 7: Line topology, using Unison, program continues to check for differences in files even after all nodes are the same. Each point represents an attempted sync.

been copied, who sent them and what the modification time of the files were. In this way a node could check if it was about to synchronise a file back to the node it had just received the file from or if local changes really had occurred to that file that were newer than a received file it should continue with its sync.

4.4 Dealing with Sub-nodes

I chose to classify directories as 'sub nodes' of a graph. The reason I choose directories is because they are easy to manage a configuration file of directories to keep in sync (from the users point of view). If we wanted to only synchronize certain files in a directory we could write a Unison configuration file with exclusions/inclusions in it. The other reason directories are a good choice is because I can have different directories in different places on different file systems by using symbolic links. I wanted to see how the freshness of different sub-nodes varied between nodes when the program was running.

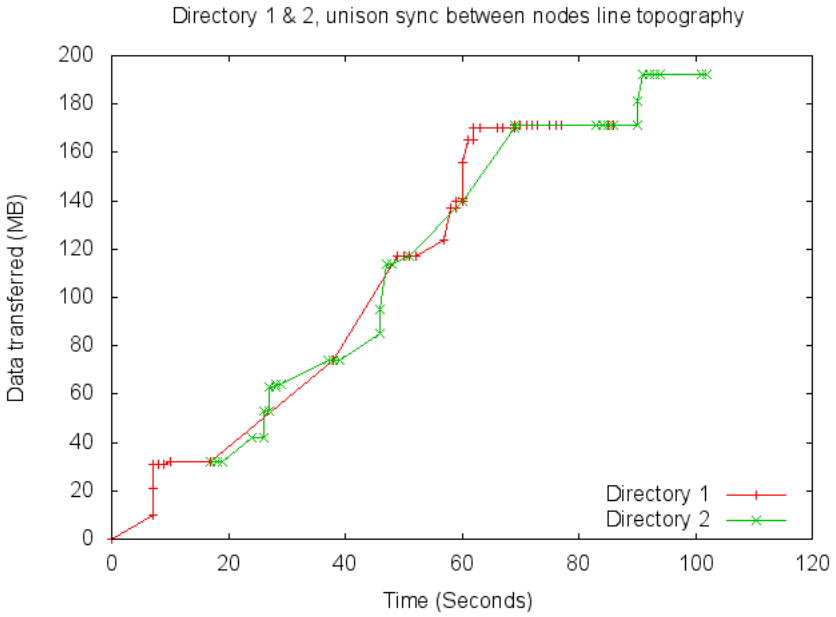
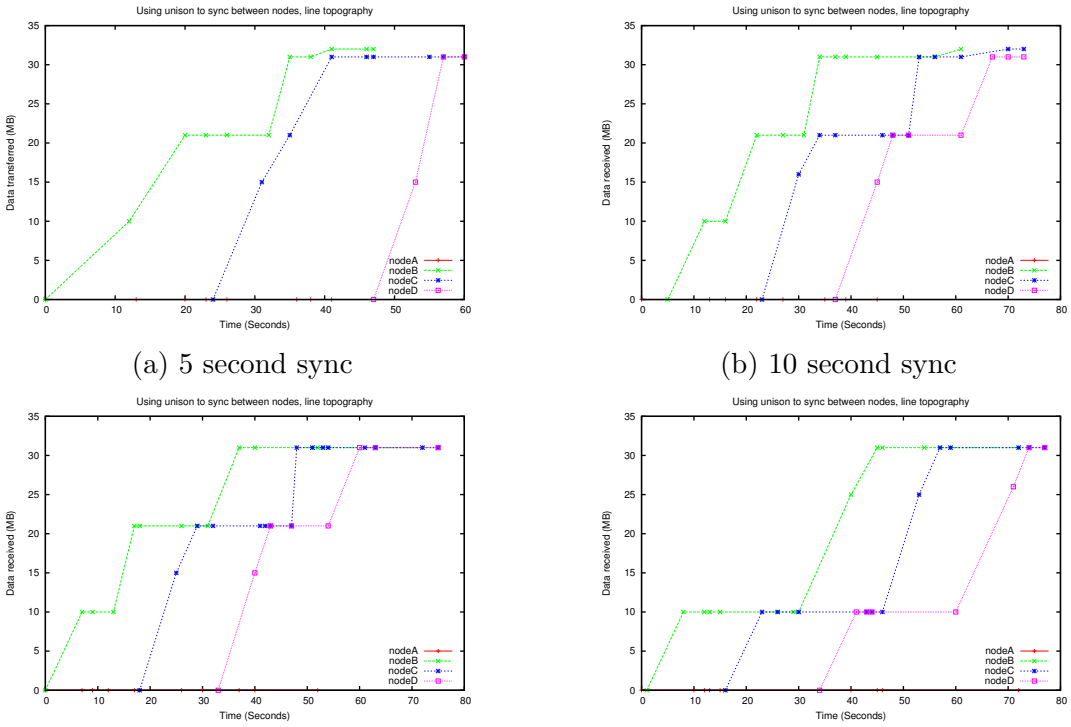


Figure 8: Line topology, using Unison, two different directories being synced

4.5 How often to sync

So how often should I sync once I noticed a change. If lots of small changes are occurring frequently it might be more efficient to perform a synchronisation after several changes have occurred. Given that there is overhead with each synchronisation, fewer copies means less data sent over the network.



(a) 5 second sync

(b) 10 second sync

(c) 20 second sync

(d) 30 seconds sync

Figure 9: Comparison how frequently to sync

As you can see in Figure when using Unison it is best to just sync as often as possible. This is because Unison only sends the difference between files and the network overhead associated with synchronising is negligible when dealing with large files.

SCP showed a noticeable difference however...?

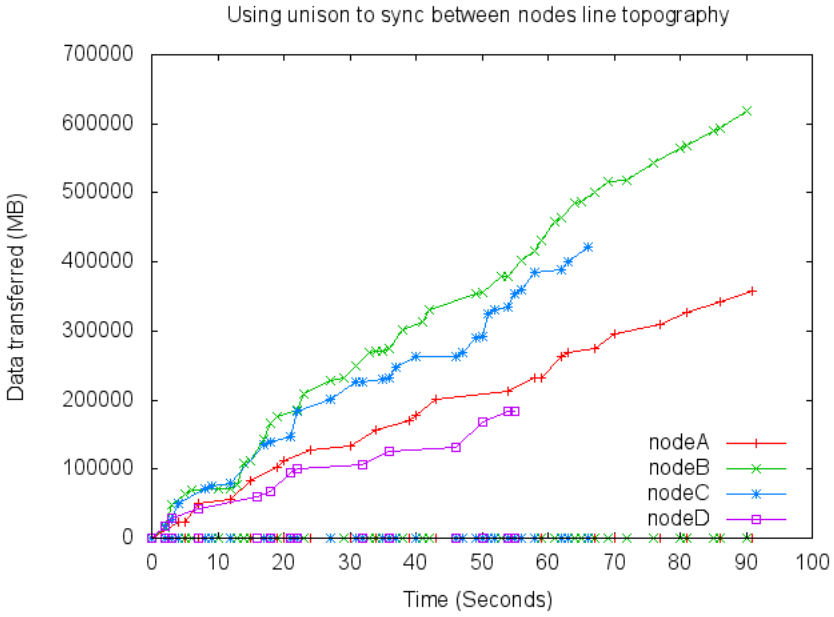


Figure 10: 2 seconds sleep text file

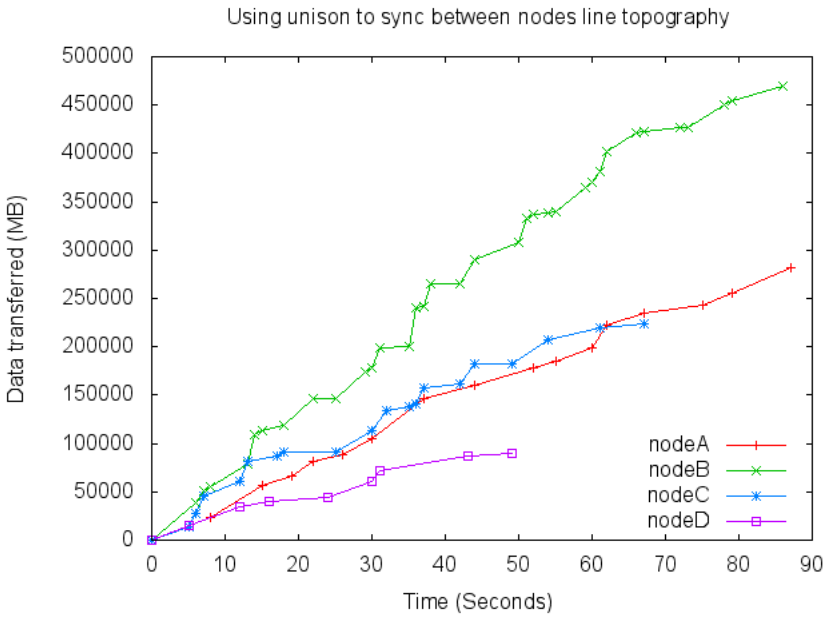


Figure 11: 5 seconds sleep text file

4.6 Wi-Fi vs 3G

Circle topology start at node A, node B is on Wi-Fi and node C is on 3G. Results and discussion to come.

5 Conclusion

5.1 Future Work

5.1.1 Mobile Nodes

5.1.2 Feedback

5.2 Results

My program does better than naïve copying, works in a variety of situations allows for fine grained user control.

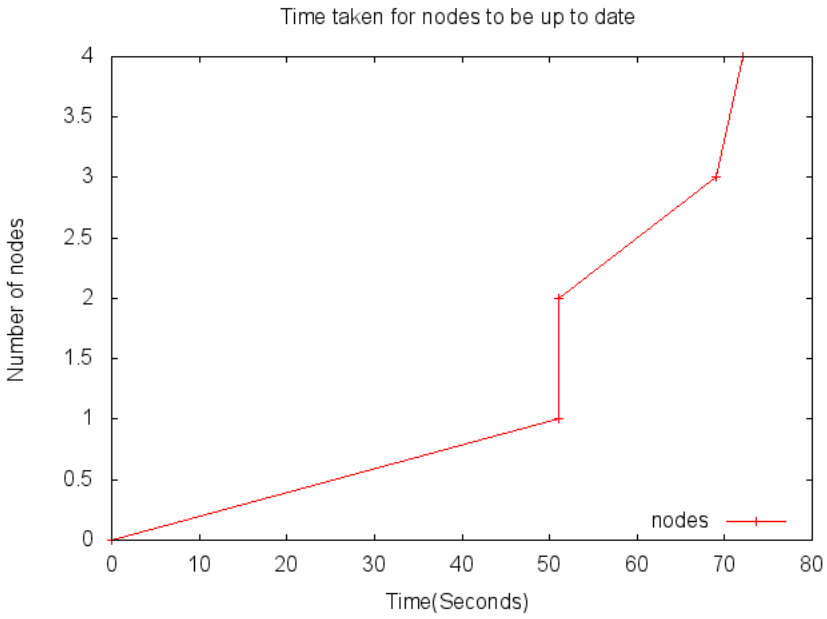


Figure 12: Unison, line, finishing times

A WatchAndSync.py

```
1 import pyinotify, os, subprocess, argparse, socket, time, glob
      , datetime
2 import readnet
```

```
3
4 wm = pyinotify.WatchManager()
5 watchedfolders = {}
6 homepath = "/home/cal/Documents/Private-Sync/"
7 #homepath = "/Users/calum/Documents/Private-Sync/"
8
9 parser = argparse.ArgumentParser()
10 parser.add_argument("-c","--scp",action="store_true",help="
    Copy using scp")
11 parser.add_argument("-r","--rsync",action="store_true",help="
    Copy using rsync")
12 args = parser.parse_args()
13
14 class Tools():
15     def updateFolderInfo(self, wfolds):
16         f = open('./folders.dat','w')
17         for fold in wfolds:
18             f.write(fold + " ")
19             for i in range(0,len(wfolds[fold])-1):
20                 f.write(wfolds[fold][i] + " ")
21             f.write(wfolds[fold][len(wfolds[fold])-1] + "\n")
22         f.close()
23
24     def timeElapsed(self, dtstamp, diff):
25         if diff == "*":
26             print "Sync ASAP"
27             return
28         diff = int(diff)
29         FMT = '%Y-%m-%d %H:%M:%S.%f'
30         #FMT = '%Y-%m-%d %H:%M:%S'
31         tdelta = datetime.datetime.now() - datetime.datetime.
              strptime(dtstamp, FMT)
32         print  tdelta.total_seconds()
33         timeDiff = tdelta.total_seconds()
34         if (timeDiff >= diff):
35             print "Time period reached"
36         else:
37             print "Time not elapsed, sleeping for " + str(diff
                  - timeDiff + 1)
38             time.sleep(int(diff - timeDiff + 1))
39
40 class MyEventHandler(pyinotify.ProcessEvent):
41     def flipIP(self,ip):
```

```
42          octets = ip.split(".")
43          if(octets[3] == "1"):
44              octets[3] = "2"
45          elif(octets[3] == "2"):
46              octets[3] = "1"
47          else:
48              octets[3] = "1"
49          return ".".join(octets)
50
51      #Get the last modified time of a file
52      def getModTime(self,path):
53          try:
54              return time.ctime(os.path.getmtime(path))
55          except Exception, e:
56              return time.ctime(0)
57
58      #Deprecated - Check for IP not to copy too
59      def getStopInfo(self):
60          stopIP = ["",""]
61          try:
62              o = open("./stop",'r')
63              stopIP = o.read().split()
64              o.close()
65          except IOError, e:
66              pass
67          return stopIP
68
69      def inStopFile(self,ip,path):
70          stopIPs = {}
71          stop = False
72          modTime = self.getModTime(path)
73          while True:
74              tmpcount = 0
75              print "Files found: " + str(glob.glob("Stop-*"))
76              for files in glob.glob("Stop-*"):
77                  #print "File: " + str(files)
78                  if ".tmp" in files:
79                      tmpcount += 1
80                      time.sleep(5)
81                      break
82                  f = open(files,"r");
83                  for line in f:
84                      l = line.split()
```

```
85                      if self.exclusions(l[1]):
86                          print str(l[1]) + " was in ignore file
                                skipping"
87                      else:
88                          print "local " + str(path) + " modtime
                                : " + modTime
89                          print "Stop " + l[1] + " modtime: " +
                                str(l[2:])
90                          ts1 = time.strptime(modTime,"%a %b %d
                                %H:%M:%S %Y")
91                          ts2 = time.strptime(" ".join(l[2:]),"%
                                a %b %d %H:%M:%S %Y")
92                          print "local <= stop: " + str(ts1 <=
                                ts2)
93                          #if l[0] == ip and l[1] == path and
                                ts1 <= ts2:
94                          #If IP sending to has sent data more
                                recently don't send back
95                          if l[0] == ip and ts1 <= ts2:
96                              print "Stop = True, file: " + l[0]
97                              stop = True
98                          else:
99                              stopIPs[l[0]] = [l[1]," ".join(l
                                    [2:])]
100
101                 if stop:
102                     f.close()
103                     #f = open(files,"w")
104                     #for k in stopIPs.keys():
105                     #    f.write(k + " " + stopIPs[k][0] + " "
                            + stopIPs[k][1] + "\n")
106                     #f.close()
107                     #stopIPs.clear()
108                     return True
109
110                 f.close()
111                 #stopIPs.clear()
112             if tmpcount == 0:
113                 break
114
115         return False
116
```

```
117     #Set flag on other server telling it not to immediately
            try and copy data here
118     def setStopFileUniq(self,ip,myIP,path,folder):
119         nodename = self.getNodeName()
120         #print "ssh",ip,"echo " + myIP + " " + path + " " +
                self.getModTime(path) + " >> " + homepath + "Stop-"
                + nodename + ".tmp;"
121         #subprocess.call(["ssh",ip,"echo " + myIP + " " + path
                + " " + self.getModTime(path) + " >> " + homepath +
                "Stop-" + nodename + ".tmp;"])
122         subprocess.call(["ssh",ip,"rm " + homepath + "Stop-" +
                nodename + ".tmp;"])
123         for cpFile in glob.glob(folder + "/*"):
124             subprocess.call(["ssh",ip,"echo " + myIP + " " +
                    cpFile + " " + self.getModTime(cpFile) + " >> "
                    + homepath + "Stop-" + nodename + ".tmp;"])
125
126     #Sets the config files on the remote node
127     def beginCopy(self, ip):
128         nodename = self.getNodeName()
129         print "ssh",ip,"touch " + homepath + "Stop-" +
                nodename + ".tmp; mv " + homepath + "Stop-" +
                nodename + " " + homepath + "Stop-" + nodename + ".
                tmp;"
130         subprocess.call(["ssh",ip,"touch " + homepath + "Stop-
                " + nodename + ".tmp; mv " + homepath + "Stop-" +
                nodename + " " + homepath + "Stop-" + nodename + ".
                tmp;"])
131
132     #Moves the Stop files back into place
133     def endCopy(self, ip):
134         nodename = self.getNodeName()
135         print "ssh",ip,"mv " + homepath + "Stop-" + nodename +
                ".tmp " + homepath + "Stop-" + nodename
136         subprocess.call(["ssh",ip,"mv " + homepath + "Stop-" +
                nodename + ".tmp " + homepath + "Stop-" + nodename
                ])
137
138     def setLastSync(self):
139         #print "echo \"" + str(datetime.datetime.now())+ "\" >
                " + homepath + "lastSync"
140         #subprocess.call(["echo", str(datetime.datetime.now())
                + " > " + homepath + "lastSync"])
```

```
141         f = open(homepath + "lastSync","w")
142         f.write(str(datetime.datetime.now()))
143         f.close()
144 
145     def getLastSync(self):
146         f = open(homepath + "lastSync","r")
147         time = f.read()
148         f.close()
149         return time.rstrip()
150 
151     def newerThanLast(self, fileName):
152         stop = False
153         print "Last sync time: " + str(self.getLastSync())
154         FMT = '%Y-%m-%d %H:%M:%S.%f'
155         #datetime.datetime.strptime(dtstamp, FMT)
156         ts2 = time.strptime(self.getLastSync(),FMT)
157         modTime = self.getModTime(fileName)
158         print "local " + str(fileName) + " modtime: " +
              modTime
159         ts1 = time.strptime(modTime,"%a %b %d %H:%M:%S %Y")
160         print "local <= stop: " + str(ts1 <= ts2)
161         if ts1 > ts2:
162             print "Newer file than last sync!"
163             stop = True
164         return stop
165 
166 
167     #Get node name from whoami file
168     def getNodeName(self):
169         w = open(homepath + "whoami","r")
170         nodename = w.read()
171         nodename = nodename[0].upper()
172         w.close()
173         return nodename
174 
175     #Deprecated stop file
176     def setStopFile(self,ip,myIP,path):
177         subprocess.call(["ssh",ip,"echo " + myIP + " " + path
              + ">" + homepath + "stop"])
178         print "ssh",ip,"echo " + myIP + ">" + homepath + "
              stop"
179 
180     def rmTree(self,path):
```

```
181             subprocess.call(["ssh",ip,"rm -r '" + path + "'"])
182             print "ssh",ip,"rm -r '" + path + "'"
183
184         #Exclude files matching patterns in the ignore file
185         def exclusions(self, path):
186             try:
187                 f = open("./ignore",'r')
188                 for line in f:
189                     if line.rstrip() in path:
190                         #print "Ignoring: " + path
191                         return True
192                 f.close()
193             except error, e:
194                 print e
195             return False
196
197         def initFileSync(self,event):
198             if self.exclusions(event.pathname):
199                 #print "Excluded returning"
200                 return
201             pathparts = event.pathname.split("/")
202             foldName = "/".join(pathparts[0:len(pathparts)-1])
203
204             print "Removing watch on: " + foldName
205             wm.rm_watch(wm.get_wd(foldName), rec=True)
206
207             self.setLastSync()
208             self.fileSync(event.pathname)
209
210             print "Putting watch back on: " + foldName
211             wm.add_watch(foldName.rstrip(),pyinotify.ALL_EVENTS,
                    rec=True, auto_add=True)
212
213             for i in range(0, len(watchedfolders[foldName]),4):
214             #     ip = watchedfolders[foldName][i]
215             #     myIP = readnet.getMyIP(ip)
216                 for f in glob.glob(foldName + "/*"):
217                     if self.newerThanLast(f):
218                         print "init: CONTINUE"
219                         self.setLastSync()
220                         self.fileSync(f)
221                     else:
222                         print "init: STOP"
```

```
223
224     #Sync the files
225     def fileSync(self,pathname):
226         t = Tools()
227         if os.path.isdir(pathname):
228             print "Watching: ",pathname
229         for folder in watchedfolders.keys():
230             print "For each folder: " + str(folder) + " in
                    watchedfolder keys"
231             if folder in pathname:
232                 for i in range(0, len(watchedfolders[folder])
                        ,4):
233                     ip = watchedfolders[folder][i]
234                     path = watchedfolders[folder][i+1]
235                     waitTime = watchedfolders[folder][i+2]
236                     lastTime = watchedfolders[folder][i+3]
237                     print "Wait: " + str(waitTime) + " Last: "
                            + str(lastTime)
238                     print "Current ip and path: " + ip + " " +
                            path
239                     readnet.logIPtraffic(ip, pathname)
240                     myIP = readnet.getMyIP(ip)
241                     subprocess.call(["ssh",ip,"/usr/bin/python
                        " + homepath + "readnet.py -i " + myIP
                        + " -f " + pathname])
242                     print "ssh",ip,"'/usr/bin/python " +
                        homepath + "readnet.py -i " + myIP + " -
                        f " + pathname + "'"
243                     fparts = folder.split("/")
244                     fname = fparts[len(fparts)-1]
245                     #stopIP = self.getStopInfo()
246                     #print "STOP: " + stopIP[0] + " " + stopIP
                            [1]
247                     #if stopIP[0] == ip and stopIP[1] ==
                            pathname:
248                     if self.inStopFile(ip,pathname):
249                         print "STOPPED to " + ip + " " + path
250                         #os.remove("./stop");
251                     else:
252                         print "CONTINUE"
253                         t.timeElapsed(lastTime, waitTime)
254                         watchedfolders[folder][i+3] = str(
                                datetime.datetime.now())
```

```
255                     t.updateFolderInfo(watchedfolders)
256                     self.beginCopy(ip)
257                     self.beginCopy(myIP)
258                     if args.scp:
259                         #print "SCP: For cpFile in " +
                                folder
260                         for cpFile in glob.glob(folder + "
                                /*"):
261                             #print "SCP GLOB:" + cpFile
262                             print "scp","-rp",cpFile,ip +
                                    ":" + cpFile + ".tmp"
263                             subprocess.call(["scp","-rp",
                                    cpFile,ip + ":" + cpFile + "
                                    .tmp"])
264                             #subprocess.call(["ssh",ip,"
                                    yes y | find /tmp/" + fname
                                    + " -type f -exec cp -p {} "
                                     + path + fname + "/ \; rm /
                                    tmp/" + fname])
265                             print "ssh",ip,"mv " + cpFile
                                    + ".tmp " + cpFile
266                             subprocess.call(["ssh",ip,"mv "
                                    + cpFile + ".tmp " +
                                    cpFile])
267                             print "END SCP GLOB"
268                     elif args.rsync:
269                         print "rsync","-rt",folder,ip + ":
                                " + path
270                         subprocess.call(["rsync","-rt",
                                folder,ip + ":" + path])
271                     else:
272                         time.sleep(5)
273                         print "unison","-batch","-
                                confirmbigdel=false","-times",
                                folder,"ssh://" + ip + "/" +
                                path + fname
274                         subprocess.call(["unison","-batch"
                                ,"-confirmbigdel=false","-times"
                                ,folder,"ssh://" + ip + "/" +
                                path + fname])
275                     print "Set stop files uniq: " +
                            pathname
276                     #Set stop file on foreign host
```

```
277                         self.setStopFileUniq(ip,myIP,pathname,
                                folder)
278                         #Set stop file for myself to look at
279                         self.setStopFileUniq(myIP,myIP,
                                pathname,folder)
280                         self.endCopy(ip)
281                         self.endCopy(myIP)
282                     subprocess.call(["ssh",ip,"/usr/bin/python
                            " + homepath + "readnet.py -i " + myIP
                            + " -f " + pathname])
283                     readnet.logIPtraffic(ip, pathname)
284
285     #Sync files - DEPRECATED
286     def oldfileSync(self,event):
287         t = Tools()
288         if os.path.isdir(event.pathname):
289             print "Watching: ",event.pathname
290         for folder in watchedfolders.keys():
291             print "For each folder: " + str(folder) + " in
                    watchedfolder keys"
292             if folder in event.pathname:
293                 for i in range(0, len(watchedfolders[folder])
                        ,4):
294                     ip = watchedfolders[folder][i]
295                     path = watchedfolders[folder][i+1]
296                     waitTime = watchedfolders[folder][i+2]
297                     lastTime = watchedfolders[folder][i+3]
298                     print "Wait: " + str(waitTime) + " Last: "
                            + str(lastTime)
299                     print "Current ip and path: " + ip + " " +
                            path
300                     readnet.logIPtraffic(ip, event.pathname)
301                     myIP = readnet.getMyIP(ip)
302                     subprocess.call(["ssh",ip,"/usr/bin/python
                            " + homepath + "readnet.py -i " + myIP
                            + " -f " + event.pathname])
303                     print "ssh",ip,"'/usr/bin/python " +
                            homepath + "readnet.py -i " + myIP + " -
                            f " + event.pathname + "'"
304                     fparts = folder.split("/")
305                     fname = fparts[len(fparts)-1]
306                     #stopIP = self.getStopInfo()
```

```
307                     #print "STOP: " + stopIP[0] + " " + stopIP
                            [1]
308                     #if stopIP[0] == ip and stopIP[1] == event
                            .pathname:
309                     if self.inStopFile(ip,event.pathname):
310                         print "STOPPED to " + ip + " " + path
311                         #os.remove("./stop");
312                     else:
313                         print "CONTINUE"
314                         t.timeElapsed(lastTime, waitTime)
315                         watchedfolders[folder][i+3] = str(
                                datetime.datetime.now())
316                         t.updateFolderInfo(watchedfolders)
317                         self.beginCopy(ip)
318                         if args.scp:
319                             #print "SCP: For cpFile in " +
                                    folder
320                             for cpFile in glob.glob(folder + "
                                    /*"):
321                                 #print "SCP GLOB:" + cpFile
322                                 print "scp","-rp",cpFile,ip +
                                        ":" + cpFile + ".tmp"
323                                 subprocess.call(["scp","-rp",
                                        cpFile,ip + ":" + cpFile + "
                                        .tmp"])
324                                 #subprocess.call(["ssh",ip,"
                                        yes y | find /tmp/" + fname
                                        + " -type f -exec cp -p {} "
                                         + path + fname + "/ \; rm /
                                        tmp/" + fname])
325                                 print "ssh",ip,"mv " + cpFile
                                        + ".tmp " + cpFile
326                                 subprocess.call(["ssh",ip,"mv
                                        " + cpFile + ".tmp " +
                                        cpFile])
327                                 print "END SCP GLOB"
328                         elif args.rsync:
329                             print "rsync","-rt",folder,ip + ":
                                    " + path
330                             subprocess.call(["rsync","-rt",
                                    folder,ip + ":" + path])
331                         else:
332                             time.sleep(5)
```

```
333                                 print "unison","-batch","-
                                        confirmbigdel=false","-times",
                                        folder,"ssh://" + ip + "/" +
                                        path + fname
334                                 subprocess.call(["unison","-batch"
                                        ,"-confirmbigdel=false","-times"
                                        ,folder,"ssh://" + ip + "/" +
                                        path + fname])
335                             print "Set stop files uniq: " + event.
                                    pathname
336                             #Set stop file on foreign host
337                             self.setStopFileUniq(ip,myIP,event.
                                    pathname,folder)
338                             #Set stop file for myself to look at
339                             self.setStopFileUniq(myIP,myIP,event.
                                    pathname,folder)
340                             self.endCopy(ip)
341                         subprocess.call(["ssh",ip,"/usr/bin/python
                                " + homepath + "readnet.py -i " + myIP
                                + " -f " + event.pathname])
342                         readnet.logIPtraffic(ip, event.pathname)
343
344     #def process_IN_CREATE(self, event):
345     #    print "Create:",event.pathname
346     def process_IN_DELETE(self, event):
347         print "Delete: ",event.pathname
348         #self.initFileSync(event)
349     def process_IN_CREATE(self, event):
350         print "CREATE: ",event.pathname
351         self.initFileSync(event)
352     def process_IN_MOVED_FROM(self, event):
353         print "Move from: ",event.pathname
354     #     self.initFileSync(event)
355     def process_IN_MODIFY(self, event):
356         #print "Modify: ",event.pathname
357         self.initFileSync(event)
358     def process_IN_MOVED_TO(self, event):
359         print "Move to: ",event.pathname
360         self.initFileSync(event)
361
362
363 def main():
364     t = Tools()
```

```
365     f = open('./folderstowatch','r')
366
367     for folder in f:
368         if(folder[0] == '#'):
369             pass
370         else:
371             info = folder.split()
372             wm.add_watch(info[0].rstrip(),pyinotify.ALL_EVENTS
                    , rec=True, auto_add=True)
373             print "Watching: ", info[0].rstrip()
374             if info[0] not in watchedfolders.keys():
375                 watchedfolders[info[0].rstrip()] = []
376             watchedfolders[info[0].rstrip()].append(info[1])
377             watchedfolders[info[0].rstrip()].append(info[2])
378             watchedfolders[info[0].rstrip()].append(info[3])
379             watchedfolders[info[0].rstrip()].append(str(
                    datetime.datetime.now()))
380     f.close()
381
382     try:
383         f = open('./folders.dat','r')
384         for folder in f:
385             if(folder[0] == '#'):
386                 pass
387             else:
388                 info = folder.split()
389                 if info[0] in watchedfolders.keys():
390                     del watchedfolders[info[0].rstrip()]
391                     #wm.add_watch(info[0].rstrip(),pyinotify.
                            ALL_EVENTS, rec=True, auto_add=True)
392                     #print "Watching: ", info[0].rstrip()
393                     if info[0] not in watchedfolders.keys():
394                         watchedfolders[info[0].rstrip()] = []
395                     watchedfolders[info[0].rstrip()].append(
                            info[1])
396                     watchedfolders[info[0].rstrip()].append(
                            info[2])
397                     watchedfolders[info[0].rstrip()].append(
                            info[3])
398                     watchedfolders[info[0].rstrip()].append(
                            str(datetime.datetime.now()))
399                 else:
400                     print "Removing: " + info[0]
```

```
401             f.close()
402         except IOError, e:
403             print "Folders.dat does not exist, skipping"
404 
405         t.updateFolderInfo(watchedfolders)
406 
407         #print watchedfolders
408         eh = MyEventHandler()
409 
410         notifier = pyinotify.Notifier(wm,eh)
411         notifier.loop()
412 
413 if __name__ == '__main__':
414         main()
```

B ReadNet.py

```
1  import subprocess, datetime, socket, argparse
2  
3  homepath = "/home/cal/Documents/Private-Sync/"
4  #homepath = "/Users/calum/Documents/Private-Sync/"
5  
6  parser = argparse.ArgumentParser()
7  parser.add_argument('-i',action="store",dest='ip',help='IP
       address to record for')
8  parser.add_argument('-f',action="store",dest='fold',help='
       Folder to record for')
9  
10 interfacenames = []
11 
12 w = open(homepath + "whoami","r")
13 nodename = w.read()
14 nodename = nodename[0]
15 w.close()
16 
17 #Get my ip corresponding to the interface with ipaddr
18 def getMyIP(ipaddr):
19         route = subprocess.check_output("ip route get " + ipaddr,
              shell=True)
20         words = route.split()
21         interface = ""
22         for word in words:
23             if word.startswith("eth"):
```

```
24              interface = word
25              #print interface
26              break
27      ifconf = subprocess.check_output("ifconfig " + interface,
            shell=True)
28      words = ifconf.split()
29      now = False
30      for word in words:
31          if word == "inet":
32              now = True
33          elif now:
34              word = word.split(":")
35              #print word[1]
36              return word[1]
37
38  #Log interface coresponding to ipaddr
39  def logIPtraffic(ipaddr, folder):
40      route = subprocess.check_output("ip route get " + ipaddr,
            shell=True)
41      words = route.split()
42      interface = ""
43      for word in words:
44          if word.startswith("eth"):
45              interface = word
46              #print interface
47              break
48      writeIface(interface, folder)
49
50  #Write the upload/download data for a given interface and
        folder
51  def writeIface(iface, folder):
52      ifs = subprocess.check_output("ifconfig -s",shell=True)
53      ilines = ifs.split("\n")
54      for i in range(1,len(ilines)-1):
55          interfacenames.append(ilines[i].split()[0])
56      output = subprocess.check_output("ifconfig",shell=True)
57      splitput = output.split()
58      interface = False
59      interfacename = ""
60      nex = ""
61      count = 0
62      upload = 0
63      download = 0
```

```
64      for split in splitput:
65          if split in interfacenames:
66              interface = True
67              interfacename = split
68              #print interfacename
69          if(nex != ""):
70              sp = split.split(":")
71              if(sp[0] == "bytes"):
72                  if(nex == "RX"):
73                      download = int(sp[1])
74                  else:
75                      upload = int(sp[1])
76                  nex = ""
77                  count += 1
78                  if(count == 2):
79                      interface = False
80                      if interfacename == iface:
81                          f = open(homepath + "log/" \
82                          + "node" + nodename.upper() + "-" \
83                          + iface + ".log",'a')
84                          f.write("#D " + folder + "\n")
85                          f.write(str(datetime.datetime.now()) +
                                " " + interfacename + " download: "
                                + str(download) + " upload: " + str
                               (upload) + "\n")
86                          f.close()
87                      count = 0
88          elif(interface):
89              if(split == "RX" or split == "TX"):
90                  nex = split
91
92  #Log all interfaces
93  def main():
94      ifs = subprocess.check_output("ifconfig -s",shell=True)
95      ilines = ifs.split("\n")
96      for i in range(1,len(ilines)-1):
97          interfacenames.append(ilines[i].split()[0])
98      output = subprocess.check_output("ifconfig",shell=True)
99      splitput = output.split()
100     interface = False
101     interfacename = ""
102     nex = ""
103     count = 0
```

```
104     upload = 0
105     download = 0
106     for split in splitput:
107         if split in interfacenames:
108             interface = True
109             interfacename = split
110             #print interfacename
111         if(nex != ""):
112             sp = split.split(":")
113             if(sp[0] == "bytes"):
114                 if(nex == "RX"):
115                     download = int(sp[1])
116                 else:
117                     upload = int(sp[1])
118                 nex = ""
119                 count += 1
120                 if(count == 2):
121                     interface = False
122                     f = open(homepath + "log/" \
123                     + str(socket.gethostname()) + "-" \
124                     + interfacename + ".log",'a')
125                     f.write(str(datetime.datetime.now()) + "␣"
                            + interfacename + "␣download:␣" + str(
                            download) + "␣upload:␣" + str(upload) +
                            "\n")
126                     f.close()
127                     count = 0
128         elif(interface):
129             if(split == "RX" or split == "TX"):
130                 nex = split
131
132 if __name__ == "__main__":
133     args = parser.parse_args()
134     if args.ip != None:
135         logIPtraffic(args.ip, args.fold)
136         #getMyIP(args.ip)
137     else:
138         pass
139         main()
```

C onTheFly.sh

```
1  vm_name_arr=("Ubuntu-Pool" "Ubuntu-Silence" "Ubuntu-Black" "
       Ubuntu-Spheros" "Ubuntu-Wild")
2  vm_addr_arr=("192.168.0.28" "192.168.0.27" "192.168.0.30" "
       192.168.0.14")
3  #Wild = 19
4  intnetarr=("lion" "tiger" "cat" "dog" "fish" "kiwi" "swish" "
       boom" "roar")
5  #These should all be in one big dictionary apart from inet
       names
6  letterarr=("a" "b" "c" "d" "e" "f" "g" "h" "i" "j")
7  ifcountarr=(2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2)
8  ethcountarr=(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
9  incount=1
10 bigncount=2
11 littlencount=1
12 folderpath="/home/cal/Documents/t18"
13 folderpath2="/home/cal/Documents/t02"
14 homepath="/home/cal/Documents/Private-Sync/"
15 waitTime=5
16
17 function clear_ifaces() {
18     i=0
19     while [ "$i" -lt "${#vm_name_arr[@]}" ]; do
20         VBoxManage modifyvm ${vm_name_arr[$i]} --nic2 none
21         echo "VBoxManage modifyvm ${vm_name_arr[$i]} --nic2
               none"
22         VBoxManage modifyvm ${vm_name_arr[$i]} --nic3 none
23         echo "VBoxManage modifyvm ${vm_name_arr[$i]} --nic3
               none"
24         VBoxManage modifyvm ${vm_name_arr[$i]} --nic4 none
25         echo "VBoxManage modifyvm ${vm_name_arr[$i]} --nic4
               none"
26         let "i++"
27     done
28 }
29
30 function clear_watched_folders() {
31     i=0
32     while [ "$i" -lt "${#vm_addr_arr[@]}" ]; do
33         ssh cal@${vm_addr_arr[$i]} "echo \"#Local folder path
               to watch, host to copy to, remote dir to copy to,
               min time between syncs\" > /home/cal/Documents/
               Private-Sync/folderstowatch; echo ${letterarr[$i]} >
```

```
            /home/cal/Documents/Private-Sync/whoami"
34          let "i++"
35      done
36  }
37
38  function git_pull() {
39      i=0
40      while [ "$i" -lt "${#vm_addr_arr[@]}" ]; do
41          echo "ssh cal@${vm_addr_arr[$i]} \"cd /home/cal/
               Documents/Private-Sync; git pull origin master\""
42          ssh cal@${vm_addr_arr[$i]} "cd /home/cal/Documents/
               Private-Sync; git pull origin master"
43          let "i++"
44      done
45  }
46
47  function search_letters() {
48      index=0
49      while [ "$index" -lt "${#letterarr[@]}" ]; do
50          if [ "${letterarr[$index]}" = "$1" ]; then
51              echo $index
52              return
53          fi
54          let "index++"
55      done
56      echo "None"
57  }
58
59  function vbmMOD {
60      #Set the NIC to intnet on the VM and attach it to the
           given network
61      echo "VBoxManage modifyvm $1 --nic$3 intnet"
62      VBoxManage modifyvm $1 --nic$3 intnet
63      echo "VBoxManage modifyvm $1 --intnet$3 $2"
64      VBoxManage modifyvm $1 --intnet$3 $2
65  }
66
67  function gatherLogs {
68      index=0
69      while [ "$index" -lt "${#vm_addr_arr[@]}" ]; do
70          echo "scp cal@${vm_addr_arr[$index]}:/home/cal/
               Documents/Private-Sync/log/* .../logs/"
```

```
71          scp cal@${vm_addr_arr[$index]}:/home/cal/Documents/
                Private-Sync/log/* ../logs/
72          let "index++"
73      done
74  }
75
76  function clean {
77      index=0
78      while [ "$index" -lt "${#vm_addr_arr[@]}" ]; do
79          echo "ssh cal@${vm_addr_arr[$index]} \"rm ${homepath}
                log/*; rm ${homepath}Stop-*; rm ${homepath}folders.
                dat\""
80          ssh cal@${vm_addr_arr[$index]} "rm ${homepath}log/*;
                rm ${homepath}Stop-*;rm ${homepath}folders.dat"
81          let "index++"
82      done
83  }
84
85  function cleanFold {
86      index=0
87      while [ "$index" -lt "${#vm_addr_arr[@]}" ]; do
88          echo "ssh cal@${vm_addr_arr[$index]} \"rm -rf ${
                folderpath}/*;\""
89          ssh cal@${vm_addr_arr[$index]} "rm -rf ${folderpath
                }/*;"
90          let "index++"
91      done
92  }
93
94  function sendKeys {
95      index=0
96      while [ "$index" -lt "${#vm_addr_arr[@]}" ]; do
97          #ssh cal@${vm_addr_arr[$index]} "rm /home/cal/.ssh/
                authorized_keys"
98          for file in /Users/calum/.ssh/*.pub; do
99              #echo "$file"
100             echo "cat $file | ssh cal@${vm_addr_arr[$index]} \
                    "cat >> /home/cal/.ssh/authorized_keys\""
101             cat $file | ssh cal@${vm_addr_arr[$index]} "cat >>
                    /home/cal/.ssh/authorized_keys"
102         done
103         let "index++"
104     done
```

```
105     #for file in /Users/calum/.ssh/*.pub; do
106     #    echo "$file"
107     #    cat $file | ssh cal@192.168.0.17 "cat >> /home/cal/.
            ssh/testfile"
108     #    echo "cat $file | ssh cal@192.168.0.17 \"cat >> /home
            /cal/.ssh/testfile\""
109     #done
110 }
111
112 function ifconf {
113     echo "ssh cal@$1 'sudo /sbin/ifconfig eth$2 192.168.$3.$4
            netmask 255.255.255.0 up; echo \"$folderpath 192.168.$3.
            $5 /home/cal/Documents/ $waitTime\" >> /home/cal/
            Documents/Private-Sync/folderstowatch '"
114     ssh cal@$1 "sudo /sbin/ifconfig eth$2 192.168.$3.$4
            netmask 255.255.255.0 up; echo \"$folderpath 192.168.$3.
            $5 /home/cal/Documents/ $waitTime\" >> /home/cal/
            Documents/Private-Sync/folderstowatch" < /dev/null
115 }
116
117 function ifconf2 {
118     echo "ssh cal@$1 \"sudo /sbin/ifconfig eth$2 192.168.$3.$4
             netmask 255.255.255.0 up; echo \"$folderpath 192.168.$3
            .$5 /home/cal/Documents/ *\" >> /home/cal/Documents/
            Private-Sync/folderstowatch; echo \"$folderpath2
            192.168.$3.$5 /home/cal/Documents/ *\" >> /home/cal/
            Documents/Private-Sync/folderstowatch\" < /dev/null"
119     ssh cal@$1 "sudo /sbin/ifconfig eth$2 192.168.$3.$4
            netmask 255.255.255.0 up; echo \"$folderpath 192.168.$3.
            $5 /home/cal/Documents/ *\" >> /home/cal/Documents/
            Private-Sync/folderstowatch; echo \"$folderpath2
            192.168.$3.$5 /home/cal/Documents/ *\" >> /home/cal/
            Documents/Private-Sync/folderstowatch" < /dev/null
120 }
121
122 if [ $2 == "vm" ]; then
123     clear_ifaces
124
125     #Read in the DOT script
126     while read line
127     do
128         first=$(echo "$line" | awk '{print $1}')
```

```
129         last=$(echo "$line" | awk '{print $(NF)}' | sed 's
                /[;]//g')
130         #echo "$first and $last"
131         index=$(search_letters $first)
132         if [ "$index" = "None" ]; then
133             #echo "None"
134             :
135         else
136             vbmMOD ${vm_name_arr[$index]} ${intnetarr[$incount
                    ]} ${ifcountarr[$index]}
137             #echo "in: $index"
138             (( ifcountarr[$index]++ ))
139             index=$(search_letters $last)
140             vbmMOD ${vm_name_arr[$index]} ${intnetarr[$incount
                    ]} ${ifcountarr[$index]}
141             #echo "in: $index"
142             (( ifcountarr[$index]++ ))
143             incount=$incount+1
144         fi
145     done <graphs/$1
146 elif [ $2 == "if" ]; then
147     clear_watched_folders
148
149     while read line
150     do
151         first=$(echo "$line" | awk '{print $1}')
152         last=$(echo "$line" | awk '{print $(NF)}' | sed 's
                /[;]//g')
153         echo "$first and $last"
154         index=$(search_letters $first)
155         if [ "$index" = "None" ]; then
156             #echo "None"
157             :
158         else
159             ifconf ${vm_addr_arr[$index]} ${ethcountarr[$index
                    ]} $bigncount $littlencount $(( $littlencount+1
                    ))
160             #echo "in: $index"
161             (( ethcountarr[$index]++ ))
162             (( littlencount++ ))
163             index=$(search_letters $last)
164             ifconf ${vm_addr_arr[$index]} ${ethcountarr[$index
                    ]} $bigncount $littlencount $(( $littlencount-1
```

```
                ))
165             #echo "in: $index"
166             (( ethcountarr[$index]++ ))
167             incount=$incount+1
168             (( bigncount++ ))
169             (( littlencount-- ))
170         fi
171     done <graphs/$1
172 elif [ $2 == "if2" ]; then
173     clear_watched_folders
174
175     while read line
176     do
177         first=$(echo "$line" | awk '{print $1}')
178         last=$(echo "$line" | awk '{print $(NF)}' | sed 's
              /[;]//g')
179         echo "$first and $last"
180         index=$(search_letters $first)
181         if [ "$index" = "None" ]; then
182             #echo "None"
183             :
184         else
185             ifconf2 ${vm_addr_arr[$index]} ${ethcountarr[
                  $index]} $bigncount $littlencount $((
                  $littlencount+1 ))
186             #echo "in: $index"
187             (( ethcountarr[$index]++ ))
188             (( littlencount++ ))
189             index=$(search_letters $last)
190             ifconf2 ${vm_addr_arr[$index]} ${ethcountarr[
                  $index]} $bigncount $littlencount $((
                  $littlencount-1 ))
191             #echo "in: $index"
192             (( ethcountarr[$index]++ ))
193             incount=$incount+1
194             (( bigncount++ ))
195             (( littlencount-- ))
196         fi
197     done <graphs/$1
198 elif [ $2 == "key" ]; then
199     sendKeys
200 elif [ $2 == "gather" ]; then
201     gatherLogs
```

```
202 elif [ $2 == "clean" ]; then
203     clean
204 elif [ $2 == "pull" ]; then
205     git_pull
206 elif [ $2 == "clean-fold" ]; then
207     cleanFold
208 elif [ $2 == "help" ]; then
209     echo "vm__________-_setup_vm_networking"
210     echo "if__________-_setup_network_addresses_etc_for_each_
        vm"
211     echo "if2_________-_setup_network_addresses_etc_for_each_
        vm_for_two_folders"
212     echo "gather______-_gather_the_logs_in"
213     echo "clean_______-_clean_out_the_logs/config_files"
214     echo "clean-fold__-_clean_out_the_files_folder"
215     echo "pull________-_pull_the_latest_code_from_the_
        repository_to_each_vm"
216     echo "help________-_display_this_help_message"
217 else
218     echo "Oops_try_again"
219 fi
220
221 neato -Teps graphs/$1 > graphs/$1-graph.eps
```