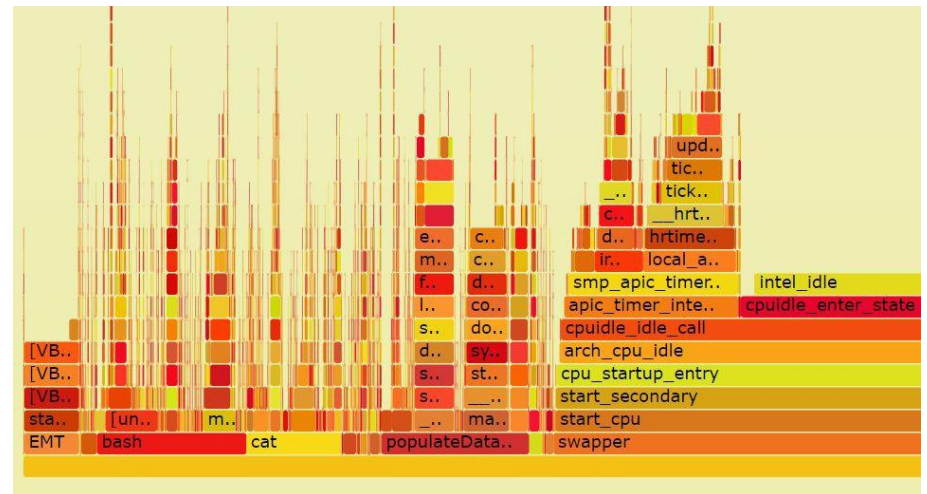




# A Virtual Cluster Monitoring Toolkit for Bottleneck Analysis

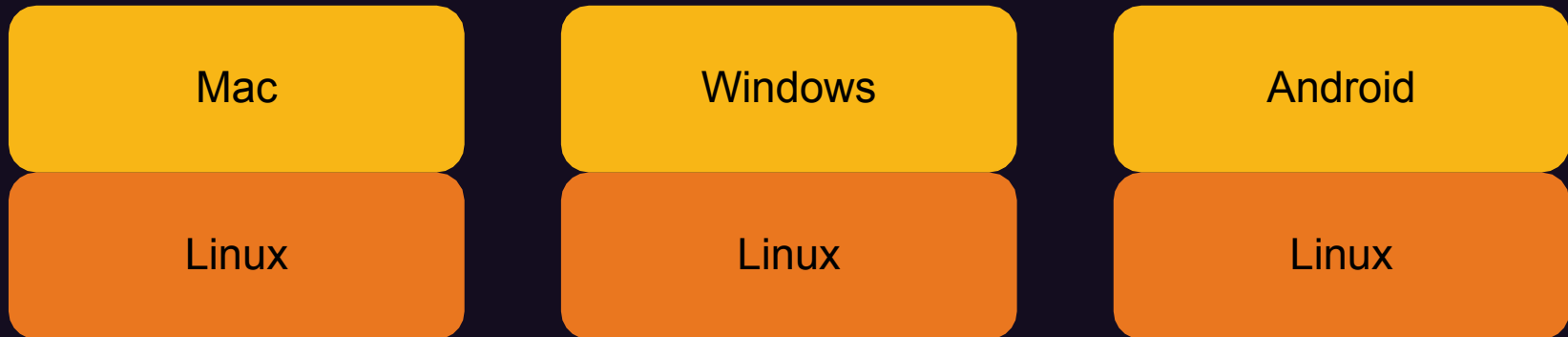
Natasha Frumkin and Christian Marquardt



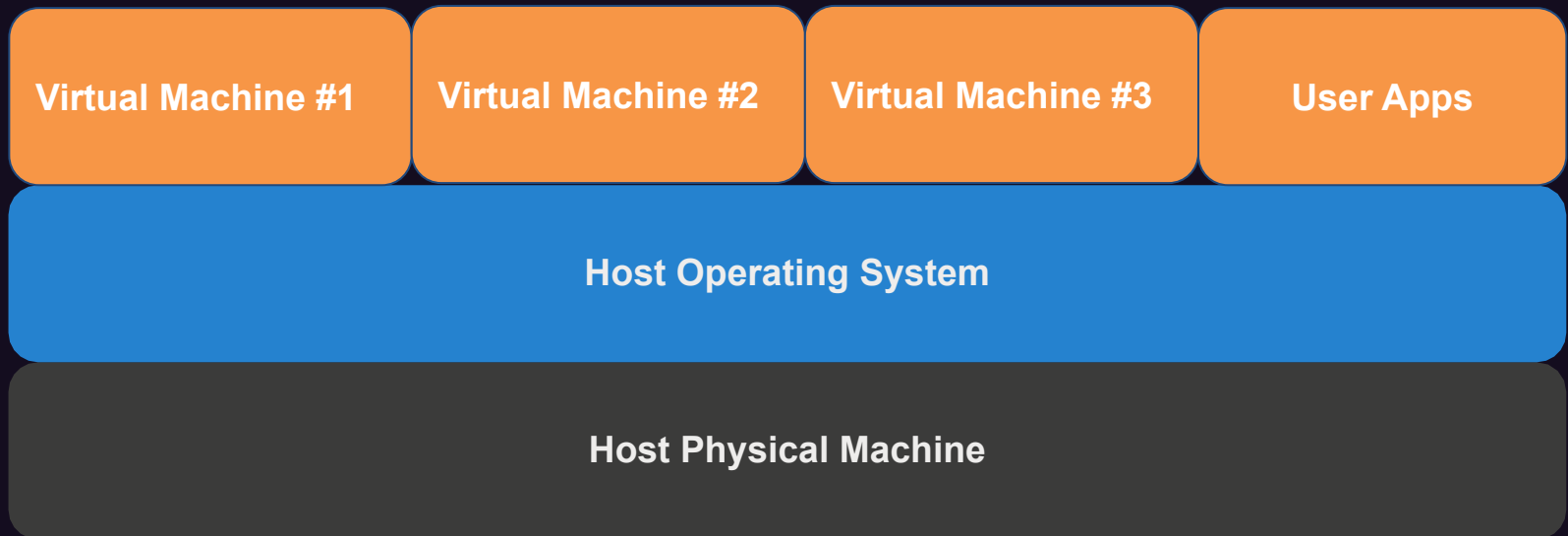
*Host Call Stack for Virtual Node Provisioning*

# Virtualization:

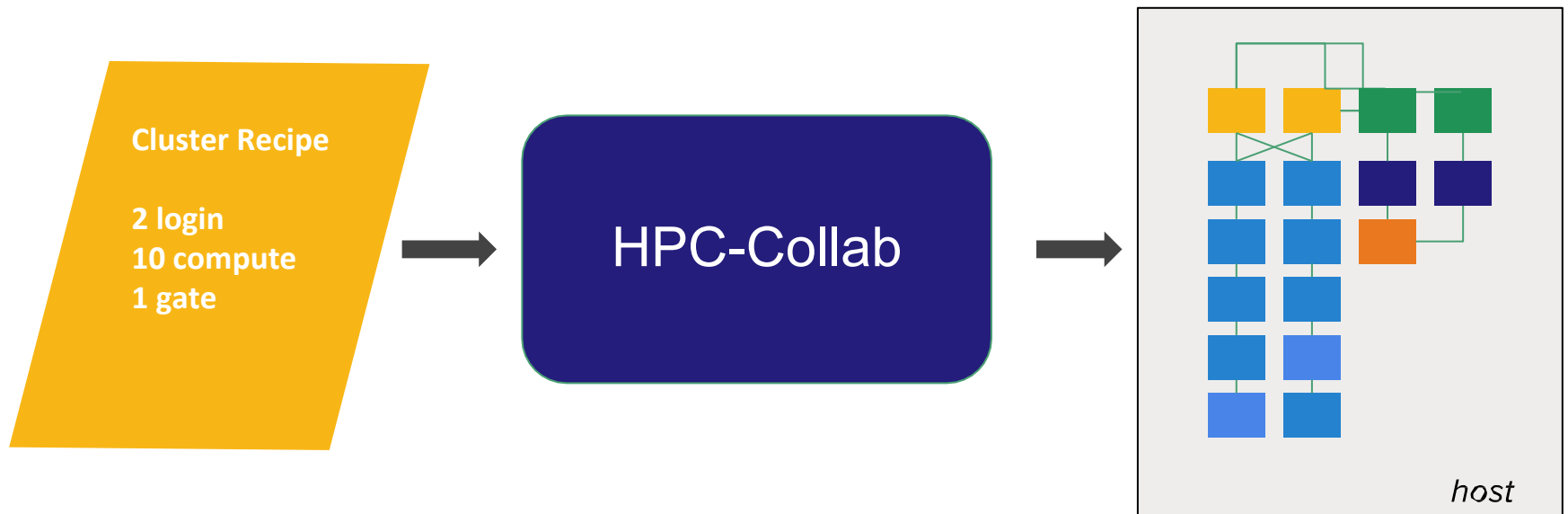
*emulating one computer on another*



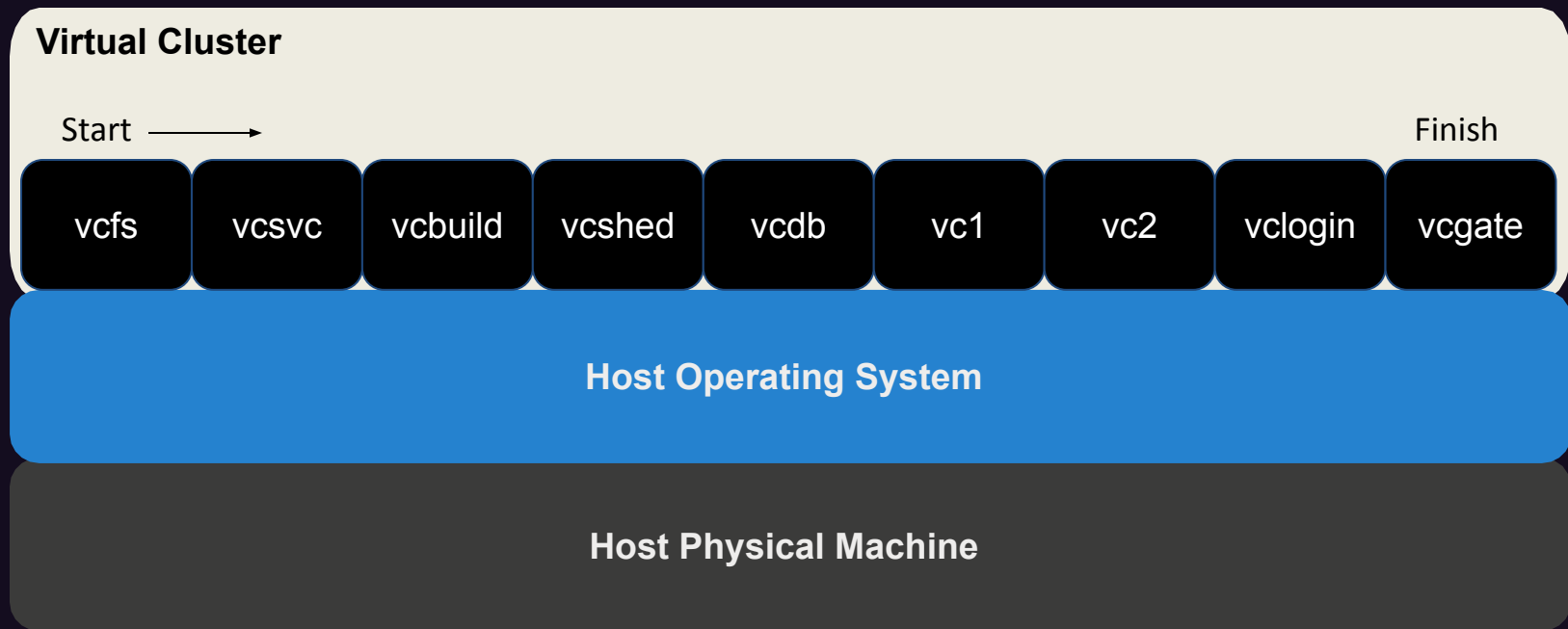
# Virtualized HPC Clusters



# HPC-Collab: a framework for designing virtual HPC clusters



# Cluster Provisioning Timeline



# Monitoring

- R/W to virtual disk
  - iostat
- Memory Usage
  - details in /proc/meminfo
  - vmstat
- CPU computation/power
  - perf
- Network performance
  - netstat
- Processor measuring
  - mpstat

```
te05:~$ iostat -x
Linux 3.10.0-1062.9.1.el7.x86_64 (te05)          07/27/2020    _x86_64_
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.36    0.04   4.06   0.05    0.00   95.48

Device:            rrqm/s   wrqm/s     r/s     w/s    rkB/s   wkB/s avgrq-sz
sda                  0.00     4.85     0.60    6.44   46.29  1135.90  336.16
```

*E.g. iostat  
visualization*

```
te05:~/monitor/MonitorScripts$ cat /proc/meminfo
MemTotal:        65744940 kB
MemFree:         525388 kB
MemAvailable:   42037196 kB
```

*E.g. /proc/meminfo  
visualization*

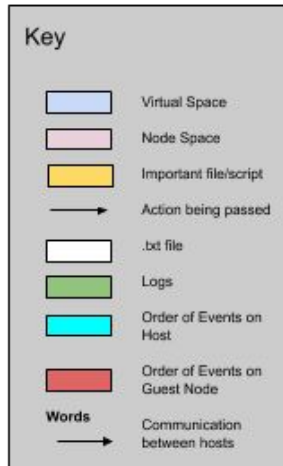
```
te05:~$ netstat -s | grep "total packets"
33624922 total packets received
te05:~$ netstat -s | grep "segments received" | grep -ve "bad"
33333616 segments received
te05:~$ netstat -s | grep "packets received" | grep -ve "total" |
256213 packets received
```

*E.g. Total, UDP, and TCP  
packets and segments  
received visualization*

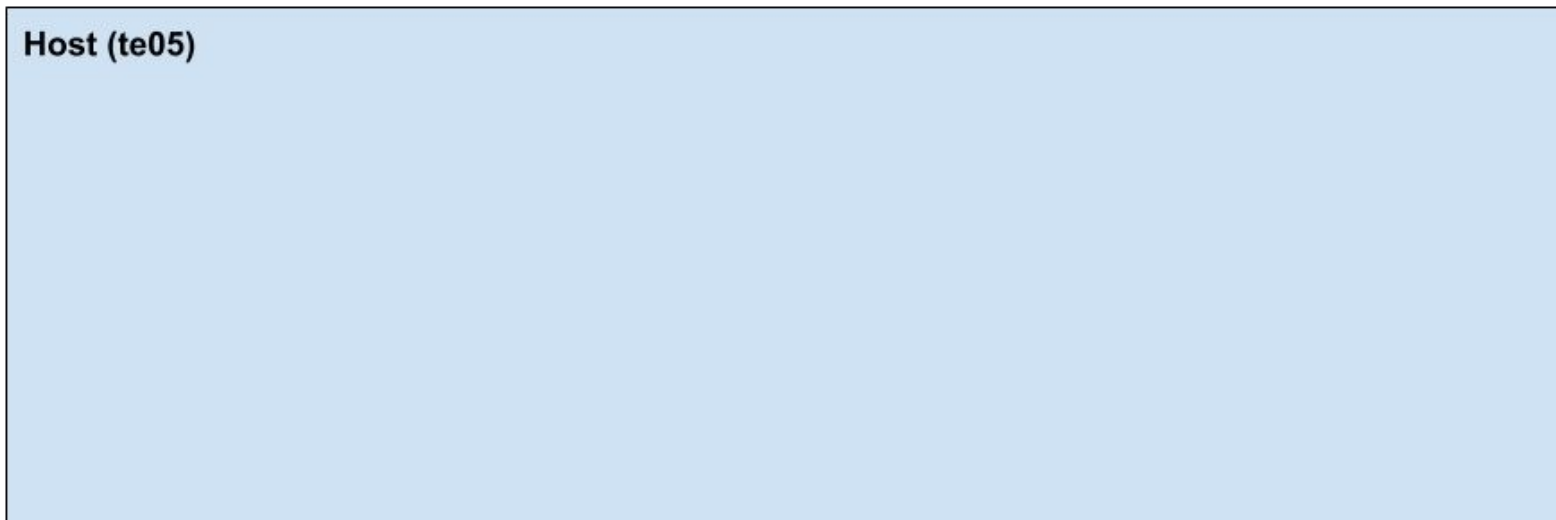


# How is our monitoring being done?

## Control Flow Diagram for Monitoring Data on our Virtualized Cluster



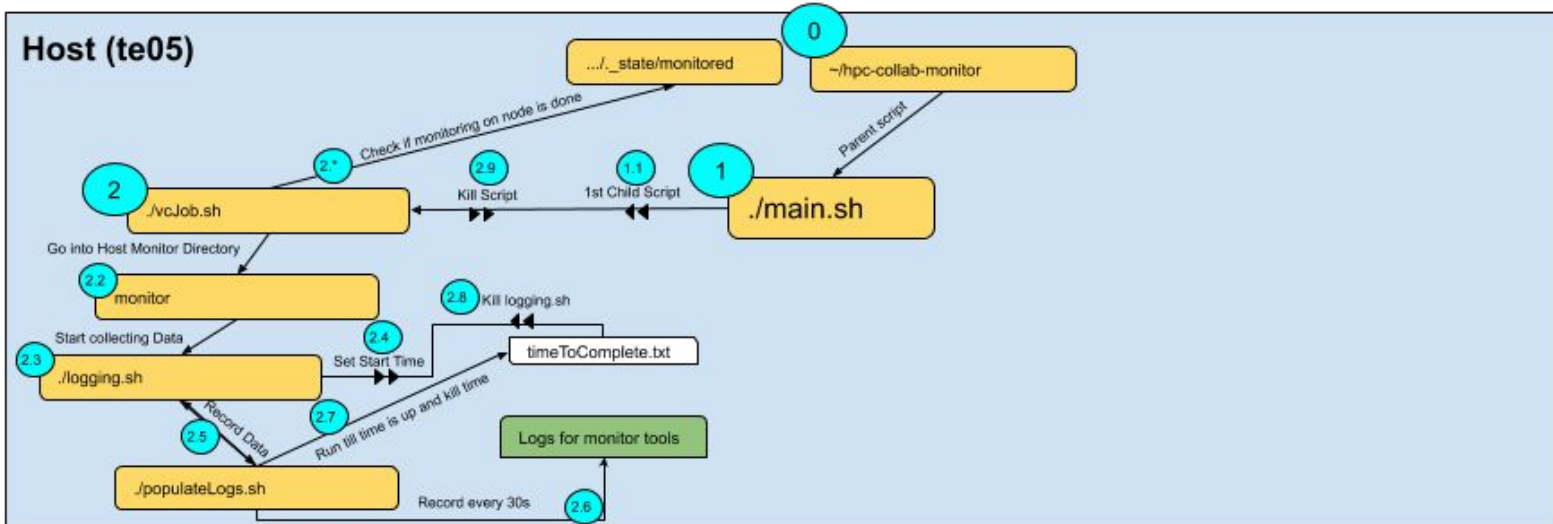
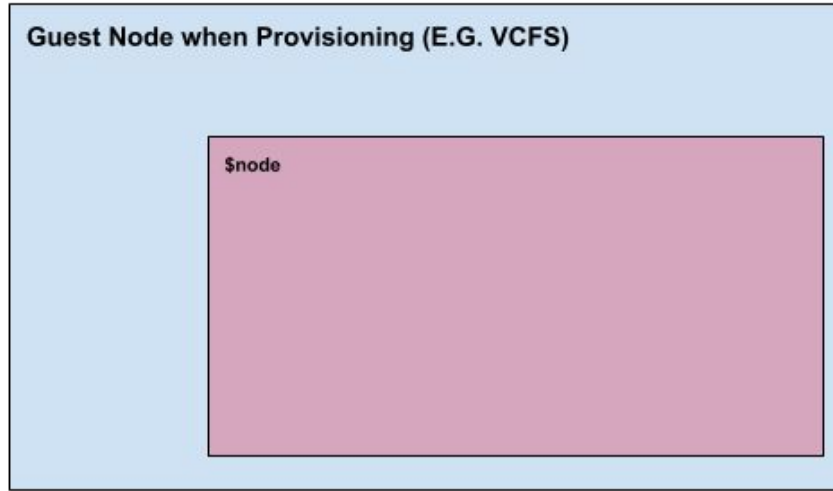
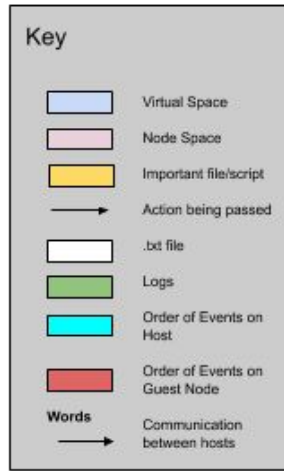
### Guest Node when Provisioning (E.G. VCFS)





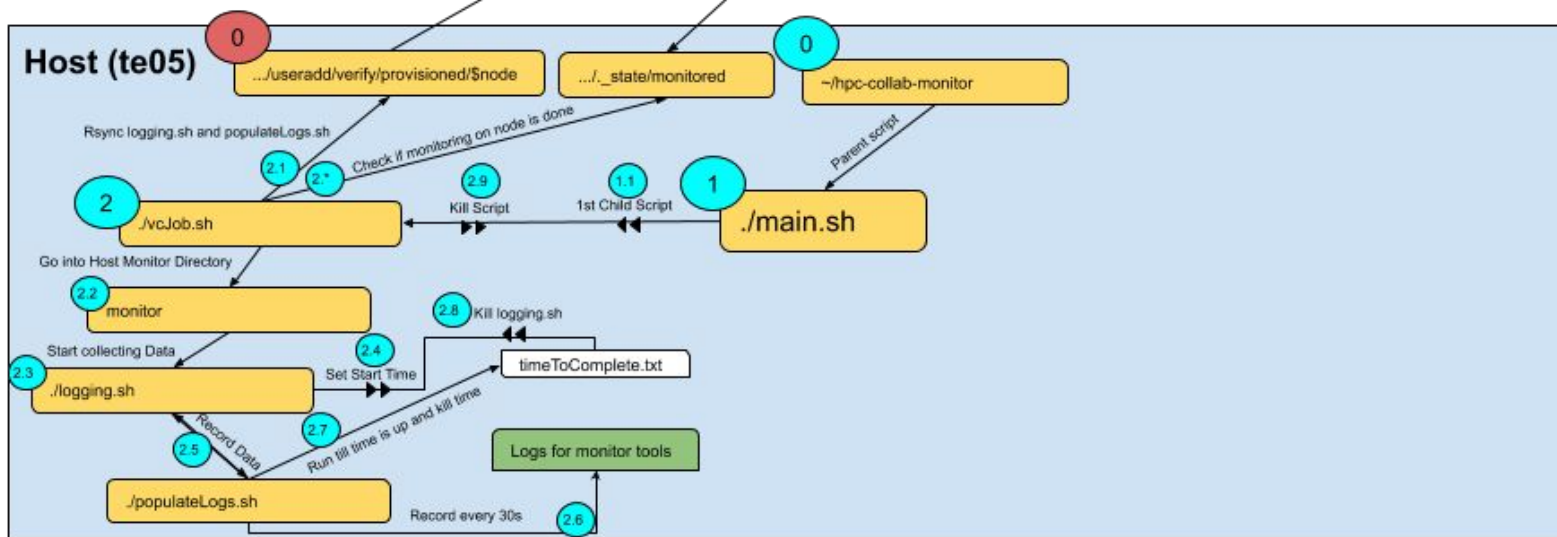
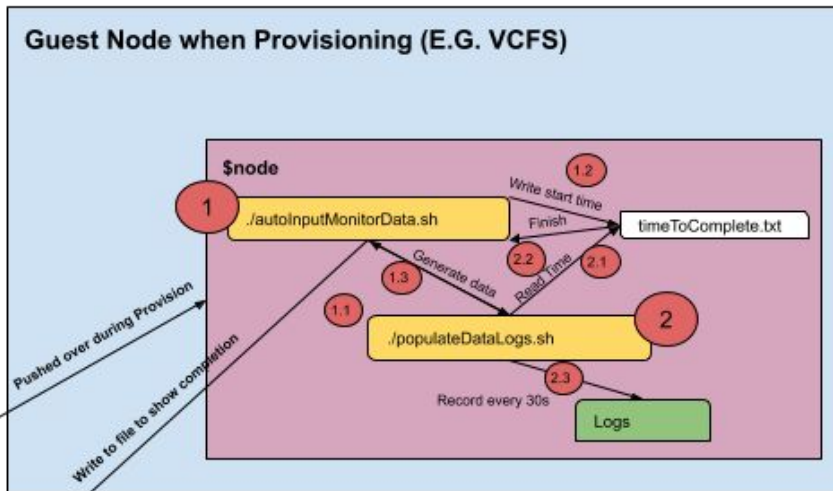
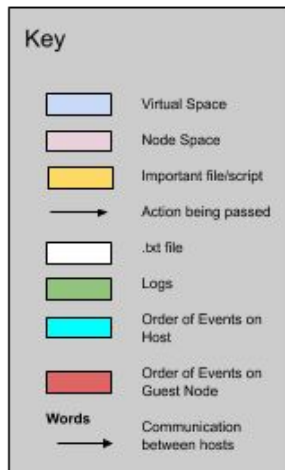
# 1. Start Provisioning and Monitoring

Control Flow Diagram for Monitoring Data on our Virtualized Cluster



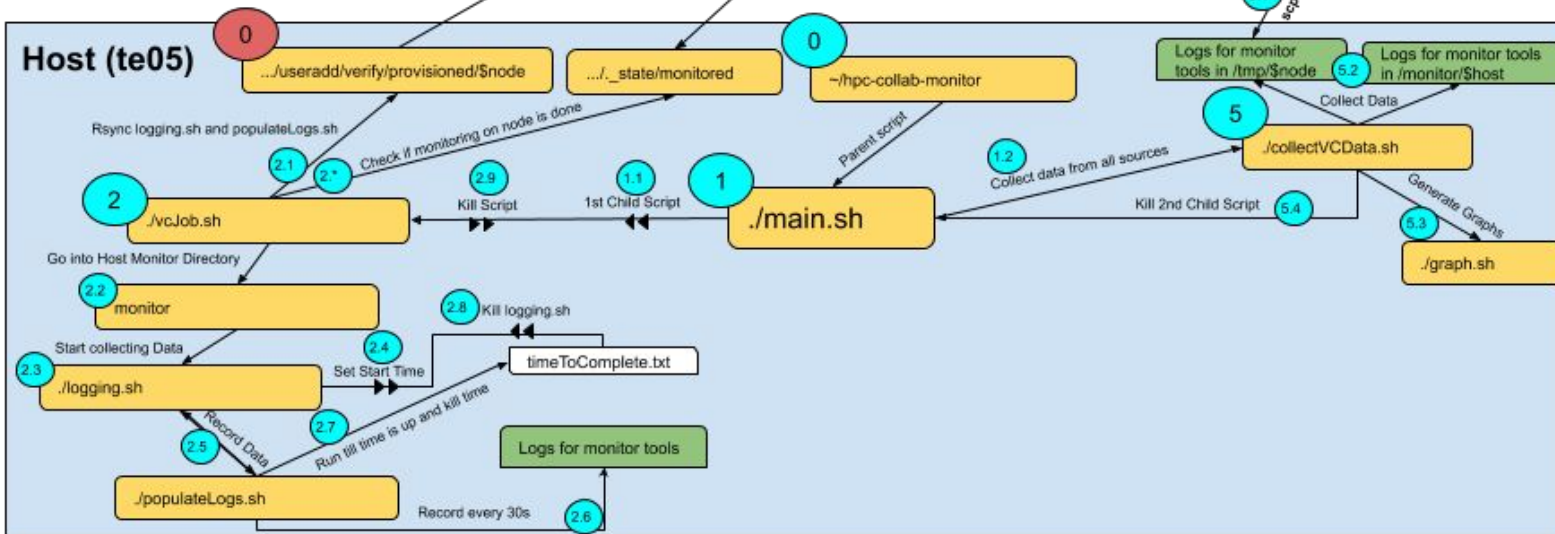
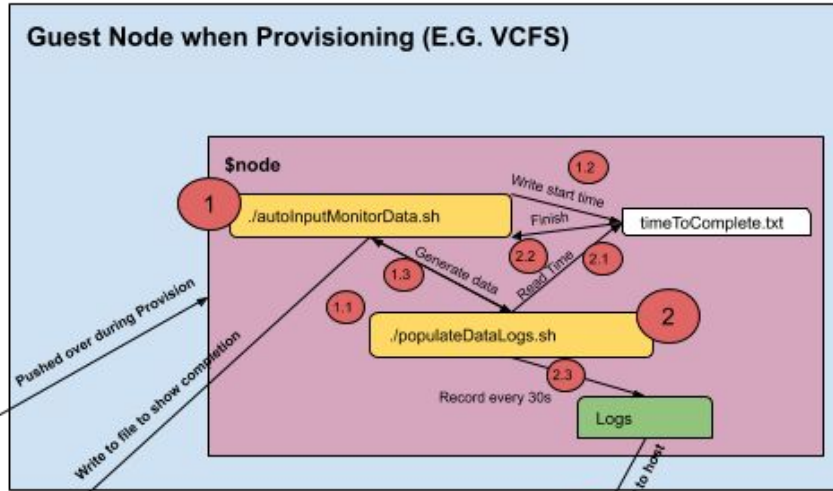
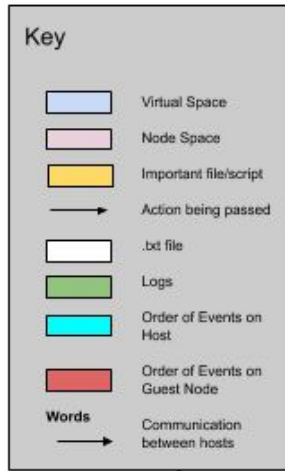
# 2. Rsync and Monitor on Virtual Nodes

Control Flow Diagram for Monitoring Data on our Virtualized Cluster



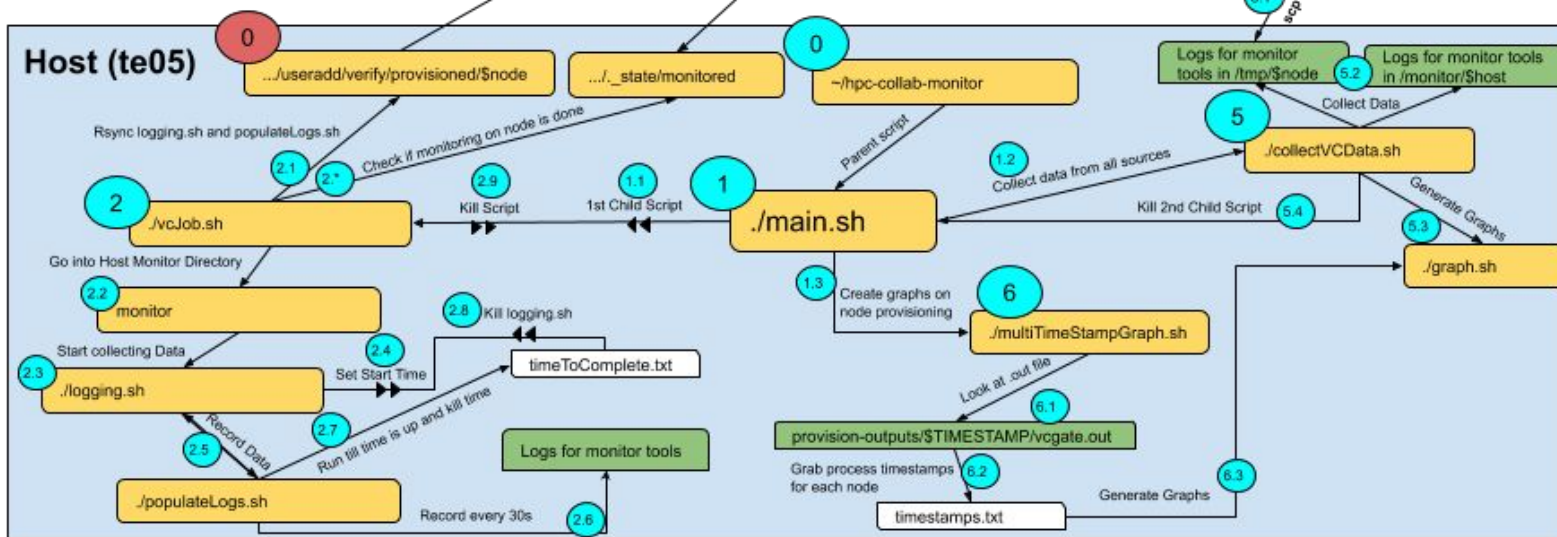
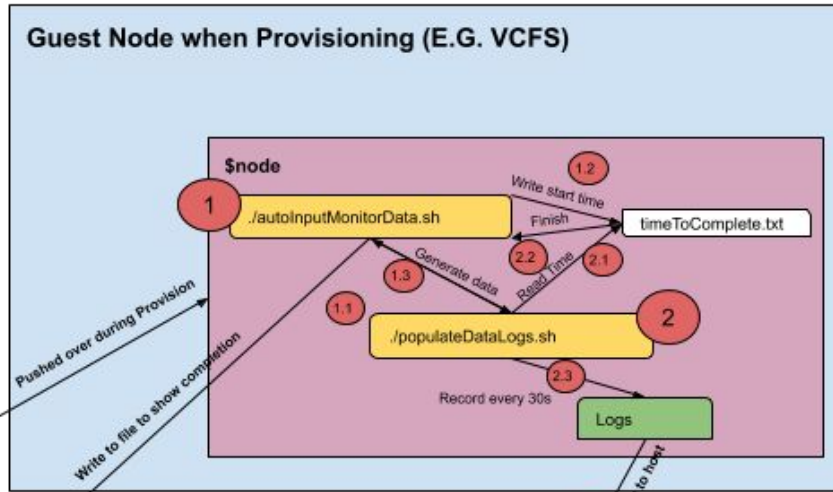
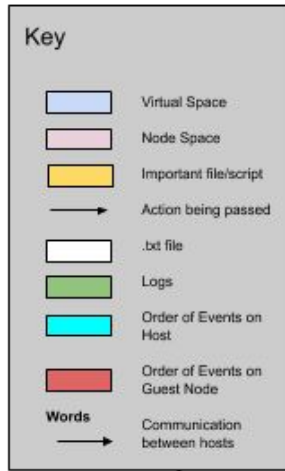
# 3. Collect Data via scp and Graph

Control Flow Diagram for Monitoring Data on our Virtualized Cluster



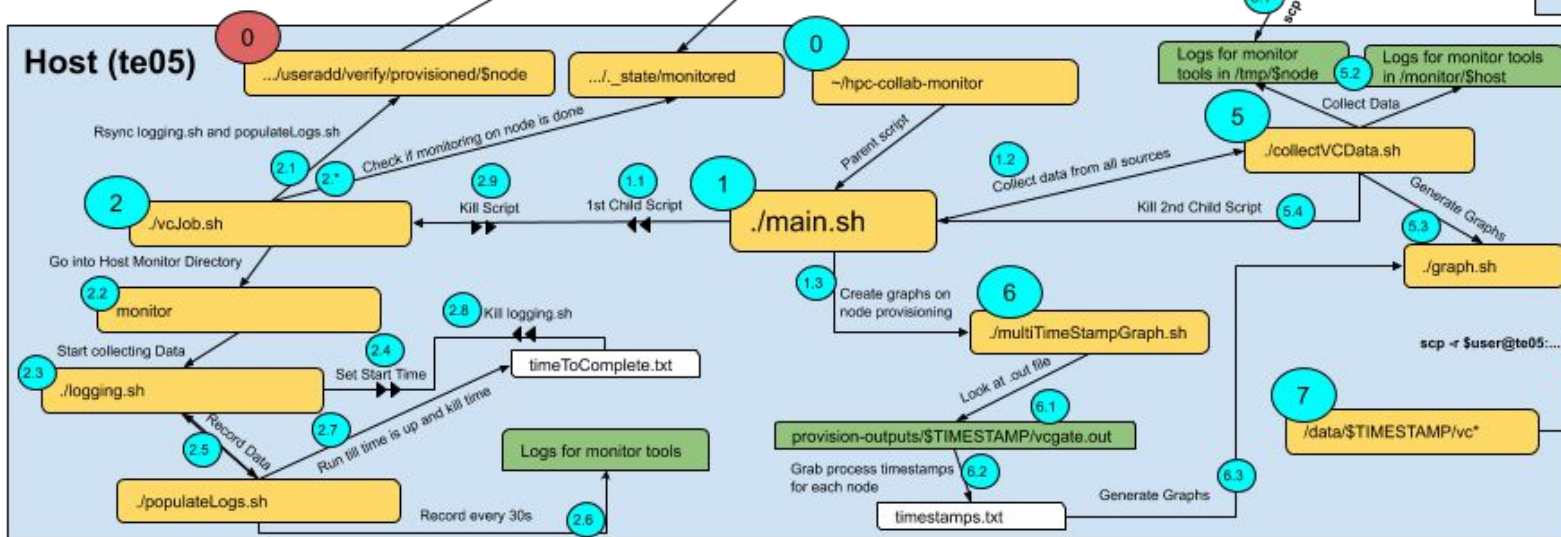
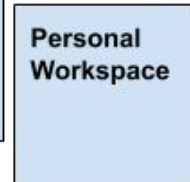
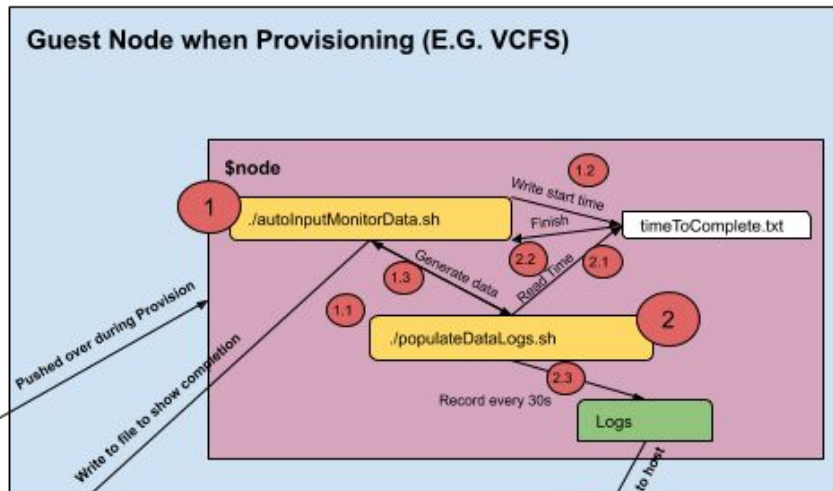
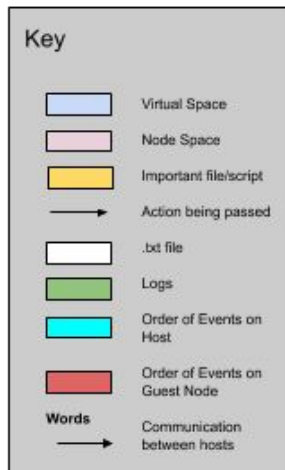
# 4. Process Graphing per Virtual Node

Control Flow Diagram for Monitoring Data on our Virtualized Cluster



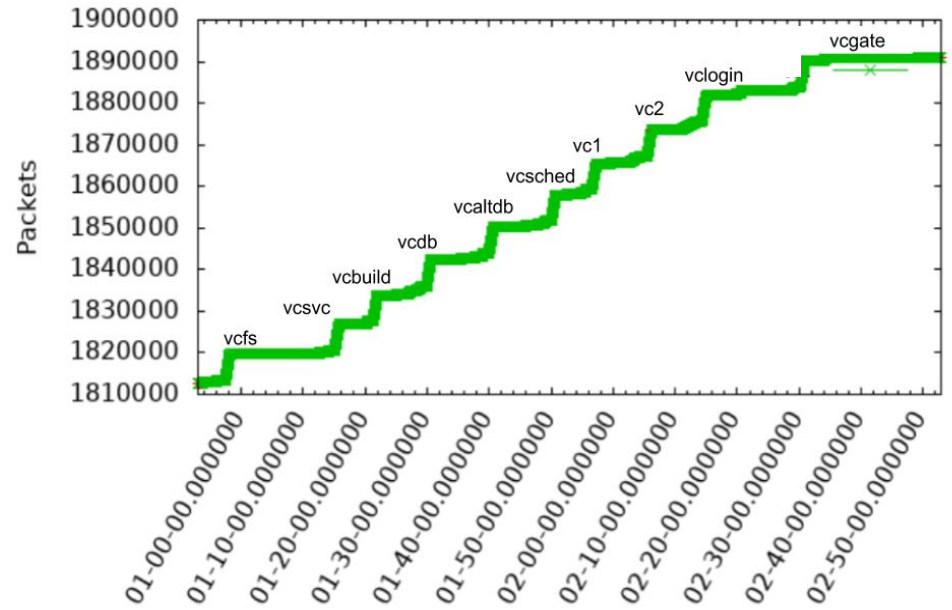
# 5. scp onto Personal Workspace

Control Flow Diagram for Monitoring Data on our Virtualized Cluster

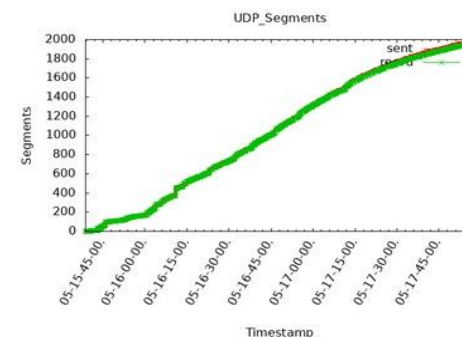
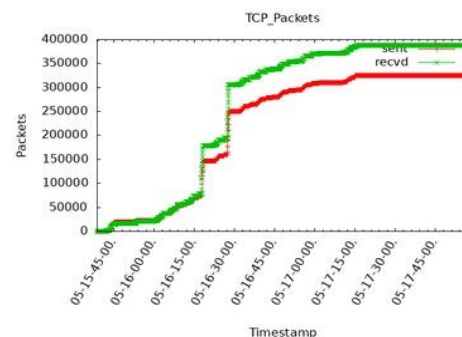
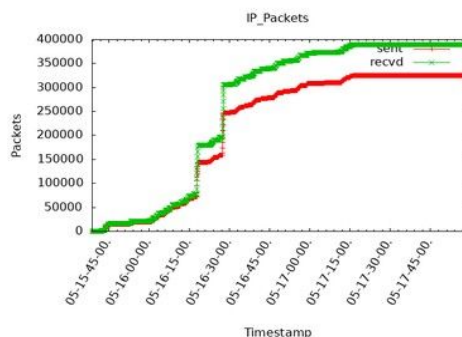
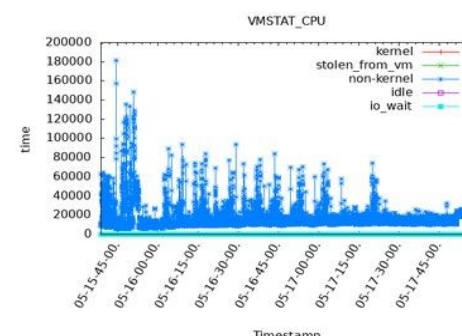
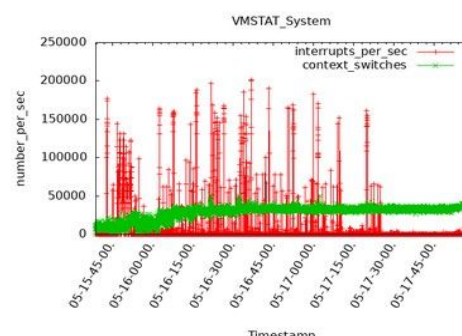
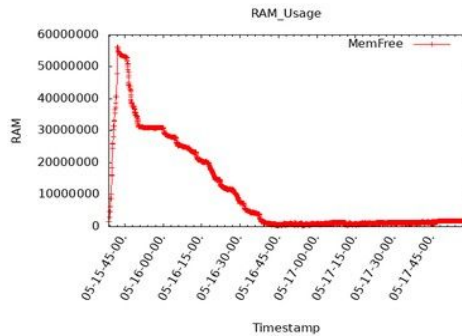
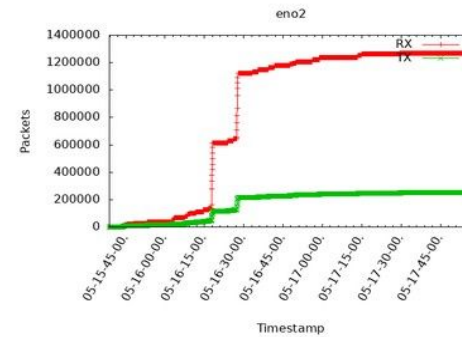
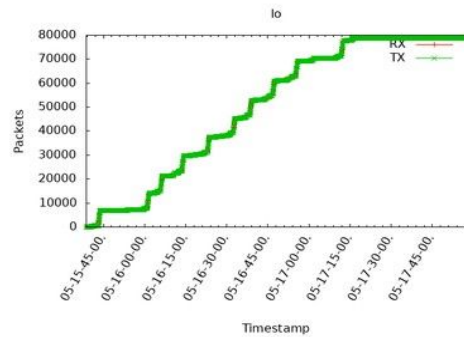
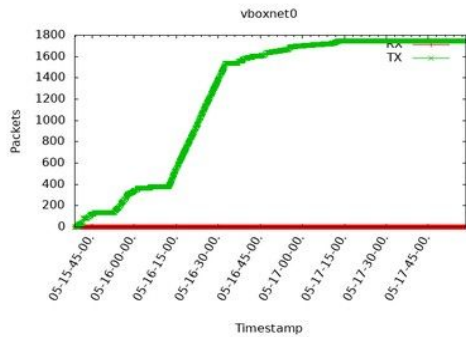


# Visualization

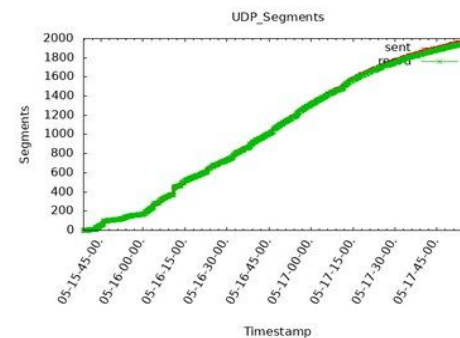
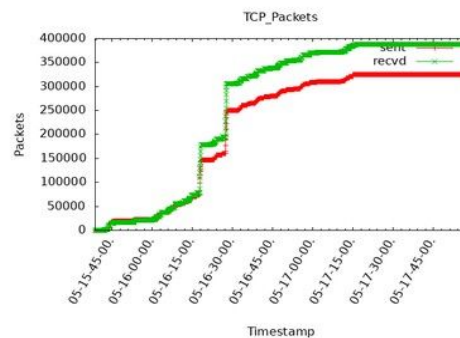
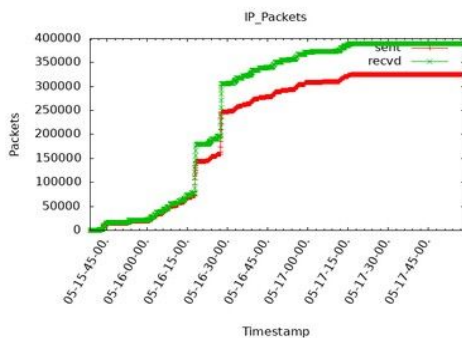
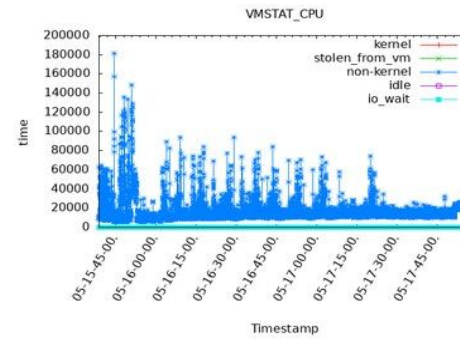
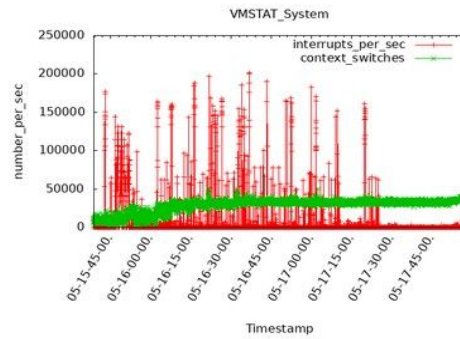
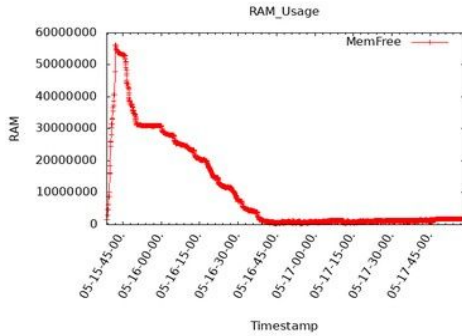
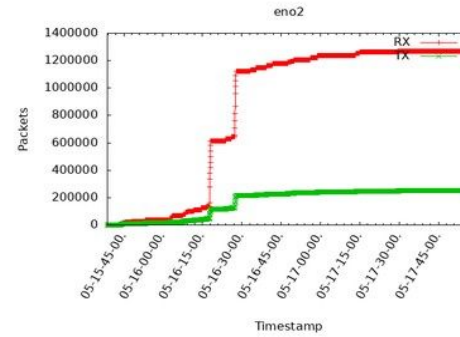
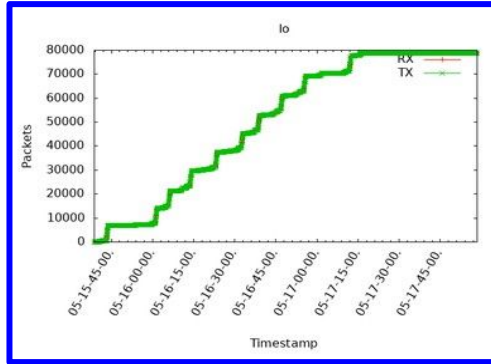
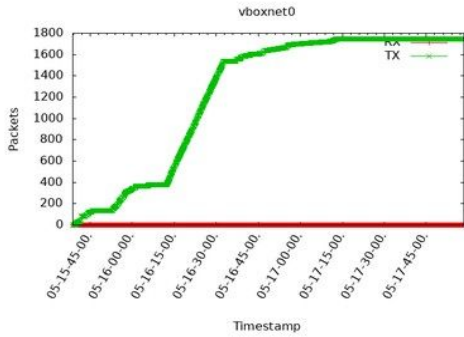
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# Anatomy of a Dashboard

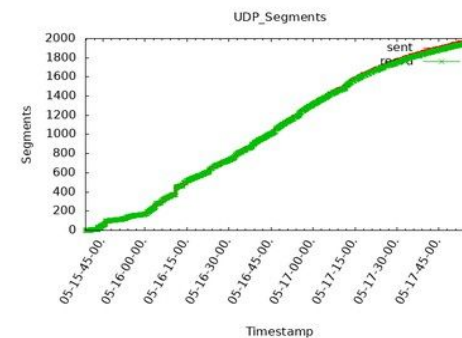
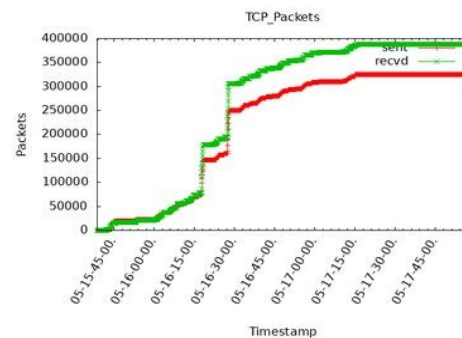
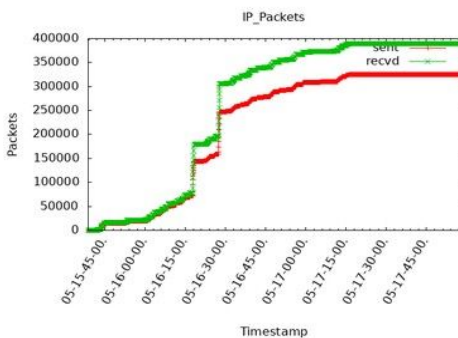
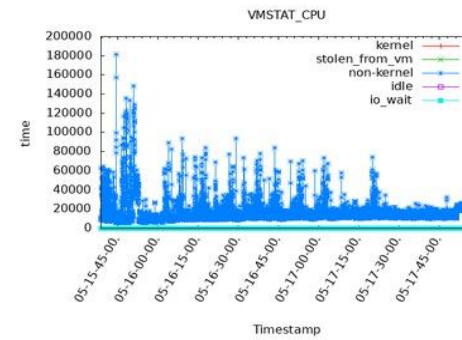
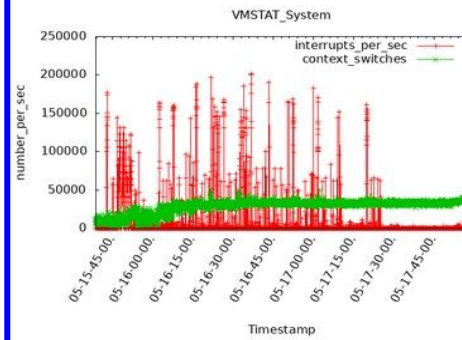
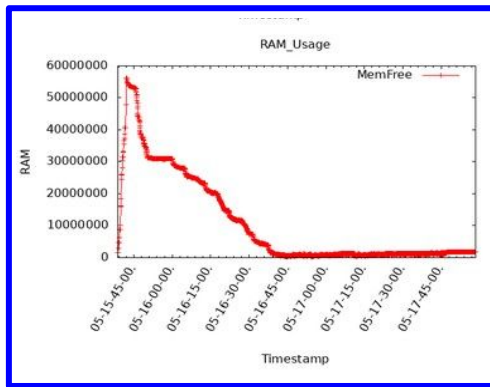
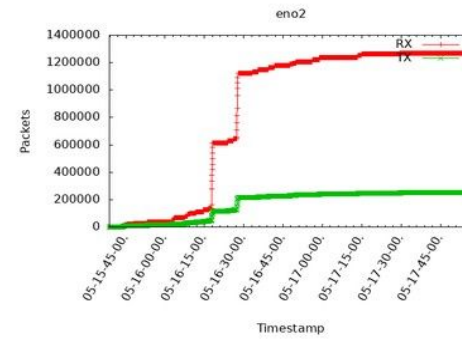
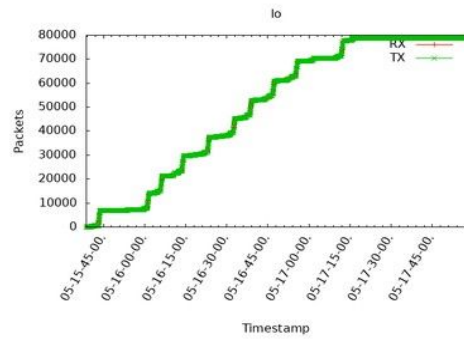
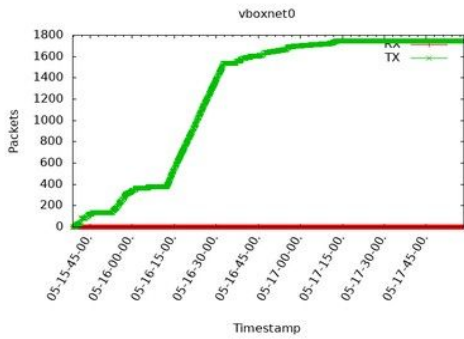


# Anatomy of a Dashboard

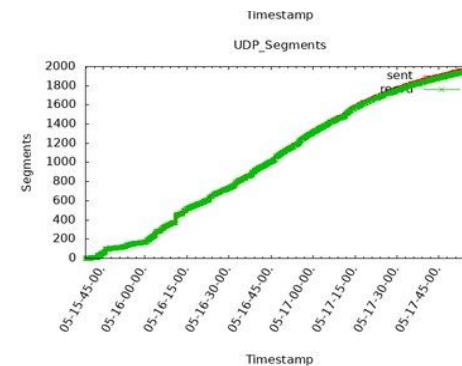
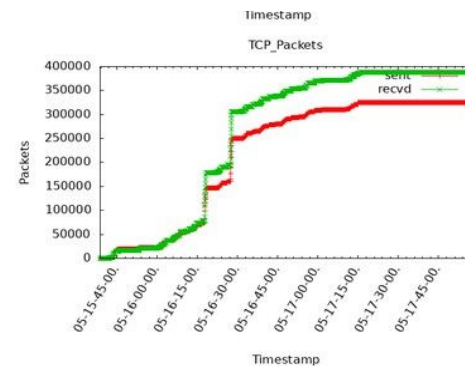
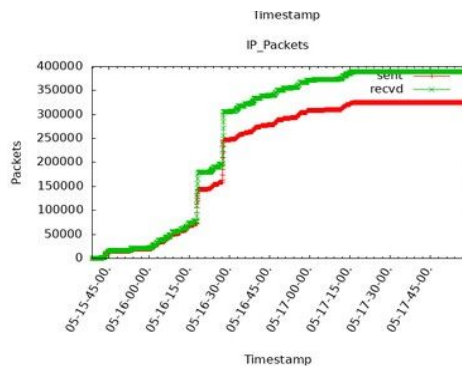
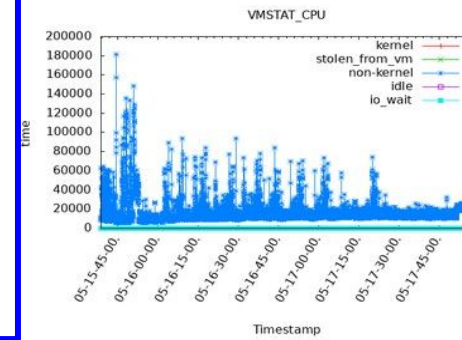
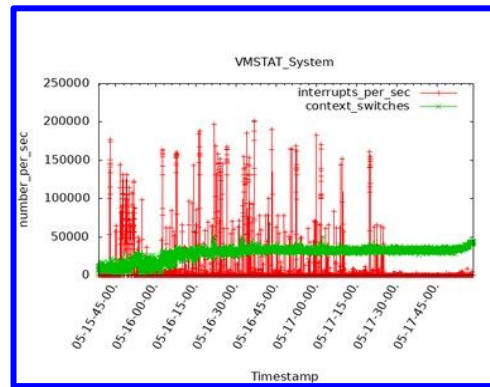
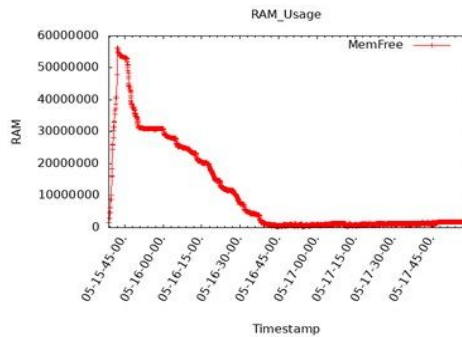
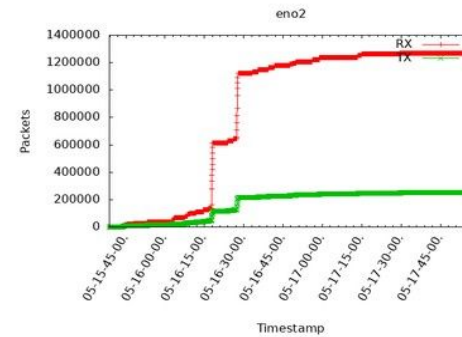
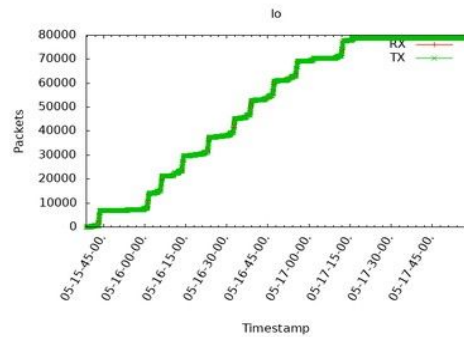
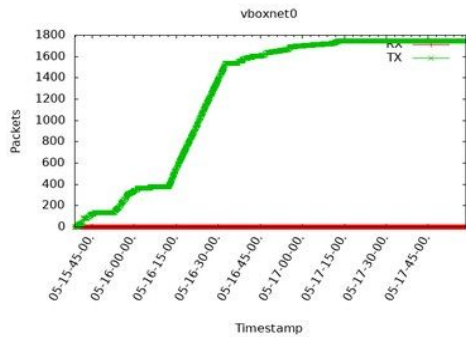




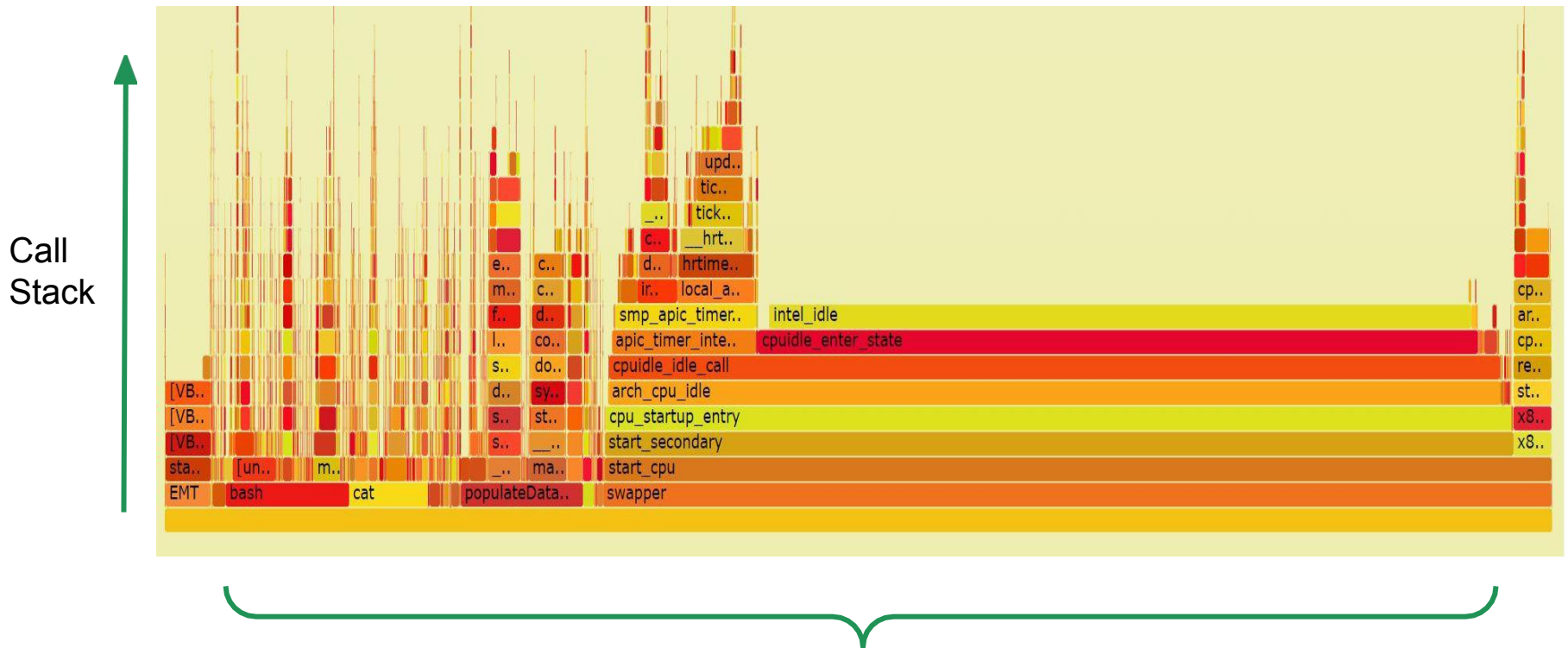
# Anatomy of a Dashboard



# Anatomy of a Dashboard



# Perf-events: a fine-grained performance analysis tool

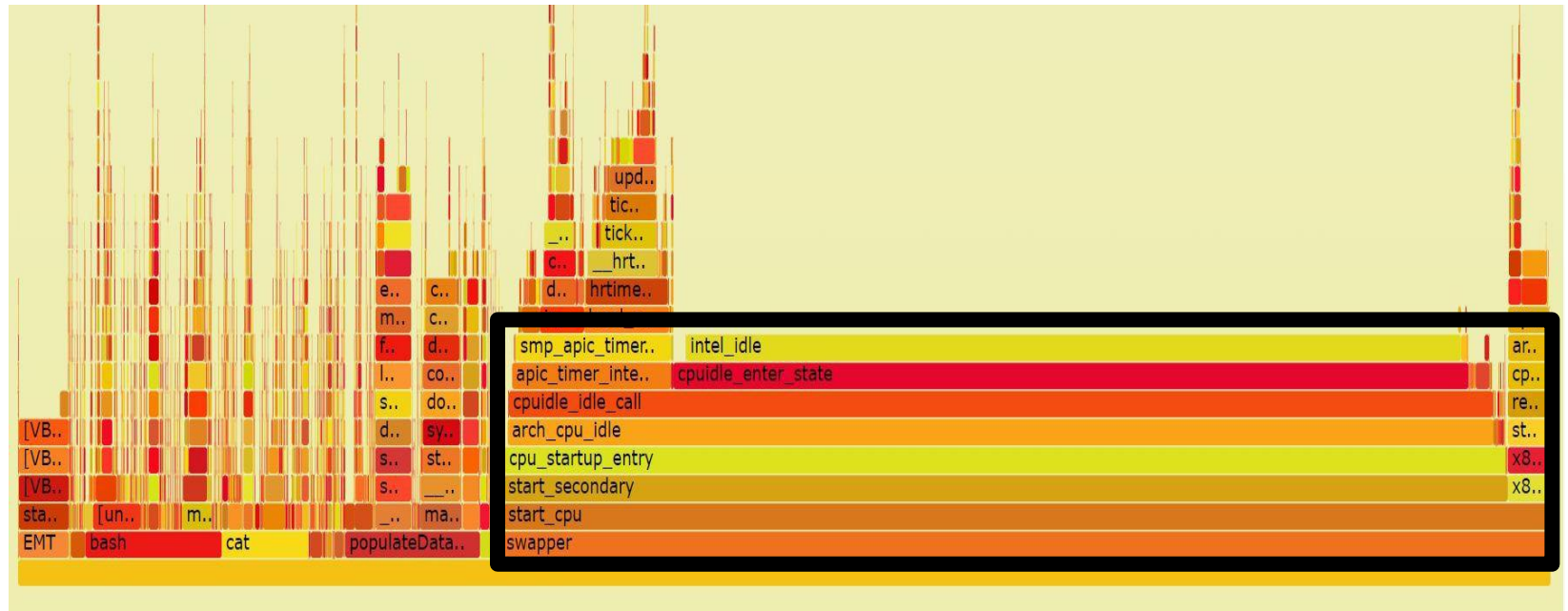


Stack Profile Population (alphabetically)



# Perf-events: a fine-grained performance analysis tool

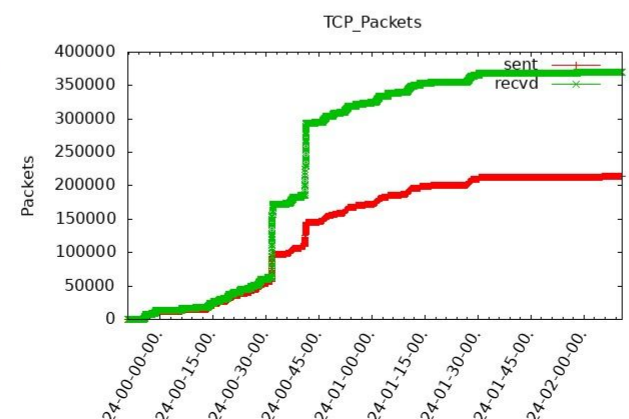
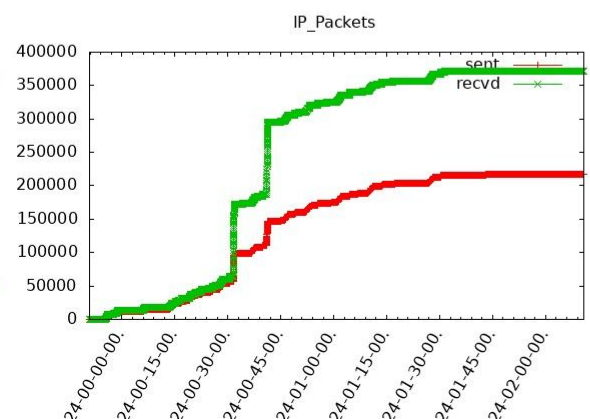
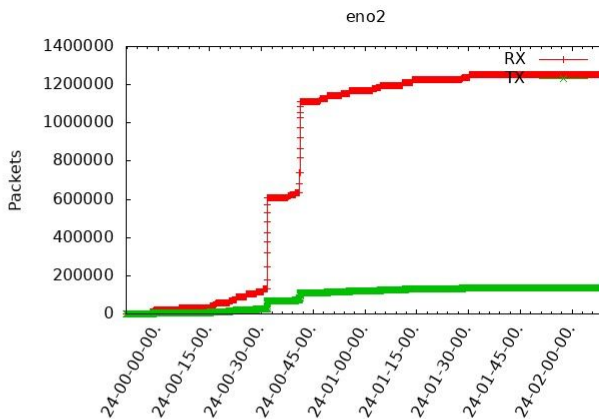
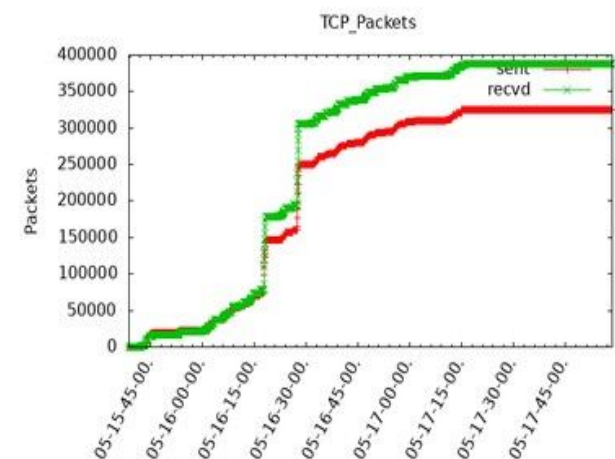
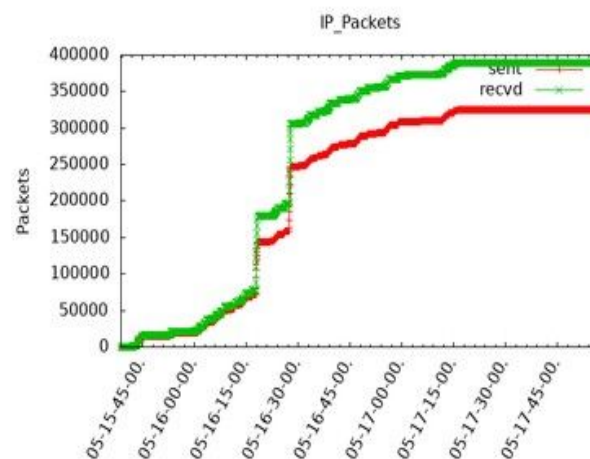
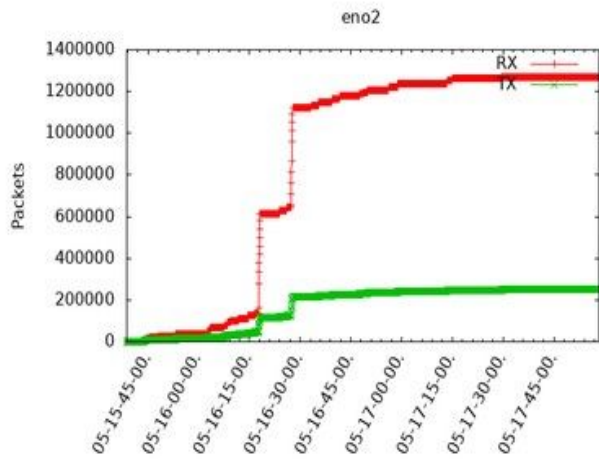
Call Stack



Stack Profile Population (alphabetically)

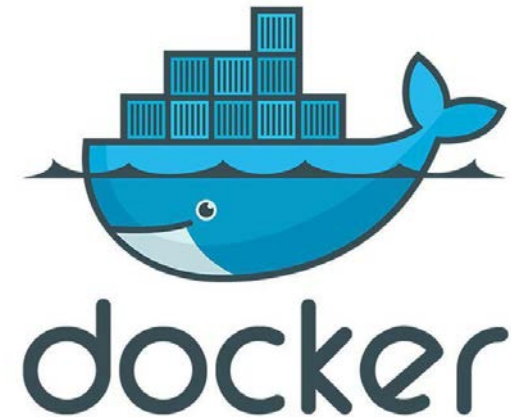


# VBuild: RPMs **cached** vs. **uncached**



# Further Directions

- Additional Functionality
  - Perf and Flame Graphs
  - Collectd
- Quantifying Virtualization
  - Overhead
  - Signatures
- Containerization
  - Faster provisioning
- Scalability concerns
  - Larger cluster
  - Clearer Results
- Code Release & Contribution
  - Enable reproducibility



Version 1.97		Sequential Output					Sequential Input				Random Seeks		
	Size	Per Char		Block		Rewrite		Per Char		Block			
		K/sec	% CPU	K/sec	% CPU	K/sec	% CPU	K/sec	% CPU	K/sec	% CPU	/sec	% CPU
te05	128408M	766	99	137384	17	52638	8	1858	96	182797	13	340.4	7
	Latency	22112us		488ms		1621ms		36716us		157ms		818ms	

e.g Bonnie++ Benchmark run on host



# Thanks for watching!



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## References

- <http://www.brendangregg.com/perf.html>
- <https://www.ibm.com/developerworks/library/l-linuxuniversal>
- [Github: https://github.com/hpc/hpc-collab](https://github.com/hpc/hpc-collab)

# Additional Materials



## Virtual Cluster ("VC") Recipe

