August 9th 2011, OSG Site Admin Workshop

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Network Time Protocol (NTP)

Agenda

- Tutorial Agenda:
  - Network Performance Primer - Why Should We Care? (**30 Mins**)
  - Introduction to Measurement Tools (**20 Mins**)
  - Use of NTP for network measurements (**15 Mins**)
  - Use of the BWCTL Server and Client (**25 Mins**)
  - Use of the OWAMP Server and Client (**25 Mins**)
  - Use of the NDT Server and Client (**25 Mins**)
  - perfSONAR Topics (**30 Mins**)
  - Diagnostics vs Regular Monitoring (**20 Mins**)
  - Use Cases (**30 Mins**)
  - Exercises

What is NTP?

- NTP is a protocol designed to synchronize the clocks of computers over a network.
  - NTP version 3 is an internet draft standard, formalized in RFC 1305
  - NTP version 4 is a significant revision of the NTP standard, and is the current development version, but has not been formalized in an RFC
  - Simple NTP (SNTP) version 4 is described in RFC 2030
- Widely used to synchronize a computer to Internet time servers or other sources, such as a radio or satellite receiver or telephone modem service.
- It can also be used as a server for dependent clients

What is NTP?

- Used to synchronize a group of servers to UTC
  - Servers will present the data in timezones as needed
- Attempts to keep time monotonically increasing while minimizing offset and skew
  - Sends signals to system clock to correct
  - 'skipping' may be large to start
- These goals contradict
  - Stability vs Accuracy

What is NTP?

- Provides accuracies typically less than a millisecond on LANs and up to a few milliseconds on WANs
- Typical NTP configurations utilize multiple redundant servers and diverse network paths in order to achieve high accuracy and reliability.
  - Redundancy – enough choices to pick a 'good' clock
  - Diverse Paths – Minimize the effect of congestion on a common path
- NTP time synchronization services are widely available in the public Internet.
  - The public NTP subnet in early 2008 includes several thousand servers in most countries and on every continent of the globe, including Antarctica.
  - These servers support a total population estimated at over 25 million computers in the global Internet.

What is NTP?

- The NTP subnet operates with a hierarchy of levels, where each level is assigned a number called the stratum.
  - Stratum 1 (primary) servers at the lowest level are directly synchronized to national time services.
  - Stratum 2 (secondary) servers at the next higher level are synchronize to stratum 1 servers and so on.
- Normally, NTP clients and servers with a relatively small number of clients do not synchronize to public primary servers.
  - There are several hundred public secondary servers operating at higher strata and are the preferred choice.
- For measurement needs, we are not going to recommend the 'normal' mode of operation…

Utility for Measurement

- Scheduling requires coarse grain agreement on time (lets start/end together)
  - Agreement must be "global" in scope – UTC
  - Individual servers communicate with multiple other hosts
- Stability/Accuracy are important
  - Virtualization is still tricky…
- One-Way latency requirements
  - Jitter (requires stability of offset within sample)
  - Latency (requires accuracy)
- Sensible compromise
  - Well defined error representation

Sensible NTP Policy

- Open firewalls and open querying
  - Let others know your notion of time
- Good error determination requires 4 clocks (4 peers)
  - E.g. Try to pick clocks of the same strata (something high, 1 preferred, 2 will work)
- Resilient setups will attempt to have the paths to all peers be as divergent as possible
  - Asymmetric paths to peers will cause offsets

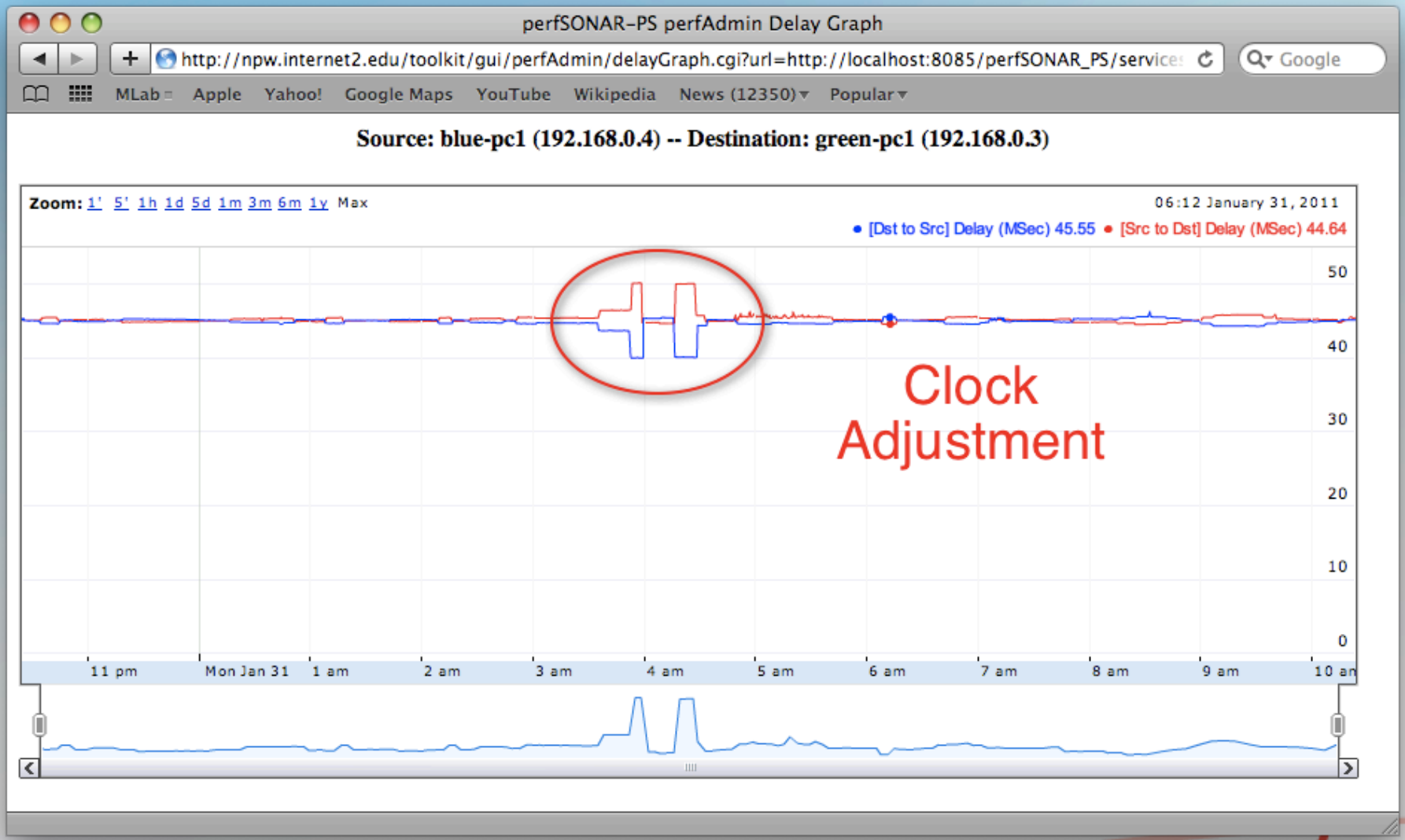
Sensible NTP Deployment

- Hardware/network requirements are minimal
- Minimize temperature variations to minimize clock wander
  - University of Delaware study – NTP is heavily influenced by the seasons (e.g. AC usage in campus buildings will impact clock skew)
- Use "real" NTP - not OpenNTP or something else
  - Linux/FreeBSD release distributions should be fine
  - You **must** configure, default config is bad
- Default configuration relies on 'pool' servers
  - Anyone can join the pool
  - Choosing from the pool does not mean you will always get the same server
  - Any stratum
  - No limits on accuracy…

Acceptable clock use

- NTP should stabilize the clock over time
- Measurements (e.g. OWAMP) will reflect this change
  - Less ‘skipping’
  - No more ‘negative’ measurements
- NTP will remain in a steady state unless there are network/host problems
  - Selecting constantly between the best ‘peer’ clocks
  - Network routing causing delay between peers
  - Host temperature fluctuations, CPU variability

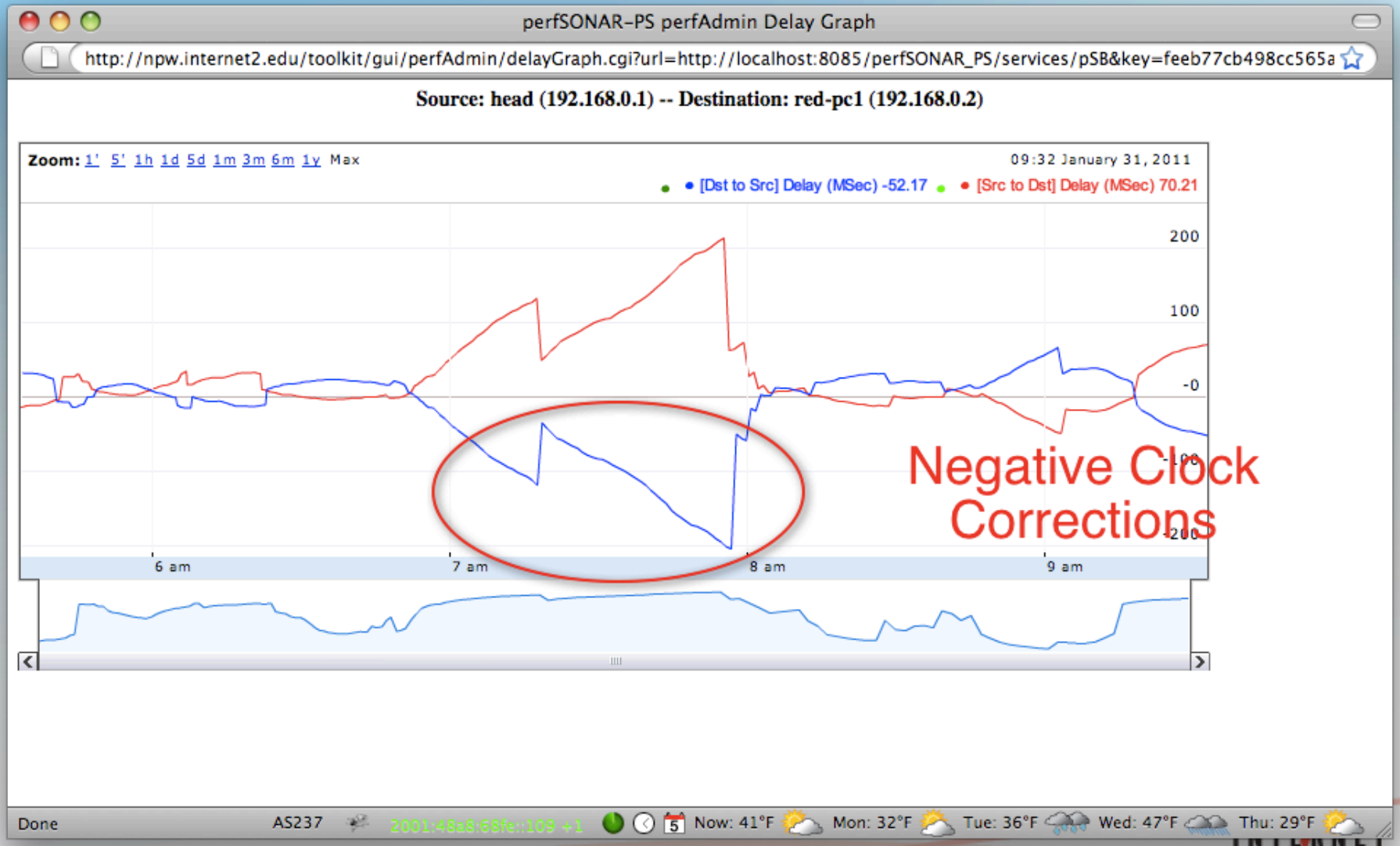
Acceptable clock use – OWAMP Data



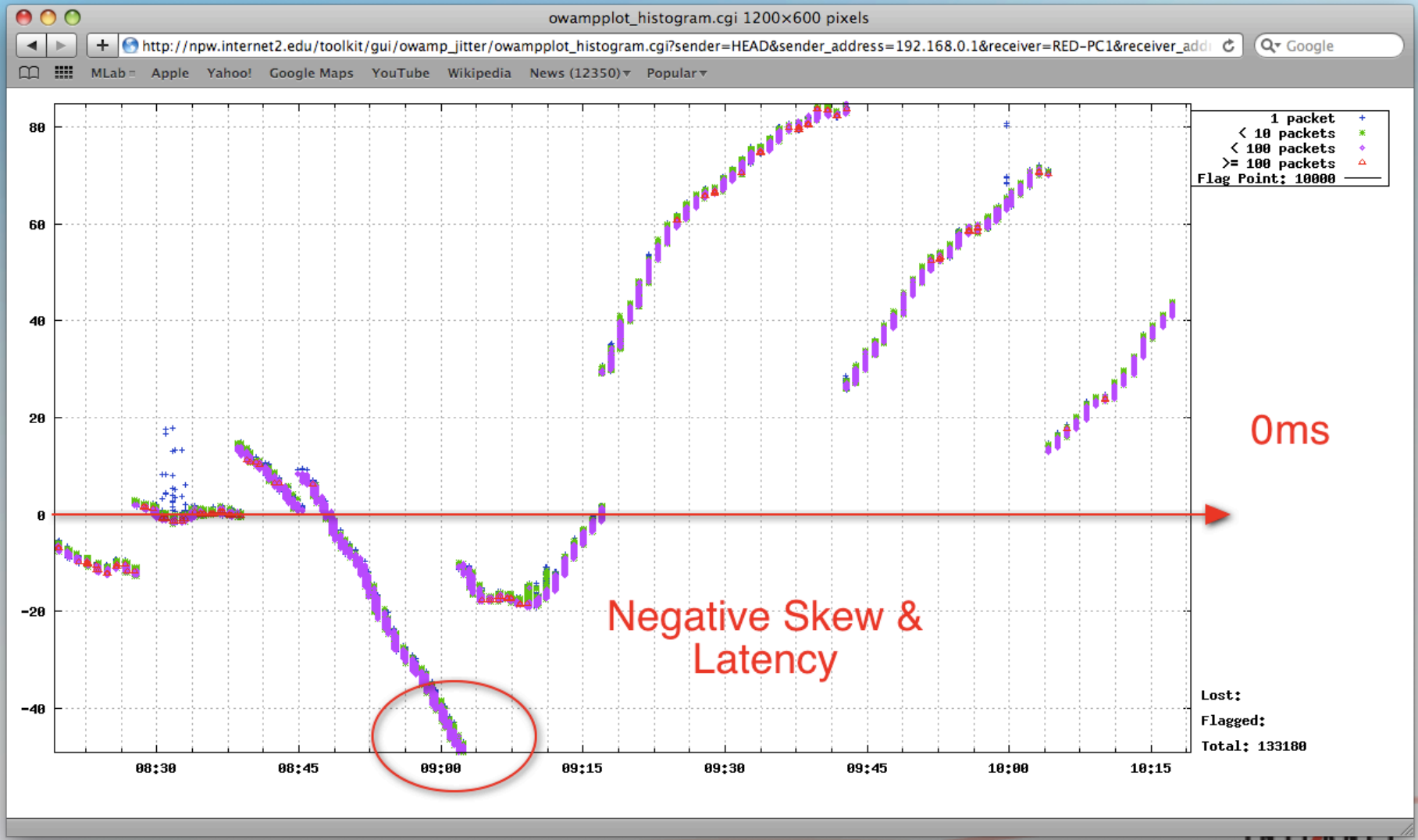
Poor clock use

- NTP cannot stabilize the clock
  - CMOS battery failure
  - Poor selection of peers
  - Network congestion
  - Host invariability (temperature, CPU)
- Frequent skips in perceived time
- Measurement is unreliable (negative latencies)
- High Jitter

Poor clock use – Skew in OWAMP Data



Poor clock use – Jitter in OWAMP Data

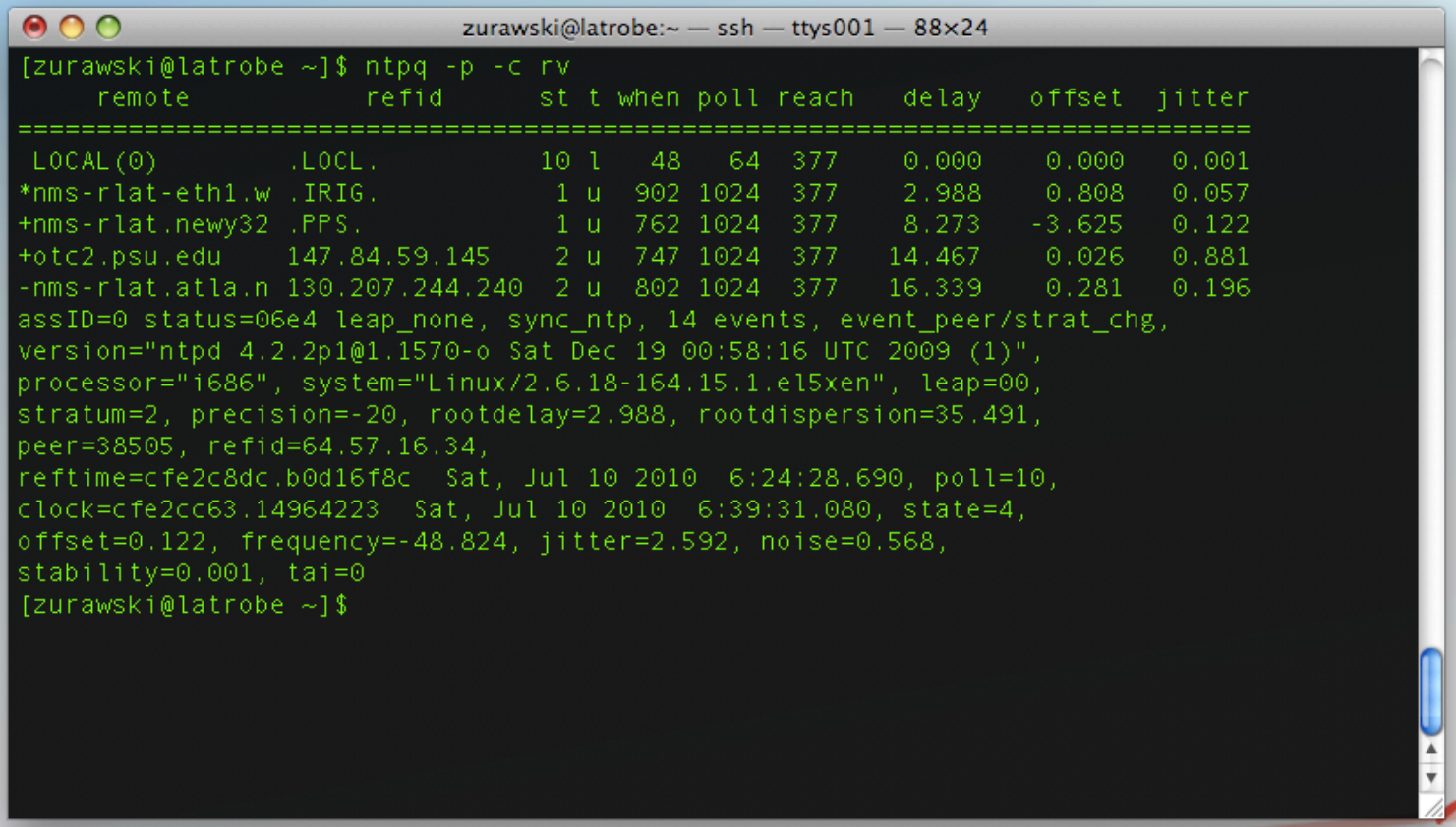


Additional Resources

- Man ntpd
- Man ntp.conf
- http://www.internet2.edu/performance/owamp/details.html#NTP
- http://twiki.ntp.org/bin/view/Support/SelectingOffsiteNTPServers
- Sample Configuration:
  - http://www.internet2.edu/performance/owamp/ntp/ntp.conf

Verify NTP

- Ntpq
- Ntpd statistics (log files)



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For more information, visit http://www.internet2.edu/workshops/npw