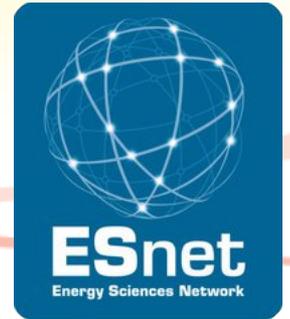


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November 18<sup>th</sup> 2013, SC13 Network Performance Tutorial  
Jason Zurawski – Internet2/ESnet

**BWCTL, IPERF, & NUTTCP (Oh My)**

# BWCTL – What is it?

- BWCTL is:
  - A command line client application
  - A scheduling and policy daemon
  - Wraps the throughput testing tools [Iperf](#) and [Nuttcp](#).
- These tests are able to measure:
  - Maximum TCP bandwidth (with various tuning options available)
  - The delay, jitter, and datagram loss of a network when doing a UDP test

# BWCTL – Quick Demo

- Caveat ... BWCTL is a serial testing tool, e.g. only one test per server at a time. Keep this in mind as we use it – all of your testing at once will most likely cause problems
- Basic syntax:
  - **bwctl -f m -t 10 -i 1 -c HOST**
  - **bwctl -f m -t 10 -i 1 -s HOST**
- Try at your own risk to other servers, suggestions:
  - bwctl.salt.net.internet2.edu
  - To not overwhelm the server, also try replacing ‘salt’ with:
    - atla
    - chic
    - hous
    - kans
    - losa
    - newy
    - seat
    - wash

# Problem Statement

- Users want to verify available bandwidth/throughput:
  - Between their site and a remote resource
  - Between two remote resources
  - Validate/Verify an SLA
- Methodology:
  - Verify available bandwidth from each endpoint to points in the middle
  - Determine problem area(s)
  - Re-run tests over time – requires access to tool instead of doing a ‘one off’ test

# Typical Solution

- Run “iperf” or similar tool on two endpoints and hosts on intermediate paths
  - Roadblocks:
    - Need software on all test systems
    - Need permissions on all systems involved (usually full shell accounts\*)
    - Need to coordinate testing with others \*
    - Need to run software on both sides with specified test parameters \*
  - Desirable features for an alternate method
    - ‘Daemon’ to run in the background
    - Protocol to exchange results/errors
    - Works with firewalls
    - Protect resources
- (\* BWCTL was designed to help with these)

# Implementation

- Applications
  - Daemon (bwctld)
  - Client (bwctl)
- Open Source License & Development
  - Modified BSD (<http://www.internet2.edu/membership/ip.html>)
  - Mailing lists for developer communication – come join us!
- Protocol Abstraction Library
  - Will support development of new clients
  - Add custom ‘hooks’ into the policy (e.g. add authentication via OpenID or similar)

# TCP Measurements

- Measures TCP Achievable Bandwidth
  - Measurement includes the end system
  - Sometimes called “memory-to-memory” tests
  - Set expectations for well coded application
- Limits of what we can measure
  - TCP *hides* details
  - In hiding the details it can obscure what is causing errors
- Many things can limit TCP throughput
  - Loss
  - Congestion
  - Buffer Starvation
  - Out of order delivery

# TCP Performance: Window Size

- Use TCP auto tuning if possible
  - Linux 2.6.7 and newer, Mac OS X 10.5, FreeBSD 7.x, and Windows Vista
  - Allow the OS to decide how large the window needs to be based on current resources and performance
- The `-w` option can be used to request a particular buffer size.
  - Use this if your OS doesn't have TCP auto tuning
  - This sets both send and receive buffer size.
  - The OS may need to be tweaked to allow buffers of sufficient size.
  - See <http://fasterdata.es.net/fasterdata/host-tuning/> for more details
- Parallel transfers may help as well, the `-P` option can be used for this
- To get full TCP performance the TCP window needs to be large enough to accommodate the Bandwidth Delay Product

# TCP Performance: Read/Write Buffer Size

- TCP breaks the stream into pieces transparently
- Longer writes often improve performance
  - Let TCP “do its thing”
  - Fewer system calls
- How?
  - -l <size> (lower case ell)
  - Example -l 128K
- UDP doesn't break up writes, don't exceed Path MTU

# UDP Measurements

- UDP provides greater transparency
- We can directly measure some things TCP hides
  - Loss
  - Jitter
  - Out of order delivery
- Use -b to specify target bandwidth
  - Default is 1M
  - Two sets of multipliers
    - k, m, g multipliers are 1000, 1000<sup>2</sup>, 1000<sup>3</sup>
    - K, M, G multipliers are 1024, 1024<sup>2</sup>, 1024<sup>3</sup>
  - Eg, -b 1m is 1,000,000 bits per second

# Example

```
boote@nms-rthr2:~  
[boote@nms-rthr2 ~]$ bwctl -x -s bwctl.kans.net.internet2.edu  
bwctl: 19 seconds until test results available  
  
RECEIVER START  
3421251446.646488: iperf -B 2001:468:9:100::16:22 -P 1 -s -f b -m -p 5  
001 -t 10 -V  
-----  
Server listening on TCP port 5001  
Binding to local address 2001:468:9:100::16:22  
TCP window size: 87380 Byte (default)  
-----  
[ 14] local 2001:468:9:100::16:22 port 5001 connected with 2001:468:4:  
100::16:214 port 5001  
[ 14] 0.0-10.2 sec 1193058304 Bytes 939913512 bits/sec  
[ 14] MSS size 8928 bytes (MTU 8968 bytes, unknown interface)  
  
RECEIVER END  
  
SENDER START  
3421251448.787198: iperf -c 2001:468:9:100::16:22 -B 2001:468:4:100::1  
6:214 -f b -m -p 5001 -t 10 -V  
-----  
Client connecting to 2001:468:9:100::16:22, TCP port 5001  
Binding to local address 2001:468:4:100::16:214  
TCP window size: 87380 Byte (default)  
-----  
[ 7] local 2001:468:4:100::16:214 port 5001 connected with 2001:468:9  
:100::16:22 port 5001  
[ 7] 0.0-10.0 sec 1193058304 Bytes 951107779 bits/sec  
[ 7] MSS size 8928 bytes (MTU 8968 bytes, unknown interface)  
  
SENDER END  
[boote@nms-rthr2 ~]$
```

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# BWCTL GUIs

performance **ps** toolkit

**User Tools**

- Local Performance Services
- Global Performance Services
- Java OWAMP Client
- Reverse Traceroute
- Reverse Ping
- PingER Web GUI

**Service Graphs**

- Throughput
- One-Way Latency
- Ping Latency
- SNMP Utilization
- Cacti Graphs

**Toolkit Administration**

- Administrative Information
- External BWCTL Limits
- External OWAMP Limits
- Enabled Services
- NTP
- Scheduled Tests
- Cacti SNMP Monitoring

**Performance Toolkit**

- Configuration Help
- Frequently Asked Questions
- About
- Credits

Throughput Tests

Active Data Sets

First Host	First Address	Second Host	Second Address	Protocol	Duration	Window Size	Bandwidth Limit	Bi-Directional	Line Graph	Scatter Graph
bwctl.ucsc.edu	128.114.0.205	desk172.internet2.edu	207.75.164.172	TCP	20			Yes	-- Select --	-- Select --
desk172.internet2.edu	207.75.164.172	infotech-sv-62.ggnnet.umn.edu	146.57.255.17	TCP	20			Yes	-- Select --	-- Select --
desk172.internet2.edu	207.75.164.172	iperf.its.vanderbilt.edu	192.111.110.34	TCP	20			Yes	-- Select --	-- Select --
desk172.internet2.edu	207.75.164.172	lab253.internet2.edu	207.75.164.253	TCP	20			Yes	-- Select --	-- Select --
desk172.internet2.edu	207.75.164.172	ndt.ScrippsCollege.edu	134.173.151.207	TCP	20			Yes	-- Select --	-- Select --
desk172.internet2.edu	207.75.164.172	perfsonar.its.iastate.edu	129.186.6.241	TCP	20			Yes	-- Select --	-- Select --
desk172.internet2.edu	207.75.164.172	perfsonar.ndsu.NoDak.edu	134.129.90.1	TCP	20			Yes	-- Select --	-- Select --

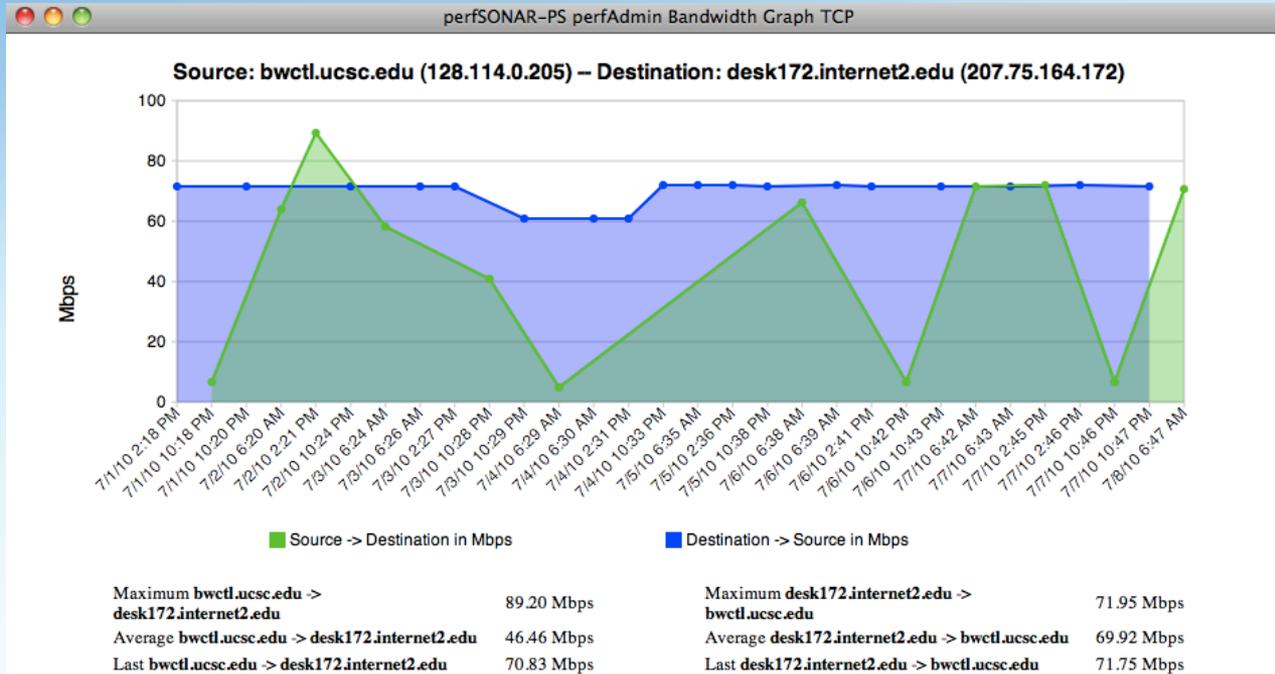
1 Week Average Bandwidth in Mbps

Host	In BW (Mbps)	Out BW (Mbps)
bwctl.ucsc.edu	~70	~45
desk172.internet2.edu	~75	~85
infotech-sv-62.ggnnet.umn.edu	~90	~85
iperf.its.vanderbilt.edu	~90	~70
lab253.internet2.edu	~90	~90
ndt.ScrippsCollege.edu	~85	~55
perfsonar.its.iastate.edu	~90	~85
perfsonar.ndsu.NoDak.edu	~90	~85

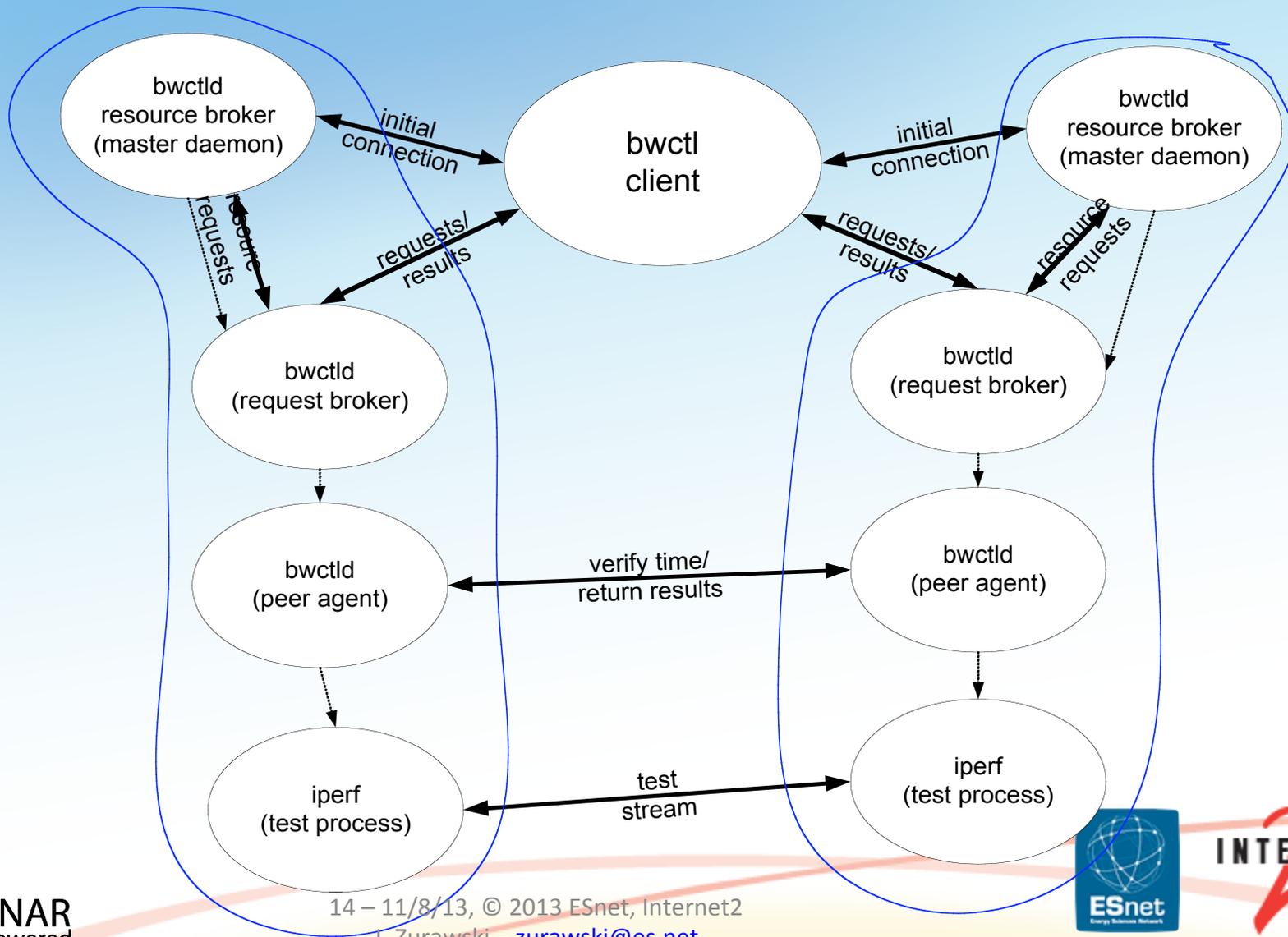
Non-Active Data Sets

First Host	First Address	Second Host	Second Address	Protocol	Duration	Window Size	Bandwidth Limit	Bi-Directional	Line Graph	Scatter Graph
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# BWCTL GUIs



# 3<sup>rd</sup> Party Testing



# General Requirements

- iperf version 2.0.x
  - Support for iperf 3 is being integrated
- NTP (ntpd) synchronized clock on the local system
  - Used for scheduling
  - More important that errors are accurate than the clock itself
- Firewalls:
  - Lots of ports for communication and testing – see the web for specifics
- End hosts must be tuned!
  - <http://fasterdata.es.net/fasterdata/host-tuning>
  - <http://www.psc.edu/index.php/tcp-performance-tuning>

# Supported Systems

- Source Code
  - All modern Unix distributions (Free BSD/Linux)
  - OS X
- Packages
  - Support for CentOS 5.x and 6.x (x86 and 64 Bit)
  - Packages have been shown to operate on similar systems (Fedora, RHEL, SL)
  - Avoid 'alien' on non-RHEL lineage, stick with source

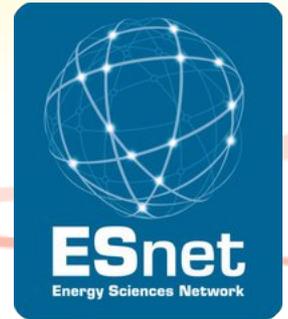
# Security & Policy Considerations

- DoS source
  - Imagine a large number of compromised BWCTLD servers being used to direct traffic
- DoS target
  - Someone might attempt to affect statistics web pages to see how much impact they can have
- Resource consumption
  - Time slots
  - Network bandwidth
- Policy
  - Restrictive for UDP
    - Allow between peers
    - Limit bandwidth, and time of tests
  - More liberal for TCP tests
    - Open for all (or peers)
    - Limit length of tests

# Availability

- Currently available
  - <http://www.internet2.edu/performance/bwctl>
  - <http://software.internet2.edu>
- Mail lists:
  - <https://lists.internet2.edu/sympa/info/bwctl-users>
    - bwctl-users@internet2.edu
  - <https://lists.internet2.edu/sympa/info/bwctl-announce>
    - bwctl-announce@internet2.edu

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# “Advanced” Use case/Debugging

- Sometimes you really want to have more control over the client and server
  - E.g. BWCTL does a good job of automation and simple tasks in throughput calculations
- IPERF/NUTTCP can be used alone (although you need control over a client and server on each end)
- The following are some examples of how to use it.
  - Learning to use these by hand will help you debug issues in the future

# Iperf Usage

- Switches:
  - -f m (Mbps output)
  - -t 30 (30 second test)
  - -i 1 (1 second interval)
  - -p 5131 (port)
  - -c (client)
  - -s (server)
  - -u (UDP mode)
  - -b 90m (rate limit for UDP)
  - -w 8M (set a window [client or server])
  - -P 4 (parallel streams)
- Things to try:
  - Effect of setting the window (on well tuned or not well tuned hosts)
  - Parallel streams
  - Links between other hosts

# Nuttcp Usage

- Switches:
  - -S (server mode)
  - --nofork (don't background)
  - -P/-p (Ports for data/control channel)
  - -T 30 (30 second test)
  - -i 1 (1 second reporting interval)
  - -r (reverse direction)
  - -N 4 (Parallel streams)
  - -u (UDP node)
  - -R 90m (rate limit for UDP)
  - -w 8M (TCP window)
- Things to Try:
  - Effect of setting the window (on well tuned or not well tuned hosts)
  - Parallel streams
  - Links between other hosts