



August 10<sup>th</sup> 2010, OSG Site Admin Workshop - Network Performance

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# **Welcome & Performance Primer**

# Who am I, Who are you?

# Agenda

- Welcome and Thanks
  - <http://www.internet2.edu/workshops/npw/>
- Tutorial Agenda:
  - Network Performance Primer - Why Should We Care? **(15 Mins)**
  - Getting the Tools **(10 Mins)**
  - Use of the BWCTL Server and Client **(30 Mins)**
  - Use of the OWAMP Server and Client **(30 Mins)**
  - Use of the NDT Server and Client **(30 Mins)**
  - BREAK **(15 mins)**
  - Diagnostics vs Regular Monitoring **(30 Mins)**
  - Network Performance Exercises **(1 hr 30 Mins)**

# Your Goals?

- What are your goals for this workshop?
  - Experiencing performance problems?
  - **Responsible for the campus/lab network?**
  - Learning about state of the art, e.g. ‘What is perfSONAR’?
  - Developing or researching performance tools?
- Is there a Magic Bullet?
  - No, but we can give you access to strategies and tools that will help
  - Patience and diligence will get you to most goals
- This workshop is as much a learning experience for us as it is for you
  - What problem/problems need to be solved
  - What will make networking a less painful experience
  - How can we improve our goods/services

# Problem: “The Network Is Broken”

- How can your users effectively report problems?
- How can you users and the local administrators effectively solve multi-domain problems?
- Components:
  - Tools to use
  - Questions to ask
  - Methodology to follow
  - How to ask for (and receive) help

# Why Worry About Network Performance?

- Most network design lends itself to the introduction of flaws:
  - Heterogeneous equipment
  - Cost factors heavily into design – e.g. *Get what you pay for*
  - Design heavily favors **protection** and **availability** over performance
- Communication protocols are not advancing as fast as networks
  - *TCP/IP* is the king of the protocol stack
    - Guarantees reliable transfers
    - Adjusts to failures in the network
    - Adjusts speed to be *fair* for all
- User Expectations
  - **Big Science** is prevalent globally
  - “The Network is Slow/Broken” – is this the response to almost any problem? Hardware? Software?
  - Empower users to be more informed/more helpful

# Motivation – A Typical Scenario

- User and resource are geographically separated
- Both have access to high speed communication network
  - LAN infrastructure - 1Gbps Ethernet
  - WAN infrastructure – 10Gbps Optical Backbone



# Motivation – A Typical Scenario

- User wants to access a file at the resource (e.g. ~600MB)
- Plans to use COTS tools (e.g. “scp”, but could easily be something scientific like “GridFTP” or simple like a web browser)
- What are the expectations?
  - 1Gbps network (e.g. *bottleneck* speed on the LAN)
  - $600\text{MB} * 8 = 4,800 \text{ Mb}$  file
  - User expects *line rate*, e.g.  $4,800 \text{ Mb} / 1000 \text{ Mbps} = 4.8 \text{ Seconds}$
  - Audience Poll: Is this expectation too high?
- What are the realities?
  - Congestion and other network performance factors
  - Host performance
  - Protocol Performance
  - Application performance



# Motivation – A Typical Scenario

- Real Example (New York USA to Los Angeles USA):

```
[zurawski@nms-rthr2 ~]$ scp zurawski@bwctl1.losa.net.internet2.edu:pS-Performance_Toolkit-3.1.1.iso .  
pS-Performance_Toolkit-3.1.1.iso          2%  17MB  1.0MB/s  10:05 ETA_
```

• Example:

- 1MB/s (8Mb/s) ??? 10 Minutes to transfer???
- Seems unreasonable given the investment in technology
  - Backbone network
  - High speed LAN
  - Capable hosts
- Performance realities as network speed decreases:
  - 100 Mbps Speed – 48 Seconds
  - 10 Mbps Speed – 8 Minutes
  - 1 Mbps Speed – 80 Minutes
- How could this happen? More importantly, why are there not more complaints?
- Audience Poll: Would you complain? If so, to whom?
- Brainstorming the above – where should we look to fix this?

# Motivation – A Typical Scenario

- Expectation does not even come close to experience, time to debug.  
Where to start though?
  - Application
    - Have other users reported problems? Is this the most up to date version?
  - Protocol
    - Protocols typically can be tuned on an individual basis, consult your operating system.
  - Host
    - Are the hardware components (network card, system internals) and software (drivers, operating system) functioning as they should be?
  - LAN Networks
    - Consult with the local administrators on status and potential choke points
  - Backbone Network
    - Consult the administrators at remote locations on status and potential choke points (Caveat – do you [should you] know who they are?)

# Motivation – A Typical Scenario

- Following through on the previous, what normally happens ...
  - Application
    - This step is normally skipped, the application designer will *blame the network*
  - Protocol
    - These settings may not be explored. Shouldn't this be automatic (e.g. autotuning)?
  - Host
    - Checking and diagnostic steps normally stop after establishing connectivity. E.g. “can I ping the other side”
  - LAN Networks
    - Will assure “internal” performance, but LAN administrators will ignore most user complaints and shift blame to upstream sources. E.g. “our network is fine, there are no complaints”
  - Backbone Network
    - Will assure “internal” performance, but Backbone responsibilities normally stop at the demarcation point, blame is shifted to other networks up and down stream

# Motivation – A Typical Scenario

- Stumbling Blocks to solving performance problems
  - Lack of a clear process
    - Knowledge of the proper order to approach problems is paramount
    - This knowledge is not just for end users – also for application developers and network operators too
  - Impatience
    - Everyone is impatient, from the user who wants things to work to the network staff and application developers who do not want to hear complaints
  - Information Void
    - Lack of a clear location that describes symptoms and steps that can be taken to mitigate risks and solve problems
    - Lack of available performance information, e.g the current status of a given network in a public and easily accessible forum
  - Communication
    - Finding whom to contact to report problems or get help in debugging is frustrating

# Motivation – Possible Solutions

- Finding a solution to network performance problems can be broken into two distinct steps:
  - Use of *Diagnostic Tools* to locate problems
    - Tools that actively measure performance (e.g. Latency, Available Bandwidth)
    - Tools that passively observe performance (e.g. error counters)
  - *Regular Monitoring* to establish performance baselines and alert when expectation drops.
    - Using diagnostic tools in a structured manner
    - Visualizations and alarms to analyze the collected data
- Incorporation of either of these techniques must be:
  - *ubiquitous*, e.g. the solution works best when it is available everywhere
  - *seamless* (e.g. *federated*) in presenting information from different resources and domains

# Diagnosis Methodology

- Find a measurement server “near me”
  - Why is this important?
  - How hard is this to do?
- Encourage user to participate in diagnosis procedures
- Detect and report common faults in a manner that can be shared with admins/NOC
  - ‘Proof’ goes a long way
- Provide a mechanism for admins to review test results
- Provide feedback to user to ensure problems are resolved



# Partial Path Decomposition

- Networking is increasingly:
  - Cross domain
  - Large scale
  - Data intensive
- Identification of the end-to-end path is key (must solve the problem end to end...)
- Discover measurement nodes that are “near” this path
- Provide proper authentication or receive limited authority to run tests
  - No more conference calls between 5 networks, in the middle of the night
- Initiate tests between various nodes
- Retrieve and store test data for further analysis

# Systematic Troubleshooting Procedures

- Having tools deployed (along the entire path) to enable adequate troubleshooting
- Getting end-users involved in the testing
- Combining output from multiple tools to understand problem
  - Correlating diverse data sets – only way to understand complex problems.
- Ensuring that results are adequately documented for later review



# On Demand vs Scheduled Testing

- On-Demand testing can help solve existing problems once they occur
- Regular performance monitoring can quickly identify and locate problems before users complain
  - Alarms
  - Anomaly detection
- Testing and measuring performance increases the value of the network to all participants

# Our Goals

- To spread the word that today's networks really can, do, and will support demanding applications
  - **Science**
    - Physics
    - Astronomy
    - Biology and Climate
  - Arts and Humanities
  - Computational and Network Research
- To increase the number of test points
  - Instrumenting the end to end path is key
  - Spread the knowledge and encourage adoption

# Other Thoughts

- See a talk from the recent Joint Techs Conference:
  - <http://www.internet2.edu/presentations/jt2010july/20100714-metzger-whatnext.pdf>
- Take home points:
  - Close to \$1 Billion USD spent on networking at all levels (Campus, Regional, Backbone) in the next 2 years due to ARRA Funding
  - Unprecedented access and capacity for many people
  - Ideal View:
    - Changes will be seamless
    - Completed on time
    - Bandwidth will solve all performance problems
  - Realistic View:
    - Network 'breaks' when it is touched (e.g. new equipment, configs)
    - Optimization will not be done in a global fashion (e.g. backbone fixes performance, but what about regional and campus?)
    - Bandwidth means nothing when you have a serious performance problem



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