“Planning and Measuring Performance Characteristics of a SharePoint Farm: Theory and Practice”

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About

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Part I – Planning for Performance

Performance Defined

- User Response Time
  - CNS Model
  - Client Latency
  - Network Latency
  - Server Latency
  - Demo
How Fast is “Fast”?  

- **Human Physiology Factor**
  - Under 0.1 sec – virtually unnoticeable.
  - Under 1 sec – perceived as interactive
  - Under 10 sec – willing to focus on a task

- **2006 Akamai/Jupiter Research**
  - 33% of broadband consumers will wait no longer than 4 sec for a page to load.

- **2009 Akamai/Forrester Research**
  - 2 sec. – average expectation of online shopper
  - 3 sec. – max time 40% shoppers are willing to wait for a page to load


- **WM100** – Webmetrics maintains index of top 100 sites by performance [http://www.webmetrics.com/resources/benchmarking.html](http://www.webmetrics.com/resources/benchmarking.html)
# SharePoint Response Time Guidance

<table>
<thead>
<tr>
<th>Type of operation</th>
<th>Examples</th>
<th>Acceptable user response time</th>
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| Common operation        | · Browsing to the home page  
 · Browsing to a document library                                       | <3 seconds                    |
| Uncommon operation      | · Creating a subsite  
 · Creating a list  
 · Uploading a document to a document library                           | <5 seconds                    |
| Rare operation          | · Backing up a site  
 · Creating a site collection                                                 | <7 seconds                    |

Response Time

- Page Load Time (PLT) or User Response Time (URT) – time until a page fully renders.

- Microsoft uses PLT1 and PLT2 – the very first access to the page, and subsequent access to the same page.
How Fast is “Fast” in my Company?

- Study publicly available metrics
- Study organization’s historical metrics
- Estimate average and peak traffic
- Define a matrix of PLT1 and PLT2:
  - For various pages
  - For various authentication groups
  - For peak and average usage
Part I – Planning for Performance

- Performance Defined

- **User Response Time**
  - URT Formula
  - Client Time
  - Network Time
  - Server Time
  - DEMO
URT Formula

\[ \text{PLT} = \text{C} + \text{N} + \text{S} \]
URT Formula (Netforecast)

\[ R \approx \frac{Payload}{Bandwidth} + AppTurns(RTT) + Cs + Cc \]

- **R** – response time
- **Payload** – total size of page and all its resources
- **AppTurns** – round trips made at application level (excluding TCP handshake/congestion control round trips & authentication)
- **RTT** – round trip time
- **Cs** – constant server time component
- **Cc** – constant client time component

Reference:
Client Scripting Performance

- Profiling script from within script is very imprecise, partly due to platform implementation. For example, on Windows XP timer would show intervals shorter than 15ms as 0.
- Profilers:
Network Performance – the Bottleneck

- Bandwidth limitations – can be addressed via technology
- Latency limitations – Speed of Light
  \[ \text{RTT/2} = \frac{(36,000 \times 2)}{300,000} \]
  \[ \text{RTT} \sim 0.5 \text{ sec.} \]
- TCP limitations
- Signal strength/QoS
Latency and Bandwidth

Overall link bandwidth = 3 Mbit/s

What is my **actual** bandwidth & latency? www.speedtest.net detects your local bandwidth and latency.
TCP Communication

- A max. packet size on Ethernet is 1500 bytes, aka MTU or max. transfer unit.

- On IPv4 networks IP overhead takes 40 bytes, hence max payload equals 1460 bytes, aka MSS or max. segment size.

- TCP requires acknowledgement (ACK) of all packets sent but allows sending a number of packets without waiting for ACK to improve speed. Eventually ACK must arrive.

- If some packets are lost, i.e. there is no ACK within a timeout, then packets are re-transmitted.
TCP Communication: Naïve Model

Part I – Planning for Performance
TCP Communication: Realistic Model
TCP Communication: TCP Window

TCP Window

Time
TCP Window

- TCP Window is a number of bytes a receiver can accept without sending ACK immediately.

- Too large window means network congestion >> lost packets >> re-transmission >> performance degradation

- Too small window means low bandwidth utilization >> performance degradation
TCP Slow Start

Optimal window size is twice the amount of data that can be “in flight” on the wire from sender to receiver at any given time:

\[
R\text{WIN} = 2 \times (\text{Bandwidth} \times \text{RTT}/2), \text{ or } R\text{WIN} = 2 \times \text{BDP}
\]

BDP – bandwidth-delay product.
RWIN – TCP receive window buffer.

TCP detects bandwidth and latency and dynamically sets window size. Usually initial \( R\text{WIN} = 64\text{KB} \). Once connection is established, TCP increases \( R\text{WIN} \), process aka “Slow Start”. On a slower WAN it can take up to 12 round trips to optimize the receive window.

TCP Congestion Control

Sender maintains congestion window, CWND and constantly tweaks it according to bandwidth and delay to avoid congestion:

**Effective bandwidth = CWND/RTT**

Various congestion control algorithms are known, ex. Tahoe, Reno. Windows Vista, 7 and 2008 use CTCP. It is advantageous over WAN, enabled by default on 2008, but not on Vista and Windows 7.

TCP Congestion Window Scaling

Ideal CWIN Size

t1 - slow start, increasing exp
 t2 - threshold is reached, increasing by one
 t3 - what happens here?
 t4 - increasing by one
 t5 - timeout occurred, cwin=1, threshold= cwin/2;
TCP Packet Loss

Packet loss may occur for many reasons, ex. when network is congested or equipment is misconfigured, or there is a signal loss, etc. Packet loss severely impacts throughput:

\[ \text{Throughput} \leq 0.7 \times \frac{\text{MSS}}{(\text{RTT} \times \sqrt{P_{\text{loss}}})} \]

MSS – Max. segment size, 1460 bytes for IPv4, 1440 bytes for IPv6 on Ethernet.
\( P_{\text{loss}} \) – probability of a packet loss.

Example: At 100ms round trip time and 10\(^{-4}\) probability of a packet loss you would get no more than 8Mbit/s throughput.

Contemporary networks have very low packet loss probability, yet some packet loss occurs on long links. WAN testing is sometimes done assuming 1 – 3% of packet loss.
Addressing TCP Limitations

- Using UDP instead of TCP
- Minimizing number of round trips
- Using few large files vs. many small files
- Using multiple browser connections
- Using HTTP persistent connections
- Using client-side caching
- Using Content Delivery Networks (CDN)
- Using WAN accelerators & offloading devices
Multiple Browser Connections

- Contemporary browsers use multiple TCP connections per hostname:
  - IE6, IE7 – 2 connections max;
  - IE8, FireFox 3.5 – 6 connections max.

- Open multiple (source) ports for multiple TCP connections.

- Despite having multiple connections a lot of sequential loading still takes place. IE8 is the first browser to download multiple script files in parallel.
HTTP Persistent Connections

- HTTP 1.1 supports persistent connections through Keep-Alive header.

- The goal is to re-use underlying TCP connection with its current CWND avoiding having to go through Slow Start again.

- Enabled by default on most browsers and on IIS 6, 7. Keep-alive timeout is 1 min for IE and 15 sec. for FireFox, and is adjustable. For changing timeout on IE6, 7 see: [http://support.microsoft.com/kb/813827](http://support.microsoft.com/kb/813827)

CDNs distribute cached content on multiple servers, which are close to end users. Internet traffic is redirected to the closest CDN server instead of the origin server.

**Advantages:**
- Low latency & high bandwidth when accessing a CDN server result in much better performance for the end users – “last mile” performance.
- As a result of many users hitting CDN cache the load on original server is reduced.
- Excellent for media streaming.

**Disadvantages:**
- Very expensive, typically affordable to large enterprises only. Ex. $0.5/GB on 50 TB monthly ~25,000$/month
- Less efficient for highly volatile content.
- It can be technically difficult to invalidate CDN cache explicitly.

**Free CDNs, primarily AJAX support:**

**More Info about CDNs:**
Use packet compression, differencing, caching, optimal route calculation algorithms, reducing packet loss.

Solutions include Cisco, Citrix, Packeteer, Riverbed, F5, Brocade.

Microsoft’s ISA and IAG, and their successor Unified Access Gateway (UAG 2010) provide caching, offloaded compression, differencing and authentication delegation.
Determining Network Performance

- Nature of network transmission complicates its mathematical modeling and projection of results between different networks. This increases amount of calibration testing needed.

- Create a reference set of web pages and test them on various networks. Calibrate earlier discussed CNS formulas using these test results.

- Tools are available:
  - [http://www.webpagetest.org/](http://www.webpagetest.org/)
  - [http://kite.keynote.com/](http://kite.keynote.com/)
  - [http://www.fiddler2.com/fiddler2](http://www.fiddler2.com/fiddler2)
  - [http://www.aptimize.com](http://www.aptimize.com)
Server Performance

- Create baseline measurement for various load profiles and PLT1/PLT2

- Use Performance counters:
  - ASP.NET Request Execution Time
  - ASP.NET Request Wait Time
  - Server Response Time (SRT) = the sum of the two.

Essential performance counters: http://support.microsoft.com/kb/815159
DEMO

- Performance Measurement Tools
- SharePoint Developer Dashboard
- Measuring PLT1 & PLT2
- SharePoint Logging DB
Questions?