Deploying and Tuning ArcGIS Server

Presented by Jim Mason and Eric Miller

ESRI Server Development
Overview

• **Tuning**
  – Detecting and Analyzing Performance Bottlenecks
  – Accommodating Performance Problems

• **Deployment**
  – High Availability Configurations
  – Distributed Installations of ArcGIS Server
  – Security Considerations
Presumptions

• Basic understanding of:
  – ArcGIS Desktop.
  – ArcGIS Server architecture and concepts.
  – Web Architectures
ArcGIS Server Case Study

Palm Springs Elevation Transect Geoprocessing Task Service

- **Geoprocessing Tool Model**
  - Input Line Feature Class
  - Extract elevations at points on the verticies of the input line.
ArcGIS Server Case Study

Palm Springs Elevation Transect Geoprocessing Task Service

- ADF Web Application
- Extract Elevations
  - Enter a series of points
  - Symbolize the points according to elevation.
ArcGIS Server Case Study

Palm Springs Elevation Transect Geoprocessing Task Service

- **ArcMap**
- **Extract Elevations**
  - Enter a series of points
  - Symbolize the points according to elevation.
ADF Geoprocessing Task Resources

• **Documentation**
  – ArcGIS Desktop Help
  – ArcGIS Server Help
  – ArcGIS Server Developer Help

• **ArcGIS Server Development Blog**

• **EDN Samples**
  – ArcGIS Buffer Geoprocessing
ArcGIS Server Case Study

Hardware Environment

Web Client

Web Server (IIS 6)

ArcGIS Server 9.2
Server Object Manager

ArcGIS Server 9.2

ArcGIS Server 9.2

Server Object Container
Predicting Usage by Modeling User Behavior

- 500 users
- 20% peak concurrency
- 100 simultaneous users (20% of 500)
- Users submit requests about once every minute
- 100 transactions/minute = 6,000 transactions/hour
ArcGIS Server: Response time factors

- Four main factors of response time
- Multiple tiers
- Performance bottleneck can occur in each tier
Bottlenecks

- Threading
- Memory
- Disk
- CPU
- Network
Bottlenecks

- Threading
  - Service availability
- Memory
- CPU
- Disk
- Network
Pooled Service Model

- State information **maintained in web server / browser.**
  - Current extent
  - Layer visibility
- **Scales better** due to shared object pool.
ArcGIS Server – Configuring Pooled Instances

- Define Min-Max instances
- Instances are distributed across all host servers
Optimum number of pooled instances for Dynamic Map Services

• Set instances to level where maximum throughput occurs (usually between 2 to 4 instances per CPU)
Bottlenecks

- Threading
- **Memory**
- CPU
- Disk
- Network
Memory Bottleneck

Performance degrades when a machine runs more instances than it can fit into memory.
Palm Springs Elevation Transect

- Deployed 8 instances on 1GB host server
- Memory started paging before CPU was fully utilized

Options to resolve:
- Increase memory
- Reduce number of instances per server
- Limit capacity on host machines
Setting Capacity

- Limits number of service instances running on a specific host machine.
- Once this limit is reached, Server starts replacing least recently used instances instead of creating new ones.
CPU/Memory Bottleneck

• **LSASS**
  - Local Security Authentication Server system process (lsass.exe) grows in CPU usage and memory utilization under heavy load.

  • **Solution:**
    - Install ArcGIS Server Service Pack 1 or later.
    - Deploy web services and applications into a new application pool.
    - Change identity of the new application pool to ArcGISWebServices user.
    - Turn off web service/web application authentication.

• **Windows_Server_2003**
  [Link](http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=326320)

• **Windows_XP**
  [Link](http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=326322)
Bottlenecks

- Threading
- Memory
- CPU
- Disk
- Network
Optimize Your Services

• **Dynamic**
  – Elevation Transect
  – Roads symbolized by current snow depth
  – Electrical network showing the latest posted work order
  – Geocoding addresses

• **Static Layers**
  – Elevation TIN
  – Imagery
  – StreetMap
  – Shaded Relief

• **The classification is subjective**
Best Practices for Geoprocessing Services
Optimizing Geoprocessing Services

**General Guidelines**

- **Simplify Models and data**
  - Preprocess steps in advance.

- **Use in-memory data**

- **Use fast-access data (uncompressed).**

- **Two instances cannot update the same data at the same time.**
Best Practices for Dynamic Map Services
Best Practices

**General Guidelines**

- **Show relevant information**
  - Start simple (additional layers can be toggled on by user)
  - Use field visibility (hide unnecessary attributes)

- **Use scale dependencies**
  - Use data appropriate for the given scale (generalize if necessary)
  - Display similar number of features at all scales for consistent user experience
ESRI_Optimized Lines and Polygons

- Outlines for all fills are simple lines instead of cartographic lines
- Picture fills are EMF-based instead of BMP-based
- Improves drawing performance by > 50%

Best Practices

Text and labeling

- Use annotation instead of labels
- Use indexed fields
- Use label and feature conflict weights sparingly
- Avoid special effects (fill patterns, halos, callouts, backgrounds)
- Avoid very large text size (60+ pts)
- Avoid Maplex for dynamic labeling
Best Practices for Static Map Services
Classic Dynamic Mapping Trade-Off

Quality vs. Speed

- Shaded Relief
- Transparent Layers
- Maplex Labeling
- Standard Labeling
If you can cache your map then no need to trade-off

1.5 seconds

4 seconds
Cached Map Service

- Tiles pre-rendered at fixed scales
- Rapid display of static base maps
- Richer symbols and more information
How Map Caching Works

• You can control:

  – Origin of the tiling scheme in map coordinates
  – Set of scales
  – Image format (PNG, JPG)
  – Tile size (default = 512 x 512)
  – Display resolution in DPI (default = 96)

• The scale, tile size, and DPI control the pixel resolution in map units at each scale level
How the Map Cache is Stored

- Map services have an associated map cache directory
  - Sub-directory under one of the GIS Server’s cache directories

- Association between the map service and the map cache directory is by name

- Accessed from clients using a virtual directory.
  - For ADF clients, anonymous access should be enabled.
How the Map Cache is Stored (continued)

• **Map cache directory organization**

  • Server Cache Directory
  • Map Cache Directory (Wyoming, SoCal, …)
  • Data Frame (Layers, Study Area, …)
  • Layer (_alllayers, roads, …)
  • Level (L01, L02, L03, …)
  • Row (R00000000, R00000001, …)
  • Tiles (C00000000.png, C00000001.png, …)
What Happens During Map Caching

- Data is pre-rendered into large in-memory tiles that are subsequently chopped up to the specified tile size
  - Minimizes the need to squeeze labels into small tile boundaries
  - Tip: remove label offsets
Anti-aliasing

- Tiles are rendered at **finer resolution** followed by **down sampling**.
  - Smoothes the edges of labels and lines by blending them with the background.
  - The resulting screen display quality is better than standard rendering in ArcMap.
Anti-aliasing

Tiles are rendered at finer resolution followed by down sampling.
- Smooths the edges of labels and lines by blending them with the background.
- The resulting screen display quality is better than standard rendering in ArcMap.
Caching map services that may overlay other services

- **Boundaries, Streets, Thematic Polygons**
- **Use PNG format for Transparency**
- **Background Color**
  - Explicitly define it
  - Use a color not used in Symbology (e.g., RGB(1,2,3))
  - Use dark backgrounds when overlaying anti-aliased lines or labels on imagery
Impact of Tile Size selection

- **Larger size produces fewer tiles**
  - Less disk space (block size)
  - Faster creation, Easier to manage

- **Smaller size**
  - Allows partial update of the display

- **Example: Oahu**

<table>
<thead>
<tr>
<th>Tile Size</th>
<th>Files</th>
<th>Size on Disk</th>
<th>Creation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>512x512</td>
<td>19K</td>
<td>0.2 GB</td>
<td>1 hour</td>
</tr>
<tr>
<td>128x128</td>
<td>311K</td>
<td>1.2 GB</td>
<td>5 hours</td>
</tr>
</tbody>
</table>
## Impact of Scale selection

**StreetMap USA**
- 48 states
- Cached on 6 dual-CPU servers

<table>
<thead>
<tr>
<th>Scale</th>
<th>Files</th>
<th>Creation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:500K</td>
<td>4K</td>
<td>2 min</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1:64K</td>
<td>0.3M</td>
<td>2 hours</td>
</tr>
<tr>
<td>1:32K</td>
<td>1.1M</td>
<td>4.5 hours</td>
</tr>
<tr>
<td>1:16K</td>
<td>4.7M</td>
<td>37 hours</td>
</tr>
</tbody>
</table>

Total Size on Disk: 57 GB
Bottlenecks

- Threading
- Memory
- CPU
- Disk
- Network
Disk Bottlenecks

• Problem: Disk contention
  • Output: Temporary files returned to the user as output
  • Cache: Pre-rendered map and globe tiles.
  • Jobs: Files needed by geoprocessing services
  • Data source
  • Page File

• Solutions
  – Network Attached Storage (NAS)
  – Fast SCSI III drives
  – Fast Network between storage and server.
Bottlenecks

- Threading
- Memory
- CPU
- Disk
- Network
Scaling Out – Adding More ArcGIS Server Components

Web Client

Web Server (IIS 6)

ArcGIS Server 9.2

ArcGIS Server 9.2
Server Object Manager

ArcGIS Server 9.2

Server Object Container
Distributed Installs:

• The following topics in the online help provide complete instructions for a distributed install:

  – How the GIS Server Works
  – Configuring a Distributed Installation of ArcGIS Server

• The online help can be found at the following URLs:
Distributed Installs:

• **Highlights**

  – Determine which ArcGIS Server Components to scale to additional machines.

  – Run the required post-installs

  – Add required OS users and groups

  – Configure required server directories
Distributed Installs: Required OS Users and Groups

**Web Server**
- Web Applications Post Install
  - ArcGIS Web services account
- Administrators
- Domain admin users

**SOM**
- GIS Server Post Install
  - SOM account
  - SOC account
  - ArcGIS Web services account
  - agsadmin
  - ArcGIS Web services account
  - Domain admin users

**SOC**
- GIS Server Post Install
  - SOM account
  - SOC account
  - ArcGIS Web services account
  - agsadmin
  - agsuser

**Key**
- Green text = Required post install
- Blue text = Group or account added by post install
- Red text = Group or account that you must manually add
- = Operating system group
<table>
<thead>
<tr>
<th>Server directories</th>
<th>Log directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>The SOC account should have at least Write level file permissions to these directories and Change level share permissions.</td>
<td>The SOM account needs Write level file permissions and Change level share permissions to the log directory.</td>
</tr>
<tr>
<td><strong>Server cache directory</strong></td>
<td><strong>Log directory</strong></td>
</tr>
<tr>
<td>· Create directory</td>
<td>· Share directory</td>
</tr>
<tr>
<td>· Give SOC account file permissions</td>
<td>· Give SOM account share permissions</td>
</tr>
<tr>
<td>· Share directory</td>
<td>· Set as server log directory using ArcCatalog</td>
</tr>
<tr>
<td>· Give SOC account share permissions</td>
<td></td>
</tr>
<tr>
<td>· Create virtual directory</td>
<td></td>
</tr>
<tr>
<td>· Set as server cache directory using ArcCatalog or Manager</td>
<td></td>
</tr>
<tr>
<td><strong>Server jobs directory</strong></td>
<td><strong>Data directories</strong></td>
</tr>
<tr>
<td>· Create directory</td>
<td>The SOC account needs at least Read level file permissions to data directories (Write level if the data will be edited), and Read level share permissions (Change level if the data will be edited).</td>
</tr>
<tr>
<td>· Give SOC account file permissions</td>
<td><strong>Data directory</strong></td>
</tr>
<tr>
<td>· Share directory</td>
<td>· Create directory</td>
</tr>
<tr>
<td>· Give SOC account share permissions</td>
<td>· Give SOC account file permissions</td>
</tr>
<tr>
<td>· Create virtual directory</td>
<td>· Share directory</td>
</tr>
<tr>
<td>· Set as server jobs directory using ArcCatalog or Manager</td>
<td>· Give SOC account share permissions</td>
</tr>
<tr>
<td></td>
<td>· Give domain admin users access</td>
</tr>
</tbody>
</table>
Distributed Installs: Network Considerations

• If installing in a **Workgroup**

  – Simple File Sharing must be “Off” on XP.

  – Core ArcGIS Server accounts must be local users.

  – **Local Security Policy Setting**
    • For “Network access: Sharing and security model for local accounts”
      Set to “Classic – local users authenticate as themselves”.
Scaling Out – Adding More Computing Power

Web Client

Web Server (IIS 6)
ArcGIS Server 9.2
Server Object Container
ArcGIS Server 9.2
Server Object Container
ArcGIS Server 9.2
Server Object Container
Scaling Out – Adding More Computing Power

Add Machine

Machine Name: New_Machine

Capacity (Maximum number of instances): <Unlimited>

Description:

ArcGIS Server Properties

The list below shows the machines available to host services.
NOTE: you need to add at least one machine to use the server.

<table>
<thead>
<tr>
<th>Machine Name</th>
<th>Description</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>napoleon14</td>
<td></td>
<td>&lt;Unlimited&gt;</td>
</tr>
</tbody>
</table>
Detecting Bottlenecks

- Single user testing is inadequate

- Simulating multiple users
  - Low Tech:
    - Recruit others in the office
  - High Tech: Load simulation tool
    - Web Application Stress Tool (WAST)
    - Application Center Test (ACT)
    - Visual Studio 2005 Team Edition for Testers
Test Strategy for ArcGIS Online

• Static Maps and Globe

• Performance depends on web server’s ability to deliver tiles.

• High volume load test
  – Random request for tiles
  – …popular tiles requested more frequently
Sub Main()
    Dim ResponseBody, JobID, JobStatus
    While true
        Host = "Napoleon14"
        call SOAP_Request(PrefixSOAP + SubmitJob + SuffixSOAP, ResponseBody)
        JobID = ExtractResult(ResponseBody)
        JobStatus = ""
        Test.Sleep(3000)

        'Poll Job Status
        While JobStatus <> "esriJobSucceeded"
            Host = "10.49.102.37"
            call SOAP_Request(PrefixSOAP + "<tns:GetJobStatus><JobID>" + JobID + "</JobID>", JobStatus = ExtractResult(ResponseBody)
            If JobStatus <> "esriJobSucceeded" Then Test.Sleep(1000)
        Wend
    Wend
End Sub
Application Center Test
Application Center Test
Additional Information

How To: Use ACT to Test Web Services Performance
Improving .NET Application Performance and Scalability
J.D. Meier, Srinath Vasireddy, Ashish Babbar, and Alex Mackman
Microsoft Corporation, May 2004

Monitor Statistics and Log Files

- Creation Time
- Wait Time
- Usage Time
Security: Overview

• **Server Communications Architecture Overview**

• **Core Server Security**
  - Firewalls
  - Proxy Servers

• **Application Security**
  - Encryption
  - Authentication
  - Authorization
  - Reverse Proxy Servers
ArcGIS Server Communications Architecture

- **SOAP over HTTP** between clients and web server tier.
  - There is no direct SOAP transfer between web clients and the application tier.

- **SOAP/Binary over DCOM** between desktop clients and application server using local connections.

- **SOAP/Binary over DCOM** between web server tier and application server.
  - Exception: Service is a client to another service.
Core Server Security: Firewalls

- **Firewalls** between ArcGIS Server components **not recommended.**
  - Use a DMZ Reverse-Proxy to protect your Server from the internet.

- **NAT Firewalls**
  - Will not work
    - **NAT** makes internal IPs inaccessible to external COM clients.

- **Non-NAT Firewall**
  - Not Recommended
    - Must open range of ports that can quickly become saturated.

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**HowTo: Configure ArcGIS Server for firewalls and NAT devices**

[http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=28703](http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=28703)
Core Server Security: Firewalls

- **Windows Firewall**
  - Not recommended for server class deployments
  - **HowTo:** Configure Windows XP SP2 Firewall to work with ArcGIS Server
    - [http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=27798](http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=27798)
Core Server Security: Proxy Servers

- **ArcCatalog** and other **ArcGIS Desktop Applications**
- When making connections to ArcGIS Server Servers and Services.

![Options dialog box showing proxy server configuration](image)
Core Server Security: Proxy Servers

- For ArcGIS Server Application Server Components (SOC)

  - When Service is a client
    - Geodatabase service synching
    - Service containing web reference to another service
    - Configure in ArcGIS Server post-install.

![GIS Server Post Install](image)
Core Server Security: Proxy Servers

- For the .NET Manager web application when it, itself, is a client to web services.
  - Example: Adding web services while authoring a web application
  - Alter Proxy Server settings in IE (IIS applications inherit)
Core Server Security: Proxy Servers

• For the **Java Manager** web application when it, itself, is a client to web services.

  – Example: When adding web services while authoring a web application

  – Alter Proxy Server settings in the JVM of the embedded Tomcat servlet engine (embedded Tomcat applications inherit)

    • `%AGSHOME%/javajava\manager\service\jre`

    • [http://java.sun.com/j2se/1.5.0/docs/guide/net/proxies.html](http://java.sun.com/j2se/1.5.0/docs/guide/net/proxies.html)
ADF applications and ArcGIS Server services are standard web applications and services.

Use standard web application security approaches for:

- Encryption
- Authentication
- Authorization
Web Applications and Services Security

• Encryption (SSL)
  – Install SSL server certificates into ADF and ArcGIS Server Web Services web servers.

• Instructions available from any Certificate Authority

– Install SSL client certificates into ArcGIS Desktop libcurl store.
Web Applications and Services Security

- **Encryption (SSL)**
  - Install SSL client certificates into ArcGIS Desktop libcurl certificate bundle.
    - [http://curl.haxx.se/docs/sslcerts.html](http://curl.haxx.se/docs/sslcerts.html)
    - Add path to libcurl certificate bundle in ArcCatalog.
Web Applications and Services Security

- **Authentication**
  - Basic and Digest
    - Web application server provides framework to authenticate users.
    - Basic is completely unencrypted.
    - Digest is encrypted, but may suffer from different implementations on IIS and Apache.
    - Neither is recommended unless using with SSL.

- **Forms**
  - Web application provides authentication for users.
  - Username/password is not encrypted.
  - Not recommended unless using with SSL.
Web Applications and Services Security

• Authentication

  – Windows integrated (IIS only)
    • Similar to Basic/Digest, but uses a different transmission scheme.
    • IE Users may not be challenged if they are logged into the OS.
    • Only works over intra-net.

  – Client-Cert
    • Uses encrypted certificates to authenticate both server and user.
Web Applications and Services Security

- **Authorization**
  - User-role mapping
    - Access Control List files
    - Databases
    - web.config

- **Single Sign On**
  - Combines Authentication and Authorization
Web Applications and Services Security

• **Reverse-Proxy Servers**
  
  – Recommended to avoid firewall between ArcGIS Server components.
• **Reverse-Proxy Servers**

  – **IIS** has no native reverse-proxy server, but many 3rd party solutions exist.

  • Microsoft ISA Server contains a reverse-proxy server (expensive for just a reverse-proxy server)

  • Isapi rewrite (~$70.00)

  • Write your own:
Web Applications and Services Security

- Reverse-Proxy Servers

  - Apache

  - HowTo: Configure ArcGIS Server for the Microsoft .NET Framework to work with a Reverse Proxy. [Link](http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=32634)

  - HowTo: Configure ArcGIS Server Java to work with a Reverse Proxy. (Coming Soon)
Summary

• Performance
  – Detecting and Analyzing Performance Bottlenecks
  – Best practices for avoiding Threading, Memory, CPU, Disk and Network bottlenecks.

• Deployment
  – Distributed Installations of ArcGIS Server
  – High Availability Configurations
  – Security
Further questions?

• TECH-TALK AREAS
  – **What:** Further opportunity to discuss questions and concerns about performance, deployment and security.
  – **Where:** Tech Talk Area 1, Oasis 3A
  – **When:** during the next 30 minutes

• ESRI Showcase

• ESRI Developers Network (EDN) website
Session Evaluations Reminder

Session Attendees:
Please turn in your session evaluations.

... Thank you