ArcGIS Enterprise: Performance and Scalability Best Practices

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Agenda
ArcGIS Enterprise: Performance and Scalability Best Practices

- ArcGIS Enterprise overview
- ArcGIS Server site design and administration consideration
- Performance concepts
- Scaling and Workload separation
- Sizing, testing and monitoring: process and tools
- Infrastructure Capacity Planning
- Performance Testing
- Monitoring ArcGIS Enterprise
- Use Cases
- Tools
ArcGIS Enterprise
What are the core components of ArcGIS Enterprise?


- ArcGIS Web Adaptor
- Portal for ArcGIS
- ArcGIS Server
- ArcGIS Data Store
Scaling and workload separation
Workload Separation

Initial Deployment

Complete GIS
Server Roles

- Follow best practices on workload separation and assign only one server role per ArcGIS Server site.

- If small site and consider combining multiple server roles in a single site:
  - Be careful combining GIS Server role with other server roles.
  - Be careful combining Image Server role with other server roles.
  - Avoid combining GeoEvent Server role with other server roles.
  - Never combine GeoAnalytics Server role with any other server role.
Scaling the base ArcGIS Enterprise deployment

• Conduct capacity planning and testing
• Add machine to hosting server as needed, especially when using:
  - Spatial analysis tools
  - Insights for ArcGIS
ArcGIS Server
Site design and administration consideration
ArcGIS Server site design: Silos, Sites & Clusters

- **Silo**
  - Configuration Stores
  - LB

- **Site recommended**
  - Configuration Store *(shared)*
  - LB

- **Cluster To be deprecated**
  - Configuration Store *(shared)*
  - LB
  - Cluster A
  - Cluster B
ArcGIS Server site design and management consideration
Multi-node, high number of services

- Ensure require infrastructure resources
  - Network stability
  - NAS stability for ArcGIS Server and Portal config stores
  - RAM
  - CPU
- Avoid during the working hrs:
  - Publishing high number services
  - Adding/removing nodes
- Distribute recycle times
ArcGIS Server site design and management consideration

- Identify unused services and reduce min (to 0 if possible)
- Tune slow services
- Provide best practices to the publishers
- Monitor resources:
  - RAM and committed memory
  - CPU
  - Network latency

All available as part of System Monitor, https://systemmonitoring-emcs.esri.com/ (esridemo/esridemo)
Performance concepts
Performance

- Speed, e.g. response time (seconds)
Scalability

- The ability to increase output and maintain acceptable performance
Capacity

- The maximum level of output the system can produce, e.g.
- $X$ cars/sec
- $X$ maps/sec
Bottleneck

• Resource(s) limiting the performance or capacity

Not bottleneck

Think of:
- Lanes - as CPU processor
- Toll - as ArcGIS Server instances
- Cars - as map requests

bottleneck
Throughput (request/hr)
Resource utilization: CPU, Memory, Network

- CPU Utilization (%)
- Throughput (req/hr)
- Network used (Mbps)
- Memory used (Mb)
- Response Time (sec)

Step Load (users)
Capacity

User load
Throughput (req/hr)
CPU Utilization (%)
Network used (Mbps)
Response Time (sec)
Memory used (Mb)
Content length (bytes)

Capacity (~ 85% utilization)

Time
Process and Tools
Relationship between System Tools

- User Load
- CPU%
- Capacity models
- Performance Tests
System Tools framework
System Tools are not just tools

- Tool
- Patterns
- Discipline
Infrastructure Capacity Planning
Provide sufficient hardware resources
Most systems are CPU bound

GIS Systems are bound by:
1. CPU - typically
2. Memory – when large number of services
3. Disk – Image Service, Synchronization
4. Network – low bandwidth deployment
5. Poorly configured virtualization can result in 30% or higher performance degradation

Most well-configured and tuned GIS systems are CPU bound.
System Designer
Solution Architecture design methodology

- Gathering requirements
- Designing
- Capacity: CPU, Network, Memory
- Reporting
Performance Testing
**Tuning methodology**

Profile each tier starting from the top
Identify slow responses - Fiddler

Fiddler measurement approximately 5.2 seconds
Review historical data: ArcGIS Server 10.3.1 Statistics


- Total requests
- Average response time
- Maximum response time
- Timeouts
- Maximum running instances
- 30 min resolution reports
Review historical data: ArcGIS Server Logs

http://www.arcgis.com/home/item.html?id=90134fb0f1c148a48c65319287dde2f7
Review historical data: System Monitor – ArcGIS Server Statistics

- [https://systemmonitoring-emcs.esri.com/#/arcgis/ESLSRV12](https://systemmonitoring-emcs.esri.com/#/arcgis/ESLSRV12)
- User: esridemo
- Password: esridemo
Profile mxd: Mxdperfstat
http://www.arcgis.com/home/item.html?id=a269d03aa1c840638680e2902dadecac

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<th>Refresh Time (sec)</th>
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<th>Features</th>
<th>Vertices</th>
<th>Labeling</th>
<th>Geography Phase (sec)</th>
<th>Graphics Phase (sec)</th>
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<th>DBMS LIO</th>
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<th>Layer Spatial Reference</th>
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<td>csnGeometryPoint</td>
<td>GCS_WGS_1984</td>
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Analyze Oracle Trace

Compare elapsed time

Elapsed time slightly changed due to different test runs
Analyze Oracle Execution plan

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<th>Rows (1st)</th>
<th>Rows (avg)</th>
<th>Rows (max)</th>
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<tr>
<td>129600</td>
<td>129600</td>
<td>129600</td>
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</table>

**Inefficient spatial index**

- SQL query execution plan
- Optimization needed for spatial index
- Performance analysis tool provided

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**Notes:**
- Misses in library cache during parse: 1
- Misses in library cache during execute: 1
- Optimizer mode: ALL_ROWS
- Parsing user id: N4
- Number of plan statistics captured: 1
Testing process

- Application
- GIS Services
- Infrastructure: Hardware and Software
Required skill set
Configuration, Tuning, Testing
System Test Tool features

GIS Test Automation

• ArcGIS Services
  - Mapping
  - Feature Service
  - OGC
  - Geocoding
  - Image Service
  - Network Analyst
  - Geoprocessing
  - Tile Cache
• Application Testing
• Discipline relevant report
## Test tools feature comparison

<table>
<thead>
<tr>
<th>Tool</th>
<th>Cost</th>
<th>Learning Curve</th>
<th>OS Metrics</th>
<th>GIS Data Generation</th>
<th>GIS Test Automation</th>
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<td>Load Runner</td>
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<td>High</td>
<td>Windows/Linux</td>
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<td>Visual Studio</td>
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<td>Windows</td>
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<td>JMeter</td>
<td>Free</td>
<td>High</td>
<td>Requires additional plugin</td>
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<td>No</td>
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<tr>
<td>System Test</td>
<td>Free</td>
<td>Low</td>
<td>Windows/Linux</td>
<td>Yes</td>
<td>Yes</td>
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</table>

Tech Support by Esri PS as part of consulting support
Performance testing

Value

• Identify bottlenecks
• Determine system capacity
• Demonstrate performance SLA
System Test Tool features

Dynamic Map Services Benchmark: Performance

A load test is defined by a given map service and during this type of test:
1. Learn how to add ArcGIS Server services and a data to the environment.
2. Create a web test and a load test.
3. Run test and validate results.

In this tutorial, you locate a map service that is sourced to the SampleWorldCities dataset that comes included with ArcGIS Server. You identify a location that will be able to run the load test.

Important: ArcGIS Server 10.1 or higher is required. Make sure the SampleWorldCities default map service that comes with ArcGIS Server is loaded.

Scenario

Your advisor is planning to publish a world map that allows users to view cities. They would like to know what performance metrics to expect.

High Level Steps:
1. Create a project.
2. Add ArcGIS Server services.
3. Create test data.
5. Start load test.
6. Validate results.
Monitoring ArcGIS Enterprise
Monitoring ArcGIS Enterprise
Challenges

- Multiple administrators
- Multiple disparate monitoring/diagnostic tools
- Data collected in a reactive fashion: on demand and for limited time
- Correlation of data with different timestamp is difficult
- ArcGIS administrators do not have access to all tools, data and reports
- Challenging to quickly identify the root cause and take appropriate measures
Standards for effective ArcGIS Enterprise monitoring

- Many excellent monitoring tools on the market
- Challenges:
  - focus on data collection and operational information
  - not GIS “aware” out of the box
  - substantial customization to meet ArcGIS Enterprise needs
  - expertise in designing effective queries and dashboards
- System Monitor
  - can supplement existing tools or
  - be used as reference implementation
### Standards for effective ArcGIS Enterprise monitoring

**Selecting the right monitoring tool for ArcGIS Enterprise**

<table>
<thead>
<tr>
<th>Holistic monitoring of all tiers:</th>
<th>✓</th>
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<tr>
<td>Web Application</td>
<td>✓</td>
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<tr>
<td>Network</td>
<td>✓</td>
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<tr>
<td>Web Server</td>
<td>✓</td>
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<tr>
<td>RDBMS: Oracle, SQL, Postgresql</td>
<td>✓</td>
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<tr>
<td>Windows: CPU, Mem, Network, Disk</td>
<td>✓</td>
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<tr>
<td>Linux: CPU, Mem, Network, Disk</td>
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<tr>
<td>Custom extensions</td>
<td>✓</td>
</tr>
<tr>
<td>Non-Intrusive monitoring (no agents)</td>
<td>✓</td>
</tr>
<tr>
<td>Esri components:</td>
<td>✓</td>
</tr>
<tr>
<td>Portal for ArcGIS Server</td>
<td>✓</td>
</tr>
<tr>
<td>ArcGIS Server</td>
<td>✓</td>
</tr>
<tr>
<td>Geodatabase</td>
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</tr>
<tr>
<td>Collection Intervals:</td>
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<td>1 min</td>
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<td>5 min</td>
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<td>30 min</td>
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<tr>
<td>hourly</td>
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<tr>
<td>Data aggregation:</td>
<td>✓</td>
</tr>
<tr>
<td>hourly</td>
<td>✓</td>
</tr>
<tr>
<td>daily</td>
<td>✓</td>
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<tr>
<td>High volume collection</td>
<td>10,000 stats/sec or greater</td>
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<tr>
<td>Statistical Analysis</td>
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</tbody>
</table>

| Raw data retention               | 15-90 days |
| Raw data statistics retention    | always     |
| Aggregate data retention         | 2-5 years  |
| Actionable Reports:             | ✓ |
| Templates                        | ✓ |
| Custom                            | ✓ |
| Real time                         | ✓ |
| Hourly                           | ✓ |
| Daily                             | ✓ |
| Monthly                           | ✓ |
| Alerts and Notification           | ✓ |
| On-premise option                 | ✓ |
| Cloud option                      | ✓ |
| Costs and LOE:                   | $0 |
| Installation                     | simple (30 min) |
| Configuration                    | simple (30 min) |
| Enterprise System consulting experts | ✓ |
| Proven track record of fixing real problem | ✓ |
| Overall ROI                      | High |
Standards for effective ArcGIS Enterprise monitoring: Single Spike
Max very high while other stats low
Word of caution about averages
Do not use averages without additional statistics

If we stick a head into a freezer (20 degrees) and feet into oven (140 degrees), average temperature would be “comfortable” 80 degrees.
Word of caution about small samples size

- What are the height statistics?
  - Sample size is 1
    - Min=p5=avg=p95=p99=max
  - Sample size is 2
    - Min=p5
    - p95=p99=max

Always check if sample size sufficient (ideally >100)
Standards for effective ArcGIS Enterprise monitoring
Selecting the right monitoring tool for ArcGIS Enterprise

• Evaluate based on how effective in resolving real problems:
  - Why monitor a problem if you don’t fix it?
  - Source: LifeLock Dentist Commercial 30: https://www.youtube.com/watch?v=k8piX3PCsx4
Standards for effective ArcGIS Enterprise monitoring

“PIECE” of mind with System Monitor

- **Proactive**
- **Integrated**
  - Dashboards across all tiers
- **End-to-End**
  - All tier monitoring
- **Continuous**
  - %Coverage provided
- **Extendable**
  - Custom queries

Key Performance Indicators:

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<tr>
<th></th>
<th>% Coverage</th>
<th>% Uptime</th>
<th>% Alert</th>
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<tr>
<td>1</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
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<tr>
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<tr>
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<td>6</td>
<td>100.00</td>
<td>98.75</td>
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</table>
Standards for effective ArcGIS Enterprise monitoring

Value

- Proactive validation:
  - Configuration
  - Resource Utilization
  - Usage Trends
  - Performance SLA
  - Uptime SLA
Standards for effective ArcGIS Enterprise monitoring
Actionable information and reports for different audience
Benefits of ArcGIS Enterprise monitoring

- **The key customer benefits:**
  - reduced administration costs
  - **improved users satisfaction**

- **This is accomplished through**
  - Early detection of problems
  - Quantification of uptime, performance, utilization
  - Identifying over and under-utilized resources
  - Usage trends
  - Reduce the risk of sizing and performance-related problems for complex enterprise-level Platform and custom application development projects.
  - **Improved customer communications between GIS and IT**
  - **Reduce the number of Technical Support** incidents regarding system architecture and performance-related problems.
ArcGIS Enterprise
Use cases
## Impact of maintenance window

### System Monitor Excel Report

<table>
<thead>
<tr>
<th>Folder</th>
<th>Service</th>
<th>Avg(sec)</th>
<th>Max(sec)</th>
<th>Date</th>
<th>Hour</th>
<th>Weekday</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>CENSUS_EXT</td>
<td>CD_ACS_5Y13</td>
<td>81.68</td>
<td>326.73</td>
<td>2016-04-23 03:00:00-07:00</td>
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<td>UCVU_DC_2010</td>
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High CPU – site restart
Monitor memory and ArcGIS Server instances
Monitor memory and ArcGIS Server instances

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<thead>
<tr>
<th>Site</th>
<th>Cluster</th>
<th>folder</th>
<th>Service</th>
<th>ServiceType</th>
<th>MaxInstances</th>
<th>FreeInstMin</th>
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<th>BusyInstMax</th>
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<td>instances.</td>
</tr>
</tbody>
</table>
Monitor memory and ArcGIS Server instances

- Resource(s) limiting the performance or capacity

Think of:
- Lanes - as CPU processor
- Toll - as ArcGIS Server instances
- Cars - as map requests
Monitor network between ArcGIS components

Critical to have communication to config store and nodes
Network fluctuation
This site experienced periodical instability
Equal Interval Spike
Max, p99, 95 high; avg low

Equal Interval Spikes

<table>
<thead>
<tr>
<th>Min</th>
<th>Avg</th>
<th>P95</th>
<th>P99</th>
<th>Max</th>
<th>Samples</th>
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<tbody>
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<td>0</td>
<td>19</td>
<td>95</td>
<td>99</td>
<td>99</td>
<td>100</td>
</tr>
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</table>

![Graph showing equal interval spikes with statistics table and data points over time.](image_url)
Monitor Network Time with Web Application extension
Monitor virtual resource in ArcGIS Enterprise
Avoid over allocation and live migration of running virtual machines during work hours
<table>
<thead>
<tr>
<th>Level</th>
<th>Architectural Design and Capacity Planning</th>
<th>Performance and Scalability Testing</th>
<th>Monitoring</th>
<th>Trend Analysis and Quantification</th>
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Try these ArcGIS Enterprise tools

- [https://systemmonitoring-emcs.esri.com/apps](https://systemmonitoring-emcs.esri.com/apps)

*System Monitor 3.0 available through Professional Services engagement. Contact your or account management*
Try System Monitor
Follow System Monitor Quick Starts

Customer

System Monitor Collector
- 1 CPU cores
- 1 GB RAM
- 1 GB Disk

SM Desktop

Proxy Server

Collector (Windows Service, IWA)

SM Portal

Target environment (Counters)

WMI (IWA)

JSN (Named user)

HTTP (files)

HTTPS (token)

Cuda (Named user)

Access/Secret KEY

SSL, Token Authentication (Indefinite, push only)

One way from Collector to Report server

Reporter and Repository
managed by Esri in Amazon
AWS Cloud

Reporter (Windows Service)

https://monitoring-emcs.esri.com
Token Authentication

Encrypted passwords (RSA 256)
37017 (Configurable)

Assigned available port

Externalization
Demo Show Case

https://systemmonitoring-emcs.esri.com/apps
Q & A