Enterprise GIS - Designing, Testing and Monitoring

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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
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

Cluster A

Cluster B

Site recommended

To be deprecated

Configuration Stores

Configuration Store

(shared)

Configuration Store

(shared)

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

Think of:
- Lanes - as CPU processor
- Toll - as ArcGIS Server instances
- Cars - as map requests
Step Load and Response Time

![Graph showing Step Load (users) vs. Response Time (sec) over time.](image)
Throughput (request/hr)
Resource utilization: CPU, Memory, Network

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

(time)
Capacity

Capacity (~ 85% utilization)
Process and Tools
Process and Tools
Relationship between System Tools

System Designer

User Load
CPU%
Capacity models

System Monitor

Performance Tests

System Test
System Tools framework
System Tools are not just tools

- Discipline
- Patterns
- Tool
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 Tuning
Tuning methodology
Profile each tier starting from the top

- Total Response Time (t1-t2)
- Wait Time
- Usage Time
- Search & Retrieval Time
- Browser
- Web Server
- ArcGIS Server
- ArcSOC
- ArcSDE/DBMS
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/apps](https://systemmonitoring-emcs.esri.com/apps)

<table>
<thead>
<tr>
<th>Alerting</th>
<th>Name</th>
<th>Folder</th>
<th>Type</th>
<th>Throughput (Tr/sec)</th>
<th>Busy Time per Tr (sec)</th>
<th>Transactions</th>
<th>Max</th>
<th>Busy</th>
<th>Free</th>
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<td>2</td>
<td>0</td>
<td>1</td>
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Profile mxd: Mxdperfstat

http://www.arcgis.com/home/item.html?id=a269d03aa1c840638680e2902dadecac

### Table 1: Item Details

<table>
<thead>
<tr>
<th>Item</th>
<th>At Scale</th>
<th>Layer Name</th>
<th>Refresh Time (sec)</th>
<th>Recommendations</th>
<th>Features</th>
<th>Vertices</th>
<th>Labeling</th>
<th>Geography Phase (sec)</th>
<th>Graphics Phase (sec)</th>
<th>Cursor Phase (sec)</th>
<th>DBMS CPU</th>
<th>DBMS LIO</th>
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<td>1</td>
<td>167,935,665</td>
<td>SDE_GridPoint</td>
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<td>run DBMS trace; oraCPU=4.74; run DBMS trace; check oracle execution plan; oraLIO=130,936; check if index exist for query def attributes</td>
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<td>4.74</td>
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### Table 2: Source Details

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<td>csnIDBMS_Oracle,asakowicz,sde;oracle$asakowicz:1521/gis2,sde</td>
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<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>
<th>Row Source Operation</th>
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<td>1998</td>
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<td>1998</td>
<td>1998</td>
<td>1998</td>
<td>UNION-ALL cr=131605 pr=0 pw=0 time=511602 us</td>
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<td>1998</td>
<td>1998</td>
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<td>1998</td>
<td>1998</td>
<td>TABLE ACCESS BY INDEX ROWID GRIDPOINT cr=131451 pr=0 pw=0 time=4</td>
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<td>1998</td>
<td>1998</td>
<td>1998</td>
<td>DOMAIN INDEX cr=131451 pr=0 pw=0 time=4</td>
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<tr>
<td>1998</td>
<td>1998</td>
<td>1998</td>
<td>INDEX RANGE SCAN DSK_PK cr=0 pr=0 pw=0 time=2101 us cost=0 size=44</td>
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<tr>
<td>1998</td>
<td>1998</td>
<td>1998</td>
<td>INDEX UNIQUE SCAN LINESIES_PK cr=0 pr=0 pw=0 time=0 us cost=0 size=44</td>
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<tr>
<td>1998</td>
<td>1998</td>
<td>1998</td>
<td>NESTED LOOPS ANI cr=154 pr=0 pw=0 time=2242 us cost=5 size=2592</td>
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<td>1998</td>
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<tr>
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<td>1998</td>
<td>1998</td>
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<td>1998</td>
<td>1998</td>
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<tr>
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<td>BITMAP AND cr=154 pr=0 pw=0 time=2242 us</td>
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<td>1998</td>
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<td>1998</td>
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<td>1998</td>
<td>DOMAIN INDEX cr=0 pr=0 pw=0 time=1769 us</td>
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<td>1998</td>
<td>FILTER cr=0 pr=0 pw=0 time=0 us</td>
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<td>INDEX UNIQUE SCAN LINESIES_PK cr=0 pr=0 pw=0 time=0 us cost=0 size=44</td>
</tr>
</tbody>
</table>

Inefficient spatial index
Performance Testing
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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</thead>
<tbody>
<tr>
<td>Load Runner</td>
<td>High</td>
<td>High</td>
<td>Windows/Linux</td>
<td>No</td>
<td>No</td>
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<td>Visual Studio</td>
<td>Medium</td>
<td>High</td>
<td>Windows</td>
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<td>No</td>
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<tr>
<td>JMeter</td>
<td>Free</td>
<td>High</td>
<td>Requires additional plugin</td>
<td>No</td>
<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 testing:
1. Learn how to add ArcGIS Server services and a data to the load test.
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 scenario that is 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 tested.

Scenario

Your supervisor 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

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

| 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: | |
| License: | $0 |
| Installation: | simple (30 min) |
| Configuration: | simple (30 min) |
| Enterprise System consulting expertise: | ✓ |
| Proven track record of fixing real problems: | ✓ |
| Overall ROI: | High |
Standards for effective ArcGIS Enterprise monitoring: Statistics

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 temperate would be “comfortable” 80 degrees
Word of caution about small samples size

- What are the height statistics?
  - Sample size is 1
    - Min=\( p_{5} = \text{avg} = p_{95} = p_{99} = \text{max} \)
  - Sample size is 2
    - Min=\( p_{5} \)
    - \( p_{95} = p_{99} = \text{max} \)

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

<table>
<thead>
<tr>
<th></th>
<th>% Coverage</th>
<th>% Uptime</th>
<th>% Alert</th>
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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

Time span
- Now
- Day
- Week
- Month

Audience
- Admins
- Users
- Managers
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.
Key monitoring categories

Interdependency between load, resources, performance and configuration
User case: Insufficient hardware resources
User case: Increased user load or published slow services
User case: Under configured ArcGIS server instances
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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<tbody>
<tr>
<td>CENSUS_EXT</td>
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<tr>
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<td>Saturday</td>
<td>Investigate slow response times.</td>
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</table>
High CPU – site restart
Monitor memory and ArcGIS Server instances
Min, Max, Free, Busy instances
Monitor memory and ArcGIS Server instances

<table>
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<tr>
<th>Site</th>
<th>Cluster</th>
<th>folder</th>
<th>Service</th>
<th>Service Type</th>
<th>MaxInstances</th>
<th>FreeInstMin</th>
<th>FreeInstMax</th>
<th>BusyInstMax</th>
<th>Comments</th>
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<tbody>
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<td>S-10495_ags</td>
<td>GIS1</td>
<td>Global_PortsBerths_GM</td>
<td>MapServer</td>
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</tr>
</tbody>
</table>
Monitor network between ArcGIS components

Critical to have communication to config store and nodes
Network fluctuation
This site experienced periodical instability
Equal Interval spikes are likely batch jobs
Monitor Server and 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>Collection Status</th>
<th>Alerting</th>
<th>Collecting</th>
<th>Name</th>
<th>Type</th>
<th>Interval</th>
<th>Last Update</th>
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<td>✔️</td>
<td>VMHosts</td>
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<td>Feb 12, 2017 11:22:15 PM</td>
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<table>
<thead>
<tr>
<th>Counter Status</th>
<th>Alerting</th>
<th>Collecting</th>
<th>Last Update</th>
<th>Name</th>
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<td>✔️</td>
<td>Feb 12, 2017 11:22:15 PM</td>
<td>cpu.usage.average(%) (psveredh5.esri.com)</td>
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<td>✔️</td>
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</table>
## Enterprise Implementation Maturity Model

<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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<td>No</td>
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<td>No</td>
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<tr>
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</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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

Collector (Windows Service, IWA)

Proxy Server

SM Desktop

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

WMI (IWA)

ESNI (Named user)

https (token)

Cjdbc (Named user)

Access/Secret KEY

Target environment (Counters)

Windows Server
Linux Server
Web Server
ArcGIS Server

Geodatabase
Oracle
SQL Server

Report and Repository
managed by Esri in Amazon
AWS Cloud

SSL, Token Authentication
(Indefinite, push only)

One way from
Collector to
Report server

Report (Windows Service)

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

Encrypted
passwords
(RSA 256)

Assigned
available port

37017
(Configurable)
Demo Show Case

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