ArcGIS Enterprise Performance and Scalability Best Practices

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Agenda

• Definitions
• Design workload separation
• Provide adequate infrastructure capacity
• Configure
• Tune
• Test
• Monitor
Definitions
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
Capacity

Capacity (~ 85% utilization)
Process, Tools, Value
Process and tools

Esri tools
Tools download location

- **ArcGIS Monitor**
  - https://my.esri.com/

- **Others**
  - http://www.arcgis.com
  - owner:EnterprisImp
  - Show ArcGIS Desktop Content
## 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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<tbody>
<tr>
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<td>No</td>
<td>No</td>
<td>No</td>
</tr>
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<td>2</td>
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<td>Yes</td>
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<tr>
<td>3</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>
Design workload separation
ArcGIS Server sites

- Pre-planning is important
- Isolate hosting server site from traditional GIS Server duties
- Have dedicated GIS Server sites for various purposes:
  - heavily used map services, geoprocessing services, …
Provide adequate infrastructure capacity
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.
## Infrastructure

### Memory requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcSOC Map</td>
<td>50 MB</td>
<td>500 MB</td>
</tr>
<tr>
<td>ArcSOC Image</td>
<td>20 MB</td>
<td>1,024 MB</td>
</tr>
<tr>
<td>ArcSOC GP</td>
<td>100 MB</td>
<td>2,000 MB</td>
</tr>
<tr>
<td>XenApp Session</td>
<td>500 MB</td>
<td>1.2 GB</td>
</tr>
<tr>
<td>Database Session</td>
<td>10 MB</td>
<td>75 MB</td>
</tr>
<tr>
<td>Database Cache</td>
<td>200 MB</td>
<td>200 GB</td>
</tr>
</tbody>
</table>

*Wide ranges of memory consumptions*
Server CPU Spec

- Performance is impacted by SPEC Rate Per Core
- Scalability is impacted by number of cores and SPEC Rate Per Core
Network Planning
Establish and Configure DNS Appropriately!

Trace Route: LA Workstation → Phoenix DNS
LA Database Server
VM – watch out for overallocations

- 88/314 = 0.28 CPU/vm
- 92/176 = 0.52 CPU/vm

119722 vMotion Migrations
Scaling Direction

- **Scaling up**
  - Adding resources to your existing machine
  - Usually RAM
  - Commonly, due to lots of service instances

- **Scaling out**
  - Add more machines
  - Usually to get more compute power, sometimes for high availability
  - Commonly, due to increased user demand
Configure
File Geodatabase

- Local file geodatabase data
  - Better than shapefiles
  - Fastest
  - Scales with hardware
  - Best with static data
  - Make your FGDB read-only
Enterprise Geodatabase

- Fast
- Live data
- Requires database expert
- Traditional Versioning
  - fine for desktop editing, may be problematic for server
- Branch Versioning
  - New with Pro 2.1 and Enterprise 10.6. Not supported with ArcMap.
  - Designed for better scalability with many concurrent users and a web editing model

Keep statistics up-to-date
Index fields that will be queried
Configure Web Map
Cache and generalize data

- Use **generalized data** if applicable
- Cache (tiles) may reduce the amount of traffic
- Large amounts of data can be slow and overwhelming
  - Aggregate data using smart mapping
  - **on-the-fly generalization** and smaller data transfer (quantization)
Consolidate and reduce number of services

- Common setup today:

  - Enterprise portal
    - Web Layer
    - Web Layer
    - Web Layer
  - GIS Server
    - GIS Service
    - GIS Service
    - GIS Service
  - Data Store
    - Dataset
Consolidate and reduce number of services

- More efficient: consolidate layers with like security into a single service
Consolidate and reduce number of services
Configure login for your Enterprise portal

Login settings

- Identity and group stores can affect login performance significantly
- Example: Active Directory where users are in many groups can affect performance (newer releases handle this better)
Configure ArcGIS Server- instance tuning

- For predictable performance use \( \text{min} = \text{max} \)
- Default is \( \text{min} = 1, \text{max} = 2 \). Consider changing this!
- Allocate required swap space/page file
- Cached service: set \( \text{max} = 1 \) to conserve memory. Individual tile requests not serviced by the SOC process.
New ArcGIS Server 10.7 shared instances

- Recommended for services that receive infrequent requests, particularly when the server site hosts many services
- Pool of processes supporting multiple services
- Conserves memory

Currently supports only map services published from ArcGIS Pro
Use Case: Implementing ArcSOC Optimizer at ExxonMobil
ArcSOC Optimizer is an ArcGIS Monitor extension

- Decrease or increase instances, based on:
  1. historical usage
  2. available memory and process count
### ArcSOC Optimizer

**30 day decreases instances**

```
config30days.json

```json```
"SLA" : {
    "ArcSOCSLA": 200,
    "processesComment" : "http://sup:
    "MemFreeSLA(GB)": 4,
    "arcSOCGB": 0.25
}

"LowUsageGroup": {
    "usageSecLT": 40,
    "minInstancesPerNode": 0,
    "maxInstancesPerNode": 2,
    "execute": "True"
}

"StandardUsageGroup": {
    "maxInstancesPerNodeIncrement": 2,
    "minStat": "p95",
    "maxStat": "max",
    "execute": "True"
}
```json```

### 1 day increases instances

```
config1day.json

```json```
"SLA" : {
    "ArcSOCSLA": 200,
    "processesComment" : "http://sup:
    "MemFreeSLA(GB)": 4,
    "arcSOCGB": 0.25
}

"LowUsageGroup": {
    "usageSecLT": 20,
    "minInstancesPerNode": 0,
    "maxInstancesPerNode": 2,
    "execute": "False"
}

"StandardUsageGroup": {
    "maxInstancesPerNodeIncrement": 2,
    "minStat": "p95",
    "maxStat": "max",
    "execute": "True"
}
```json```

---

The ArcSOC Optimizer adjusts the number of instances based on SLA adherence over different periods. **30 day decreases instances** refer to settings that reduce the number of instances when the SLA is not met over a 30-day period. **1 day increases instances** indicate settings that increase the number of instances when the SLA is not met over a 1-day period.
The Issue

• What
  - ArcGIS Server instability & frequent outages

• Why
  - Rapid growth of WebGIS
  - Time required to increase server capacity
  - Manual adjustment of ArcSOC processes

• The bottom line
  - Reactive & unsustainable service management paradigm
  - Unhappy WebGIS users
Results & Benefits

• Initial run
  • Significant reduction of total number of SOCs
  • Increase in free memory
  • Identification of over utilized services
Results & Benefits

- The results speak for themselves
  - Vastly improved stability of ArcGIS Server
  - Improved response times of services
  - Staff time freed for other activities
  - Happy WebGIS users!!!
Tune
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
Fiddler

Fiddler measurement approximately 5.2 seconds
## Mxdperfstat

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

<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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<tr>
<td>1</td>
<td>167,935,665</td>
<td>SDE.GridPoint</td>
<td>4.75</td>
<td>run DBMS trace; oraCPU=4.74; run DBMS trace; check oracle</td>
<td>1,998</td>
<td>False</td>
<td>4.74</td>
<td>.00</td>
<td>4.56</td>
<td>4.74</td>
<td>4.74</td>
<td>130,936</td>
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</table>

<table>
<thead>
<tr>
<th>DBMS LIO</th>
<th>DBMS PIO</th>
<th>Source</th>
<th>LayerType</th>
<th>Layer Spatial Reference</th>
<th>LayerQueryDef</th>
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<tr>
<td>130,936</td>
<td></td>
<td>csnIDBMS_Oracle,asakowicz,sde:oracle$asakowicz:1521/gis2,sde</td>
<td>csnGeometryPoint</td>
<td>GCS_WGS_1984</td>
<td>ID&lt;1000</td>
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</tbody>
</table>
Oracle Trace

Compare elapsed time

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

### Inefficient spatial index

<table>
<thead>
<tr>
<th>Row</th>
<th>Op Type</th>
<th>Source</th>
<th>Time</th>
<th>Cost</th>
<th>Rows (Max)</th>
<th>Cards</th>
</tr>
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<tbody>
<tr>
<td>1998</td>
<td>VIEW (cr=131605 pw=0 pw=0 time=512477 us cost=8 size=4396 card=21)</td>
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<td></td>
<td></td>
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<tr>
<td>1998</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>1998</td>
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<td>0</td>
<td>INDEX RANGE SCAN DAS_PK (cr=0 pw=0 pw=0 time=2101 us cost=0 size=0)</td>
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<tr>
<td>0</td>
<td>INDEX UNIQUE SCAN LINES_PK (cr=0 pw=0 pw=0 time=0 us cost=0 size=8)</td>
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<td></td>
<td></td>
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<td></td>
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<td>BITMAP CONVERSION FROM ROWIDS (cr=147 pw=0 pw=0 time=455 us)</td>
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<td>FILTER (cr=0 pw=0 pw=0 time=0 us)</td>
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<tr>
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</tbody>
</table>
Test
Testing Objectives

- Meet Service-Level Agreement (SLA)
- Bottlenecks analysis
- Capacity planning
- Benchmarking different alternatives
Testing process

Application

GIS Services

Infrastructure: Hardware and Software
System Test for Web
GIS Test Automation

• ArcGIS Services
  - Mapping
  - Feature Service
  - OGC
  - Geocoding
  - Image Service
  - Network Analyst
  - Geoprocessing
  - Tile Cache

• Application Testing
• Discipline relevant report
# Web 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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<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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<tr>
<td>Visual Studio</td>
<td>Medium</td>
<td>High</td>
<td>Windows</td>
<td>No</td>
<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>
</tr>
<tr>
<td>System Test</td>
<td>Free</td>
<td>Low</td>
<td>Windows/Linux</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
System Test for Web

Dynamic Map Services Benchmark: Performance

A load test is defined by a given map service and during this type of test you:
1. Learn how to add ArcGIS Server services and a data to the web application.
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 the feature a list of cities and use that 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 running.

**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.
System Test for Web
Monitor
Root Cause Analysis (RCA)

"Source" - the most downstream failing component
"Impact" – all upstream failing components

Example 1

Example 2
Overloaded system
Load exceeds the designed capacity
Example: ArcGIS Monitor usage spike

Throughput (tr/s)

<table>
<thead>
<tr>
<th>ID</th>
<th>Type</th>
<th>Tier</th>
<th>Start Time</th>
<th>End Time</th>
<th>Min</th>
<th>Level</th>
<th>Counter Name</th>
<th>Counter Instance</th>
<th>Name</th>
<th>Counter Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>82</td>
<td>Impact</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>Free = 0</td>
<td>Root:SampleWorldCities</td>
<td>ArcGIS Server</td>
<td>ArcGIS</td>
<td>Increase minimum to reduce wait time</td>
</tr>
<tr>
<td>82</td>
<td>Impact</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>Error &gt; 0</td>
<td>Root:SampleWorldCities</td>
<td>ArcGIS Server</td>
<td>ArcGIS</td>
<td>Check windows event logs</td>
</tr>
<tr>
<td>82</td>
<td>Impact</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>% Processor Time &gt; 95</td>
<td>Total</td>
<td>10.6.3.154</td>
<td>ArcGIS</td>
<td>Check for: 1 usage spikes; 2, degraded performance, 3, unused consuming CPU</td>
</tr>
<tr>
<td>82</td>
<td>Impact</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>% Processor Time &gt; 85</td>
<td>agdname-PRD-A.4G10-0c8e4adbf1786a934-usage-1</td>
<td>AYS</td>
<td>Check for: 1 usage spikes; 2, degraded performance, 3, unused consuming CPU</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>Impact</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>seconds &gt; 0.1</td>
<td>EC2AMAZON7600EE</td>
<td>CPUBenchmark_EC2AMAZON7600EE</td>
<td>Ex</td>
<td>Check for: 1 usage spikes; 2, degraded performance, 3, unused consuming CPU</td>
</tr>
<tr>
<td>82</td>
<td>Source</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>Throughput (Tiles) &gt; 5</td>
<td>Root:SampleWorldCities</td>
<td>ArcGIS Server</td>
<td>ArcGIS</td>
<td>Usage spike. Check resource utilization and settings</td>
</tr>
<tr>
<td>82</td>
<td>Source</td>
<td>ArcGIS</td>
<td>01/28/2019 10:10 AM</td>
<td>01/28/2019 10:20 AM</td>
<td>10</td>
<td>Warning</td>
<td>Throughput (Tiles) &gt; 10</td>
<td>Summary</td>
<td>ArcGIS Server</td>
<td>ArcGIS</td>
<td>Usage spike. Check resource utilization and settings</td>
</tr>
</tbody>
</table>
Bottleneck

Source

- Network
- ArcSOC min/max
- Connection Pooling

Impact

- Performance
- Stability
Example: ArcGIS Monitor free instances = 0

Bottleneck are often created by increased load
Unstable Infrastructure

Interruption to the underlying resources

Source
- Restarting
- Overallocation
- Permissions
- VMotion

Impact
- Stability
- Performance
Example: ArcGIS Monitor CPU spike by unexpected process

e.g. virous scan
Example: ArcGIS Monitor CPU Portal for ArcGIS Server service stopped
Example: ArcGIS Monitor CPU ArcGIS Server machine rebooted

<table>
<thead>
<tr>
<th>Bin</th>
<th>Type</th>
<th>Tier</th>
<th>Start Time</th>
<th>End Time</th>
<th>Min</th>
<th>Level</th>
<th>Counter Name</th>
<th>Rule</th>
<th>Counter Instance</th>
<th>Counter Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Impact</td>
<td>3</td>
<td>01/28/2019 10:50 AM</td>
<td>01/28/2019 11:00 AM</td>
<td>10</td>
<td>Warning</td>
<td>Response Time (sec) &gt; 3</td>
<td>Countries_Sql_Eggo_Draw</td>
<td>Countries_Sql_Eggo_Draw</td>
<td>CPU</td>
<td>Check CPU. Which tier(s) are responsible? (e.g., check ArcGIS DB counter logs?)</td>
</tr>
<tr>
<td>45</td>
<td>Impact</td>
<td>3</td>
<td>01/28/2019 10:50 AM</td>
<td>01/28/2019 11:00 AM</td>
<td>10</td>
<td>Warning</td>
<td>Find String = 0</td>
<td>Countries_Sql_Eggo_Draw</td>
<td>Countries_Sql_Eggo_Draw</td>
<td>CPU</td>
<td>1. Reproduce with web debugger; 2. check app and other logs</td>
</tr>
<tr>
<td>45</td>
<td>Impact</td>
<td>3</td>
<td>01/28/2019 10:50 AM</td>
<td>01/28/2019 11:00 AM</td>
<td>10</td>
<td>Warning</td>
<td>Find String = 0</td>
<td>SampleWorldCities</td>
<td>SampleWorldCities</td>
<td>CPU</td>
<td>1. Reproduce with web debugger; 2. check app and other logs</td>
</tr>
<tr>
<td>45</td>
<td>Impact</td>
<td>3</td>
<td>01/28/2019 10:50 AM</td>
<td>01/28/2019 11:00 AM</td>
<td>10</td>
<td>Warning</td>
<td>Find String NOT = 1</td>
<td>SampleWorldCities</td>
<td>SampleWorldCities</td>
<td>CPU</td>
<td>1. Reproduce with web debugger; 2. check app and other logs</td>
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<tr>
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<td>Impact</td>
<td>3</td>
<td>01/28/2019 10:50 AM</td>
<td>01/28/2019 11:00 AM</td>
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<td>Warning</td>
<td>Free &gt; 0</td>
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<td>ArcGIS Server</td>
<td>CPU</td>
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<td>01/28/2019 10:50 AM</td>
<td>01/28/2019 11:00 AM</td>
<td>10</td>
<td>Warning</td>
<td>Error &gt; 0</td>
<td>10.0.3.154</td>
<td>WinEvt.ACE</td>
<td>ArcGIS Server</td>
<td>ArcGIS Server</td>
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<tr>
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<td>Warning</td>
<td>% Processor Time &gt; 85</td>
<td>_Total</td>
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<tr>
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<td>01/28/2019 11:00 AM</td>
<td>10</td>
<td>Warning</td>
<td>% Disktime &gt; 85</td>
<td>aggdemo-FOD-00220\–reacArc0R788a034-unn-east-1</td>
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### Example: ArcGIS Monitor CPU Database not running

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<th>End Time</th>
<th>Min</th>
<th>Level</th>
<th>Counter Name</th>
<th>Role</th>
<th>Counter Instance</th>
<th>Name</th>
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<td>01/28/2019 2:20 AM</td>
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<td>Warning</td>
<td>Response Time(s) &gt; 3</td>
<td>CountriesSql_Egds_Draw</td>
<td>CountriesSql_Egds_Draw</td>
<td>$03</td>
<td>Check 1. CPU, 2. Which tiers are responsible e.g. check ArcGIS, DB, etc.</td>
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<td>Response Time(s) &gt; 3</td>
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<td>CountriesSql_Egds_Test</td>
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<td>Check 1. CPU, 2. Which tiers are responsible e.g. check ArcGIS, DB, etc.</td>
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<td>Windows AGS</td>
<td>Windows AGS</td>
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<td></td>
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</tbody>
</table>
Summary

- Design workload separation
- Provide adequate infrastructure capacity
- Configure
- Tune
- Test
- Monitor
Print Your Certificate of Attendance
Print Stations Located at L Street Bridge

**Tuesday**
12:30 pm – 6:30 pm
GIS Solutions Expo
Hall D

5:15 pm – 6:30 pm
GIS Solutions Expo Social
Hall D

**Wednesday**
10:45 am – 5:15 pm
GIS Solutions Expo
Hall D

6:30 pm – 9:00 pm
Networking Reception
National Museum of Natural History
Please Take Our Survey on the App

Download the Esri Events app and find your event

Select the session you attended

Scroll down to find the feedback section

Complete answers and select “Submit”