ArcGIS Enterprise:
Performance and Scalability
Best Practices

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What is ArcGIS Enterprise?
What's included with ArcGIS Enterprise?

- **ArcGIS Server**—the core web services component for making maps and performing analysis.
- **Portal for ArcGIS**—allows you to share maps, applications, and other geographic information with other people in your organization.
- **ArcGIS Data Store**—lets you configure data storage for hosting and federated servers used with your deployment.
- **ArcGIS Web Adaptor**—allows you to integrate your ArcGIS Server and Portal for ArcGIS with your existing web server and your organization's security mechanisms.
Base ArcGIS Enterprise Deployment

- ArcGIS Web Adaptor
- Portal for ArcGIS
- Hosting Server
- ArcGIS Data Store (relational + tile cache)
ArcGIS Server
Architecture
Options
Silos, Sites & Clusters

Silo

Site

Configuration Stores

Configuration Store
(shared)

Cluster

Configuration Store
(shared)

Use silos or small sites
Site design 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
Site 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/Portal
Publication Best Practices
Publication Strategies
The Role of Portal & Web Layers

Portal
- Active Wells
- Proposed Wells
- Wells by Status

GeoServices
- Wells

Geodata
- Wells
Hosting server

- Scalable solution - can publish thousands of services
Process, Tools, Value
Process and Tools
Relationship between System Tools

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

- [http://www.arcgis.com](http://www.arcgis.com)
- owner:EnterpriseImp
- Show ArcGIS Desktop Content
ArcGIS Monitor
Demo: https://systemmonitoring-emcs.esri.com

ArcGIS Monitor - Status

Status: July 8, 2017 9:21

Accounts: 8 Collections / Hour: 28,388

<table>
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<th>Alerts</th>
<th>Collecting Failures</th>
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<td>8</td>
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</tbody>
</table>

Categories:
- Web
- ArcGIS
- Database
- Cloud
- Infrastructure
- Usage
- GeolInfo
- Extensions
- License

Oversee Your Enterprise GIS Usage and Performance

At Esri, we want you to get the most out of your investment in GIS and IT infrastructure. Soon we will offer ArcGIS Monitor, uniquely tailored to monitor the health of your ArcGIS implementations. ArcGIS Monitor will give you insightful information on system usage and performance, while ensuring that Esri can support you throughout the lifecycle of your GIS. Sign up now to get news on how Esri can help you improve your system operation and reduce administration costs.

First Name
Last Name
Company:
To select, begin typing.
Email:
example@domain.com

http://go.esri.com/monitor
Testing best practices
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
Bottleneck

- Resource(s) limiting the performance or capacity

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

- Step Load (users)
- Response Time (sec)
Throughput (request/hr)

Response Time (sec)

Step Load (users)

Throughput (req/hr)

time
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)
Required skill set
Configuration, Tuning, Testing
Tuning methodology
Profile each tier starting from the top

- **Total Response Time (t1-t2)**
- **Wait Time**
- **Usage Time**
- **Search & Retrieval Time**

Diagram:
- Browser
- Web Server
- ArcGIS Server
- ArcSOC
- ArcSDE/DBMS
Profile application
Fiddler measurement approximately 5.2 seconds

Application performance narrowed down to specific request and map service
Review historical stats of the culprit service
ArcGIS Server 10.3.1 Statistics

- Total requests
- Average response time
- Maximum response time
- Timeouts
- Maximum running instances
- 30 min resolution reports
Review historical stats of the culprit service

System Log Parser
Review historical stats of the culprit service
System Monitor – ArcGIS Server Statistics

<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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</thead>
<tbody>
<tr>
<td>✔️</td>
<td>Summary (default)</td>
<td></td>
<td>Cluster Summary</td>
<td>0.117</td>
<td>0.285</td>
<td>431.564</td>
<td>35</td>
<td>0</td>
<td>16</td>
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<tr>
<td>✔️</td>
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<td>Root</td>
<td>MapServer</td>
<td>0.100</td>
<td>0.245</td>
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<td>MapServer</td>
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<td>1</td>
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<td>MapServer</td>
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<td>MapServer</td>
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<td>0.000</td>
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<td>2</td>
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</table>
Profile mxd of the culprit map service

**Mxdperfstat**

<table>
<thead>
<tr>
<th>Item</th>
<th>At Scale</th>
<th>Layer Name</th>
<th>Refresh Time (sec)</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<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 execution plan; oraLIO=130936; check if index exist for query def attributes;</td>
</tr>
</tbody>
</table>

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<table>
<thead>
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<th>Layer Spatial Reference</th>
<th>LayerQueryDef</th>
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<td>GCS_WGS_1984</td>
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Oracle Trace
Compare elapsed time

Elapsed time slightly changed due to different test runs

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<tr>
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<th>count</th>
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<th>elapsed</th>
<th>disk</th>
<th>query</th>
<th>current</th>
<th>rows</th>
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<td>0</td>
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<tr>
<td>Execute</td>
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<td>0.03</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
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<td>20</td>
<td>9.67</td>
<td>9.65</td>
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<td>129581</td>
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**Total:** 21 | 9.70 | 9.65 | 129581 | 0 | 1998 |
Oracle Execution plan

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<th>Rows (max)</th>
<th>Row Source Operation</th>
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<td>INDEX RANGE SCAN D45.PK</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>APPLY</td>
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</table>

**Inefficient spatial index**
Mxdperfstat - WorldSQLExpress.mxd
mxdperfstat10.4.exe -mxd WorldSQLExpress.mxd -scale 100000000

- mxdperfstat10.4.exe -mxd WorldSQLExpress.mxd -scale 100000000
- Compare to FGDB

mxdperfstat

7/9/2016 4:09:37 PM
WorldSQLExpress.mxd
layerCount: 2
GCS_WGS 1984
euriallDecimalDegrees
X= .00 Y= -44.67 width= 1200 height= 1000

Map Display Performance (sec) for each scale

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<th>VisibleLayers</th>
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<td>38.64</td>
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<tr>
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<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>
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<td>SDE.cities</td>
<td>.05</td>
<td></td>
<td>2,274</td>
<td>True</td>
<td>.04</td>
<td></td>
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<tr>
<td>2</td>
<td>100,000,000</td>
<td>SDE.country</td>
<td>38.20</td>
<td>simplify geometry, vertices fetched=7079678</td>
<td>543</td>
<td>False</td>
<td>38.19</td>
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Testing Objectives

- Meet Service-Level Agreement (SLA)
- Bottlenecks analysis
- Capacity planning
- Benchmarking different alternatives
Required skill set
Configuration, Tuning, Testing
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>
</tr>
</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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<tr>
<td>Visual Studio</td>
<td>Medium</td>
<td>High</td>
<td>Windows</td>
<td>No</td>
<td>No</td>
</tr>
<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>

*Tech Support by Esri PS as part of consulting support*
Dynamic Map Services Benchmark: Performance

A load test is defined by a given map service and during this test:

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 feature to 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 available.

**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.
Advanced features

- Transaction based
- Import Har
- Editing
- Network
- GP
System Test output

Graph showing CPU ST/Tr vs. Step Load.
System Designer output
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.*
CPU capacity

1. User load: Concurrent users or throughput
2. Operation CPU service time (model)—performance
3. CPU SpecRate

\[
\text{\# CPU}_t = \frac{ST_b \times TH_t \times 100}{3600 \times \%CPU_t} \times \frac{\text{SpecRatePerCPU}_b}{\text{SpecRatePerCPU}_t}
\]

- subscript \( t \) = target
- subscript \( b \) = benchmark
- \( ST \) = CPU service time
- \( TH \) = throughput
- \( \%CPU \) = percent CPU
Network capacity

Network transport time

- Required bandwidth
  - Response size
  - Number of transactions

- Network transport time
  - Response size
  - Effective bandwidth

\[ \text{Mbps} = \frac{TH \times \text{Mbits} / \text{req}}{3600} \]

\[ \text{Transport (sec)} = \frac{\text{Mbits} / \text{req}}{\text{Mbps} - \text{Mbps}_{\text{used}}} \]

All Built into System Designer
System Designer
Solution Architecture design methodology

- Gathering requirements
- Designing
- Capacity: CPU, Network, Memory
- Reporting
Quick Capacity Report

- High-level summary for Rough Order of Magnitude
Monitoring overview
Monitoring Enterprise GIS

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
Motivation: Growing complexity of ArcGIS Enterprise
Requires dependable infrastructure

Certificates
Load balancer
Firewall
ArcGIS Web Adaptor
Portal for ArcGIS
Storage with immediate consistency

ArcGIS Server
ArcGIS Data Store
Database
ArcGIS Monitor
Demo: https://systemmonitoring-emcs.esri.com

ArcGIS Monitor - Status

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ArcGIS Monitor

Oversee Your Enterprise GIS Usage and Performance

At Esri, we want you to get the most out of your investment in GIS and IT infrastructure. Soon we will offer ArcGIS Monitor, uniquely tailored to audit the health of your ArcGIS implementations. ArcGIS Monitor will show you insightful information on system usage and performance, while ensuring that Esri can support you throughout the lifecycle of your GIS. Sign up now to get a head start on how Esri can help you improve your system operation and reduce administration costs.

First Name
Last Name
Company
To select, begin typing.
Email
example@domain.com

http://go.esri.com/monitor
When problems arise, what is the root cause?
Value to Customers
Maximize GIS Investments

• Administrators:
  • Detect, diagnose, and resolve issues with availability, configuration, performance and usage
  • Gather actionable, quantifiable operational metrics and usage trends over time

• Managers:
  • Increase communication among GIS and IT staff and senior management
  • Reduce administration costs

• Users:
  • Improve end-user satisfaction
Standards for effective GIS monitoring

• Many excellent monitoring tools on the market
• Few provide GIS dashboards
• **System Monitor can be used as reference implementation**
Common cases

ArcGIS Enterprise is often a victim of:
Overload:
-users
-services
Unstable Infrastructure:
- Network
- NAS
- VMWare
Bottlenecks:
- configuration
- maintenance
- workflows
Failed Requests

Chart Resolution: real-time value at
Busy Time per Tr(sec)

Chart Resolution: real-time value at collection interval when query less than 12 hrs
ArcSOC Optimizer
GeoEvent
ArcGIS Monitor

Database
Database

ArcGIS Monitor - Database

Charlotte
Tokyo
- GeoDatabase
  - Activity
  - Status
  - BaseTableRecordCount
  - BaseTableRecords
  - CpuMaxSpatialQuery (secs)
  - DatabaseSize (GB)
  - DbFreeSpace (%)
  - DboSTATE
  - DefaultVersionDepth
  - DeltaRecords
  - DeltaTableRecords
  - ElapsedMaxSpatialQuery (secs)
  - FreeListStaleRecSecs

DeltaRecords

Chart Resolution: real-time value at collection

2210
2000
1800
1600
1400
1200
Database Catalog view

ArcGIS Monitor - Catalog

Collection Status

Alerting

New York
Redlands
Sao Paulo
Sydney
System Monitor
Tokyo
Collector (12)
EXT (11)
Availability-Network Test (14)
DataStore Activity (4)
DataStore Performance (5)
DataStore Status (4)
Oracle eGDB Activity (4)
Demand (10)
Oracle eGDB Activity (1)
ArcGIS Monitor

Cloud
Cloud (AWS)
System
Rping

ArcGIS Monitor - Infrastructure

Charlotte
London
New York
Redlands
Tokyo

- Average Network Time ms
- Code
- Collection Time
- NetworkTime ms
- StatusCode

WebGIS Health

Statistics: both chart and table reflect true statistics like min, max, percentile

<table>
<thead>
<tr>
<th>Item</th>
<th>Category</th>
<th>Counter</th>
<th>Instance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability-Network Test</td>
<td>excl</td>
<td>NetworkTime ms</td>
<td>PortalStandby---PortalLB</td>
</tr>
</tbody>
</table>
WebGIS Health (Portal HA)
WebGIS Health Extension – What do you get to monitor?

- Know about failures before system fails
  - Portal for ArcGIS Primary or Standby site failure
  - Index health of Portal for ArcGIS
  - Portal for ArcGIS thinks both machines are primary/standby
  - Hosted ArcGIS for Server’s health
    - Publishing Services
  - Datastore is valid but the standby machine is down
  - Datastore failed over in the past five minutes
  - Datastore Service is not running
VMware

Avoid over allocation and live migration of running virtual machines during work hours.

**System Monitor - Catalog**

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**Collection Status**

<table>
<thead>
<tr>
<th>Alerting</th>
<th>Collecting</th>
<th>Name</th>
<th>Type</th>
<th>Interval</th>
<th>Last Update</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>VMHosts</td>
<td>EXT</td>
<td>300</td>
<td>Feb 12, 2017 11:22:15 PM</td>
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</table>

**Counter Status**

<table>
<thead>
<tr>
<th>Alerting</th>
<th>Collecting</th>
<th>Last Update</th>
<th>Name</th>
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<tbody>
<tr>
<td></td>
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<td>Feb 12, 2017 11:22:15 PM</td>
<td>cpu.usage.average(%) (psveredh5.esri.com)</td>
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<td></td>
<td></td>
<td>Feb 12, 2017 11:22:15 PM</td>
<td>cpu.usagemhz.average(MHz) (psveredh5.esri.com)</td>
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<tr>
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<td>Feb 12, 2017 11:22:15 PM</td>
<td>cpu.readysummation(milliseconds) (psveredh5.esri.com)</td>
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<tr>
<td></td>
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<td>Feb 12, 2017 11:22:15 PM</td>
<td>cpu.readysummation (%) (psveredh5.esri.com)</td>
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<tr>
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<td></td>
<td>Feb 12, 2017 11:22:15 PM</td>
<td>mem.usage.average(%) (psveredh5.esri.com)</td>
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<tr>
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<td>disk.usage.average(KBps) (psveredh5.esri.com)</td>
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<td>net.usage.average(KBps) (psveredh5.esri.com)</td>
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<td>disk.maxtotallatency.latest(milliseconds) (psveredh5.esri.com)</td>
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<tr>
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<td>cpu/VmToHostRatio (psveredh5.esri.com)</td>
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<td>vmCount (psveredh5.esri.com)</td>
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</table>
Usage (Tr/hr)

### Collection Status

<table>
<thead>
<tr>
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<th>Name</th>
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<tbody>
<tr>
<td></td>
<td><img src="https://example.com/loader.png" alt="" /></td>
<td>SLP-ELB</td>
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### Logs

- Status: ✔
- Alerts (0)
- Collecting Failures (0)

### Status

July 8, 2017 10:36 PM

<table>
<thead>
<tr>
<th>ID</th>
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<th>Counter Name</th>
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<tbody>
<tr>
<td>1</td>
<td>✔</td>
<td>0</td>
<td>Code</td>
</tr>
<tr>
<td>2</td>
<td>✔</td>
<td>0</td>
<td>Collection Time</td>
</tr>
<tr>
<td>3</td>
<td>✔</td>
<td>0</td>
<td>FeatureServer (Tr/hr)</td>
</tr>
</tbody>
</table>
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ArcGIS Monitor

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