Federal GIS Conference

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ArcGIS Enterprise Systems: Designing, Testing and Monitoring

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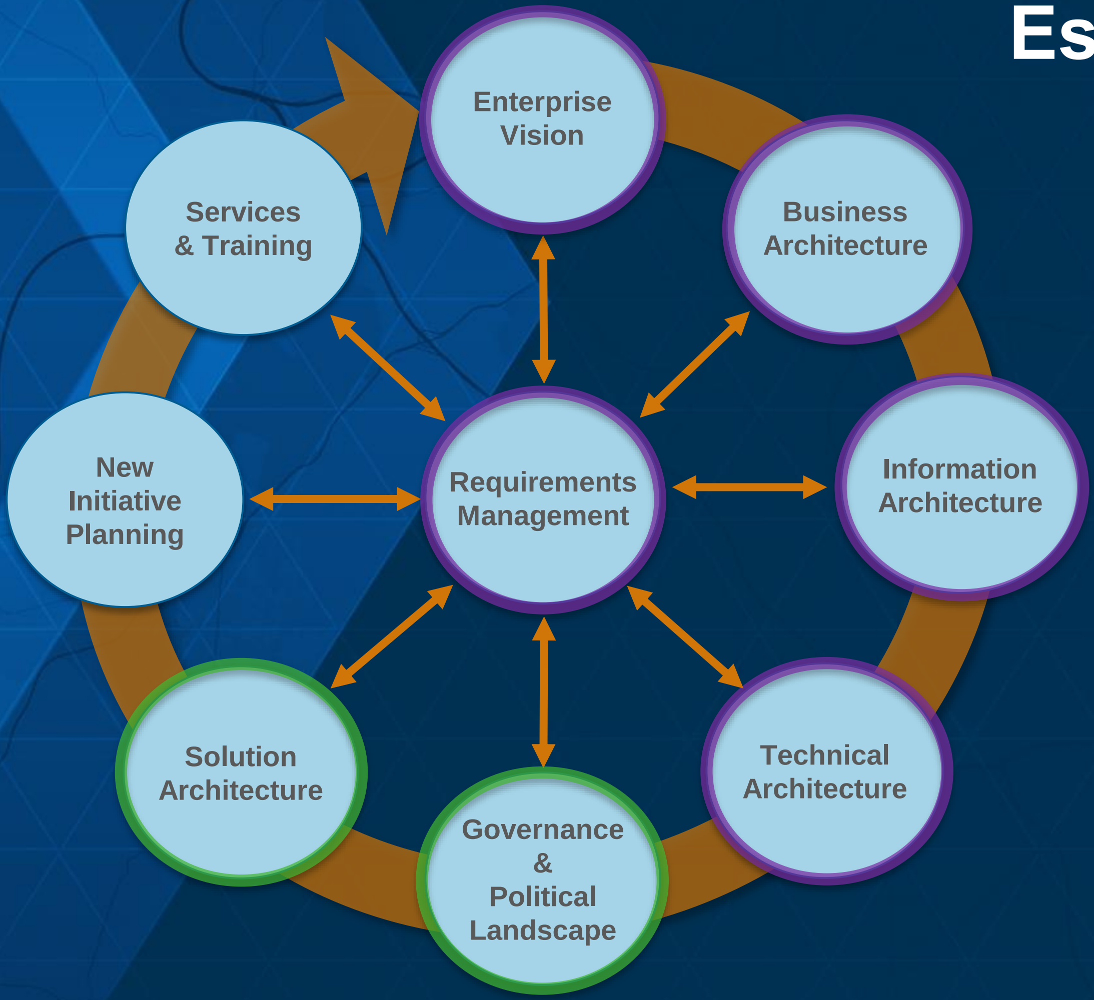
Agenda

- Esri's Solution Architecture Practice
- Overview of System Tools
- System Test and System Monitor Case Study

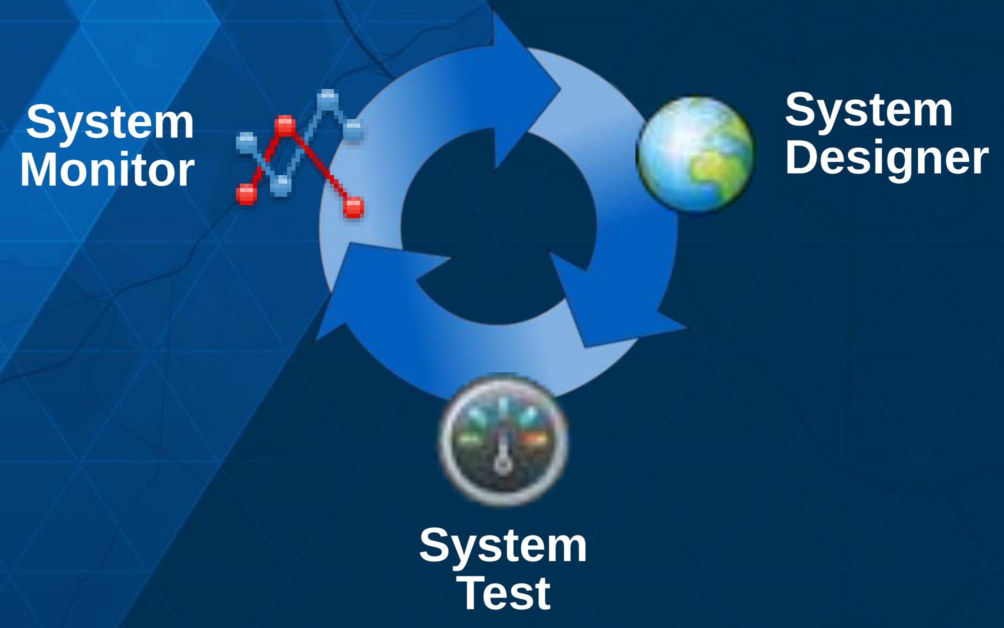


Esri's Solution Architecture Practice

- GIS platform strategy
- Align resources to realize intended business outcomes
- Develop initial impressions of SLAs
  - Performance
  - Scalability
  - Availability
- Develop Solution Road Map
  - Recommendations
  - Prescriptive activities

esri

Best Practice: Leverage System Tools



- Defined: software tools to help plan, test and monitor a system implementation.

- Maintain SLA’s
- Transparency into system
- Tune system stability & availability
- Identify “bottlenecks”
- Reduce risks
- Optimize spend
- Improved capacity planning

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

At capacity

Over capacity

Bottleneck

- Resource(s) limiting the performance or capacity

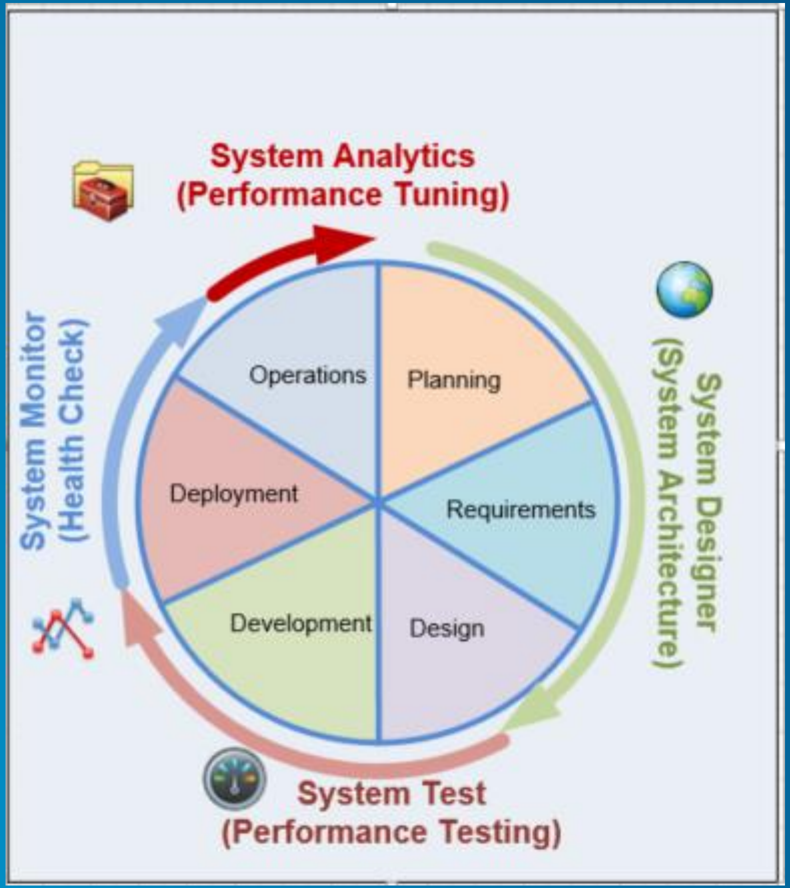
Not bottleneck

bottleneck

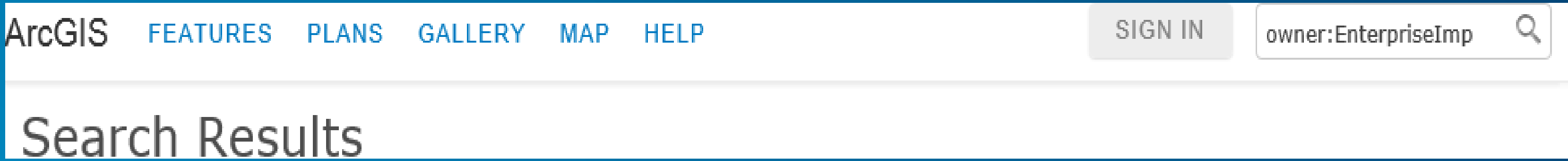
Think of :
Lanes -as CPU processor
Toll -as ArcGIS Server instances
Cars -as map requests

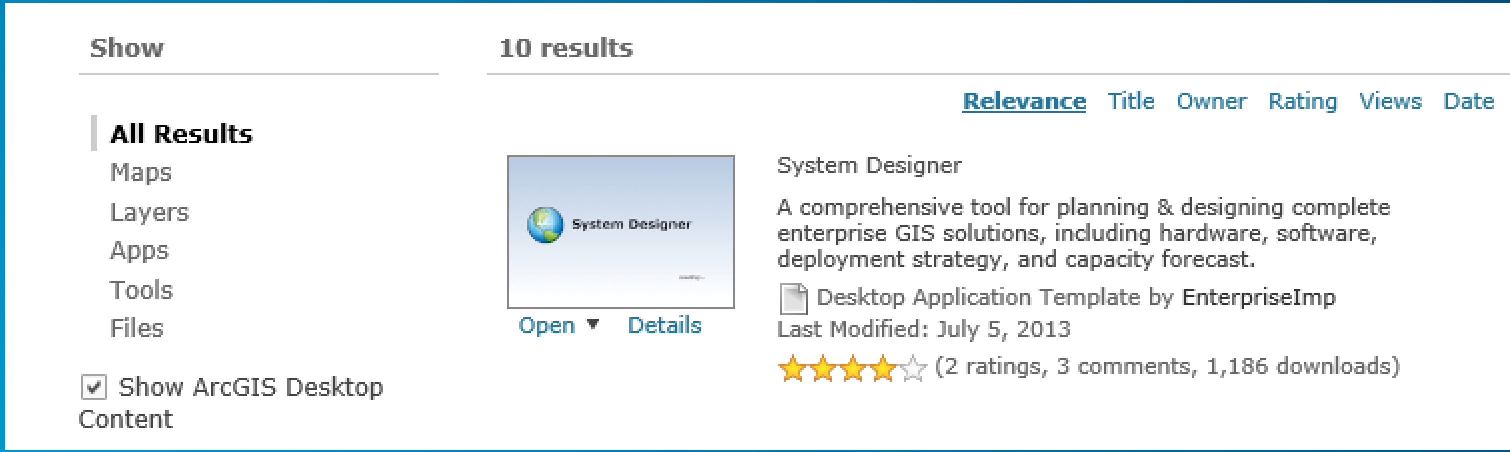
Process and Tools

Process and Tools



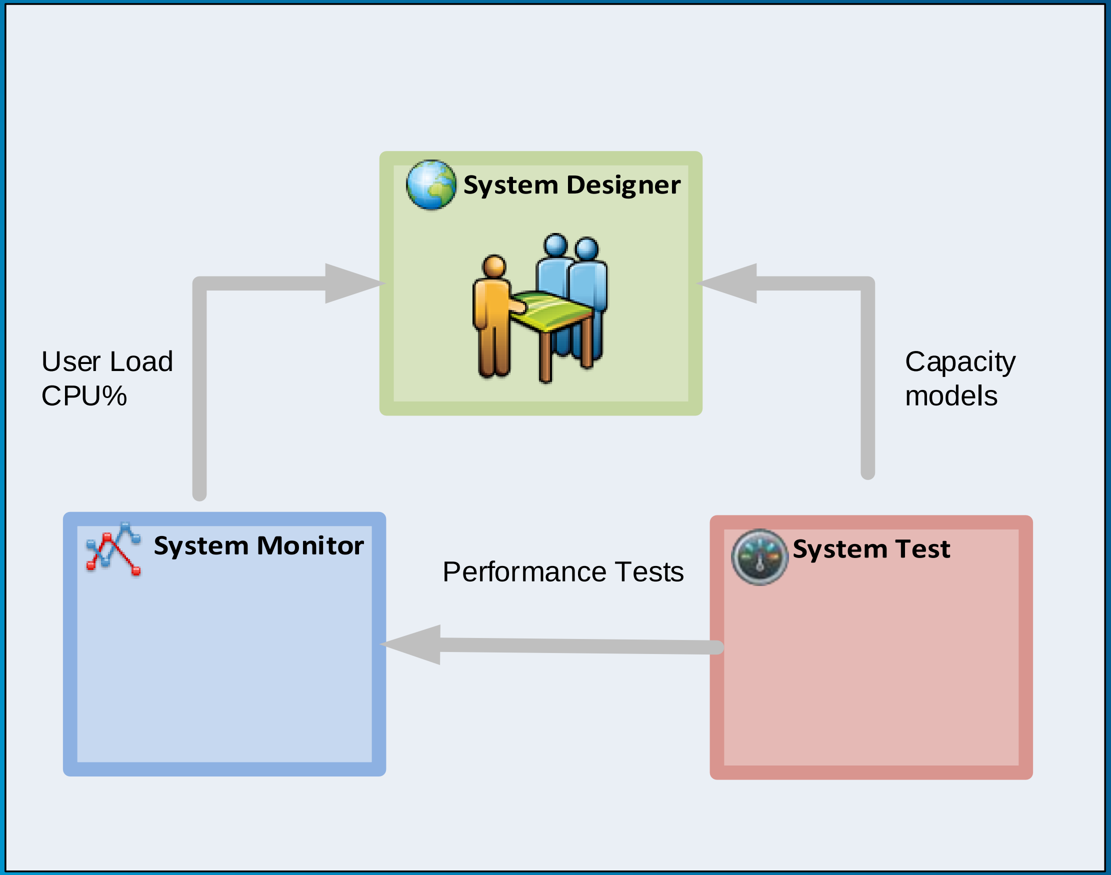
System Tools download





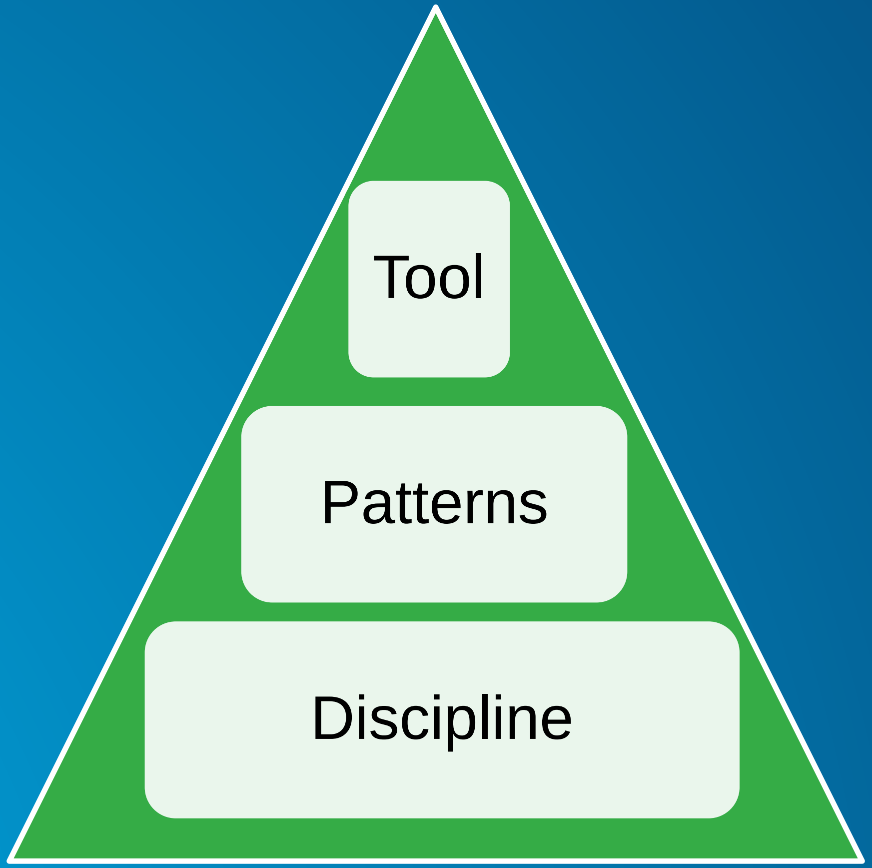
- http://www.arcgis.com
- owner:EnterpriseImp
- Show ArcGIS Desktop Content

Relationship between System Tools



System Tools framework

System Tools are not just tools



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.

Infrastructure

Memory requirements

Item	Low	High
ArcSOC Map	50 MB	500 MB
ArcSOC Image	20 MB	1,024 MB
ArcSOC GP	100 MB	2,000 MB
XenApp Session	500 MB	1.2 GB
Database Session	10 MB	75 MB
Database Cache	200 MB	200 GB

Wide ranges of memory consumptions

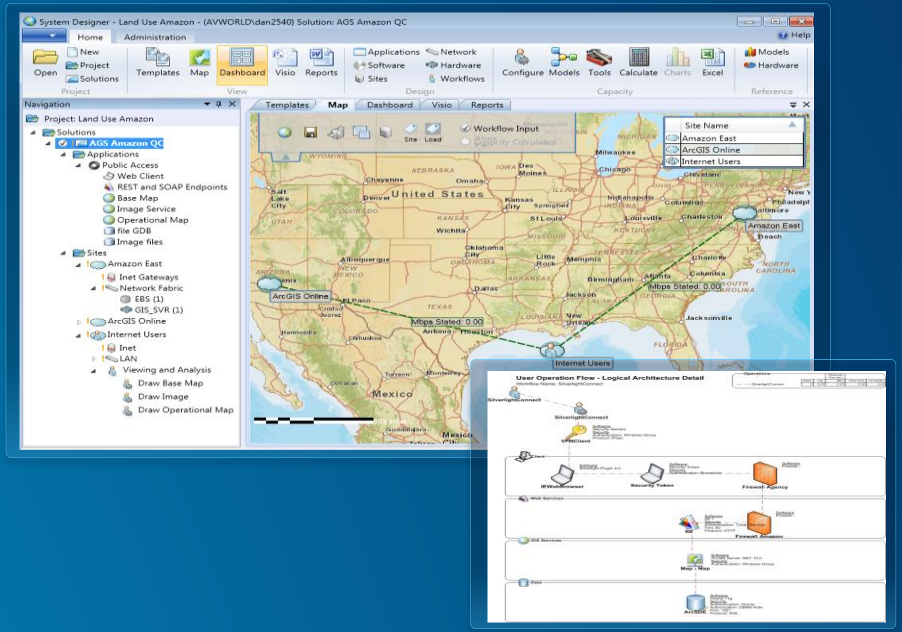
System Designer

Solution Architecture design methodology

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

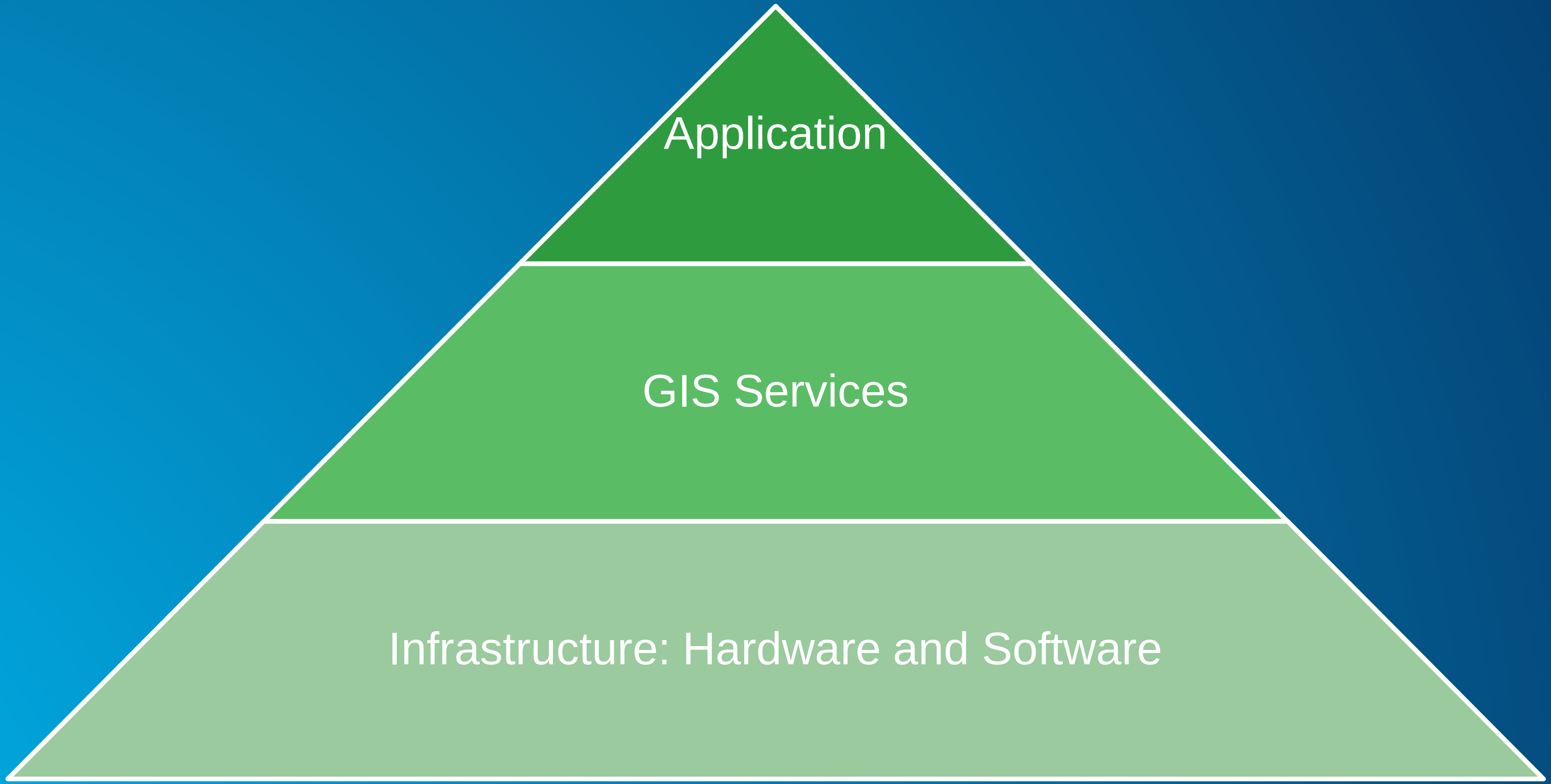
Demo

System Designer



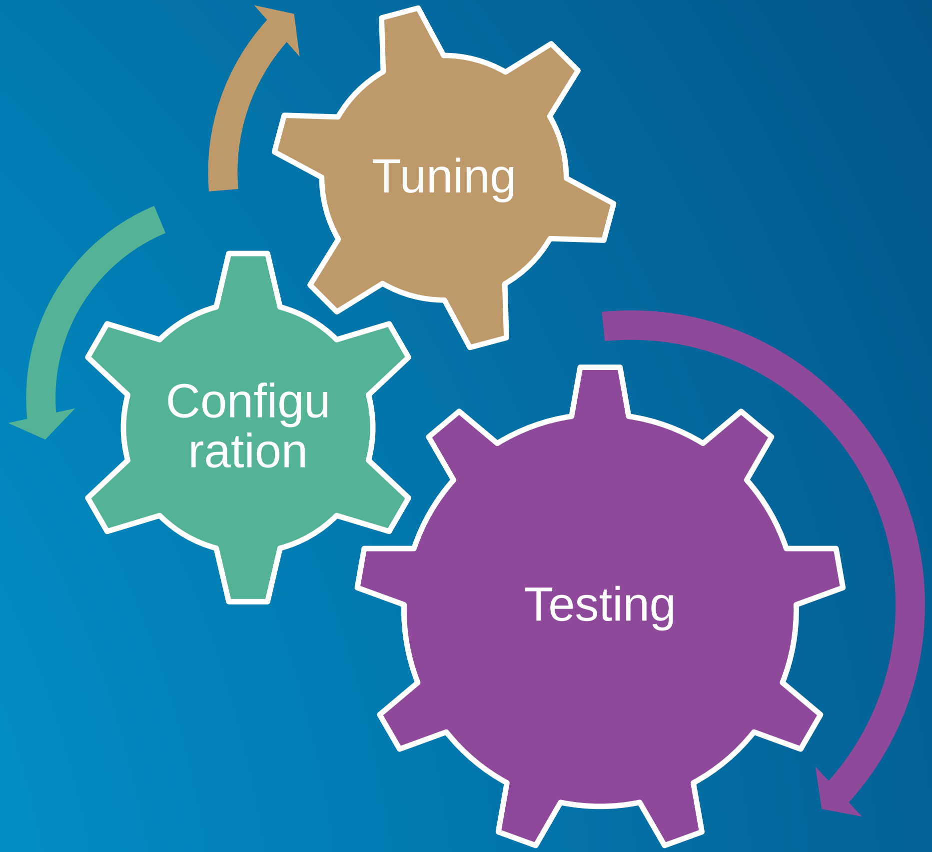
Performance Testing

Testing process



Required skill set

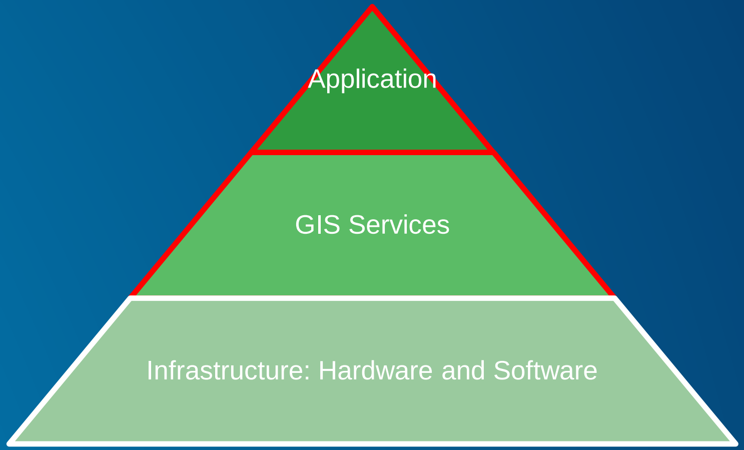
Configuration, Tuning, Testing



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

Tool	Cost	Learning Curve	OS Metrics	GIS Data Generation	GIS Test Automation
Load Runner	High	High	Windows/Linux	No	No
Visual Studio	Medium	High	Windows	No	No
JMeter	Free	High	Requires additional plugin	No	No
System Test	Free	Low	Windows/Linux	Yes	Yes

Tech Support by Esri PS as part of consulting support

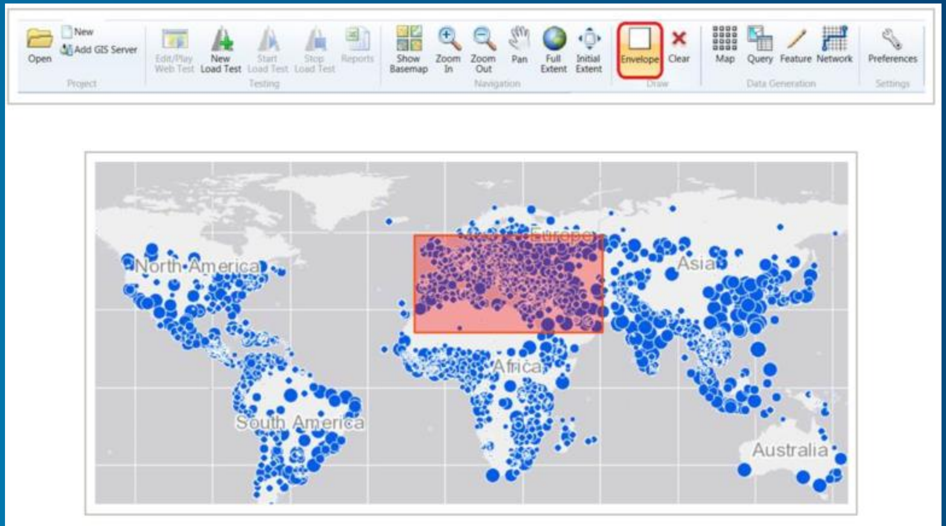
Performance testing

Value

- Identify bottlenecks
- Determine system capacity
- Demonstrate performance SLA

Demo

System Test



System Monitoring

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

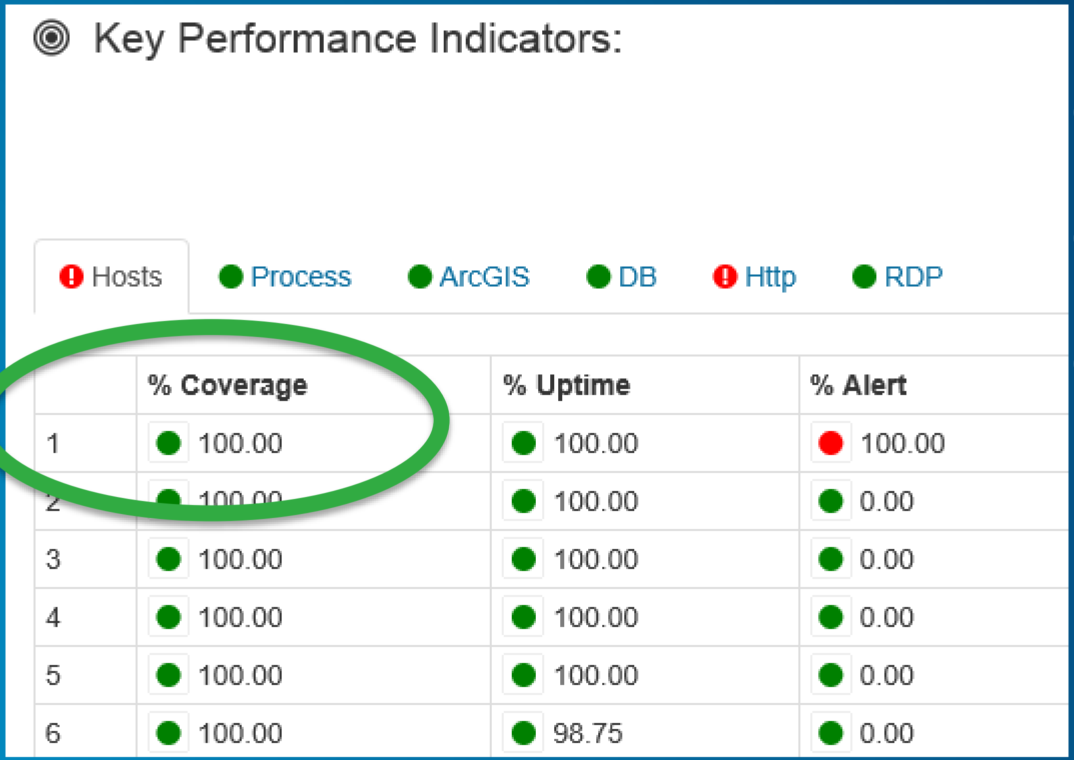
Standards for effective GIS monitoring

- Many excellent monitoring tools on the market
- Few provide GIS dashboards
- System Monitor can be used as reference implementation

Enterprise GIS effective monitoring

"PIECE" of mind with System Monitor

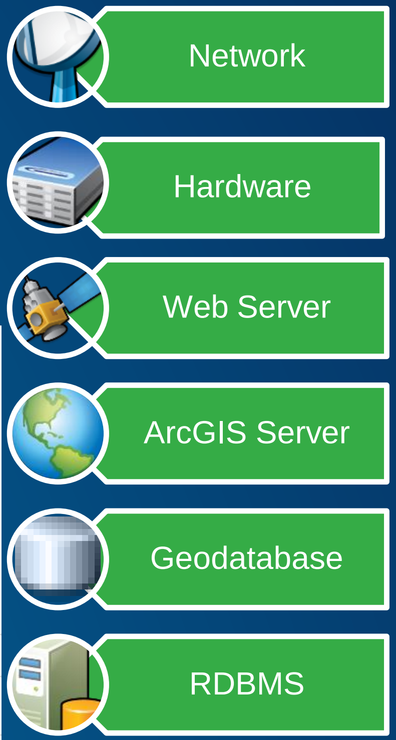
- **Proactive**
- **Integrated**
  - Dashboards across all tiers
- **End-to-End**
  - All tier monitoring
- **Continuous**
  - %Coverage provided
- **Extendable**
  - Custom queries

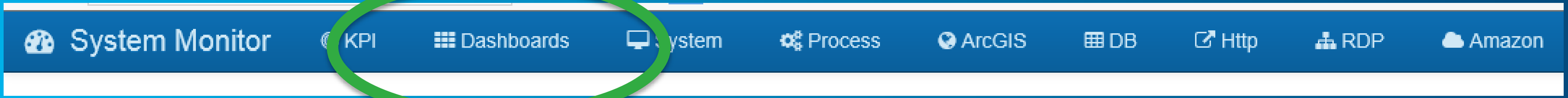


Key Performance Indicators:

Hosts | Process | ArcGIS | DB | Http | RDP

	% Coverage	% Uptime	% Alert
1	100.00	100.00	100.00
2	100.00	100.00	0.00
3	100.00	100.00	0.00
4	100.00	100.00	0.00
5	100.00	100.00	0.00
6	100.00	98.75	0.00





Monitoring

Value

- **Proactive validation:**

Configuration

Resource Utilization

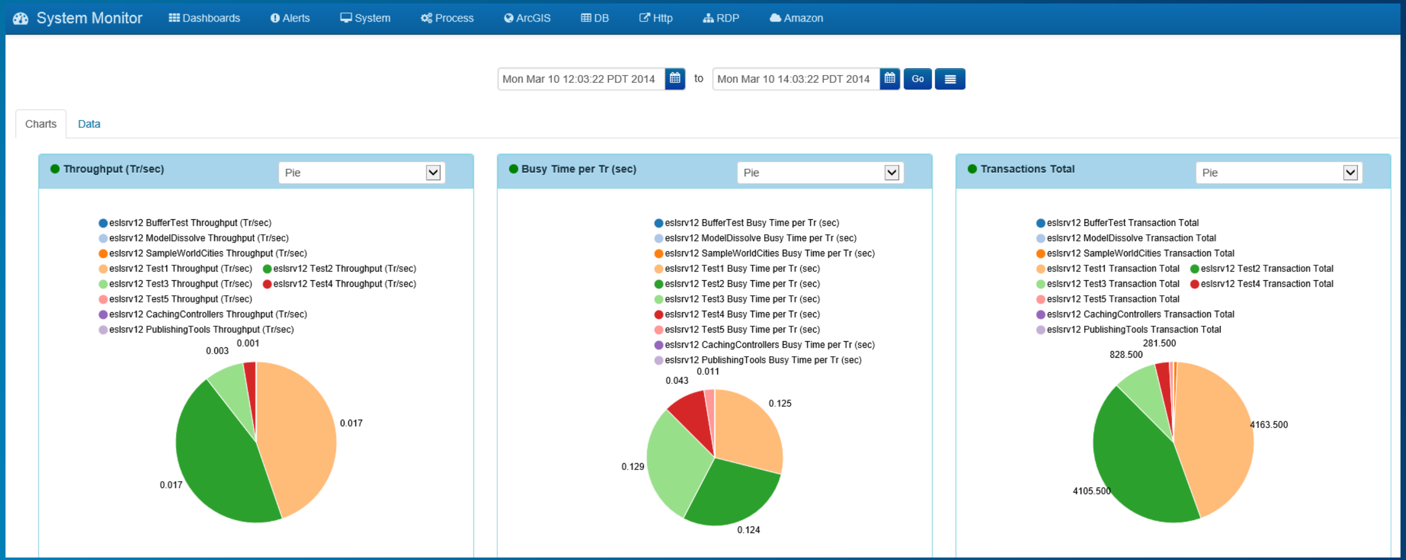
Usage Trends

Performance SLA

Uptime SLA

Demo

System Monitor

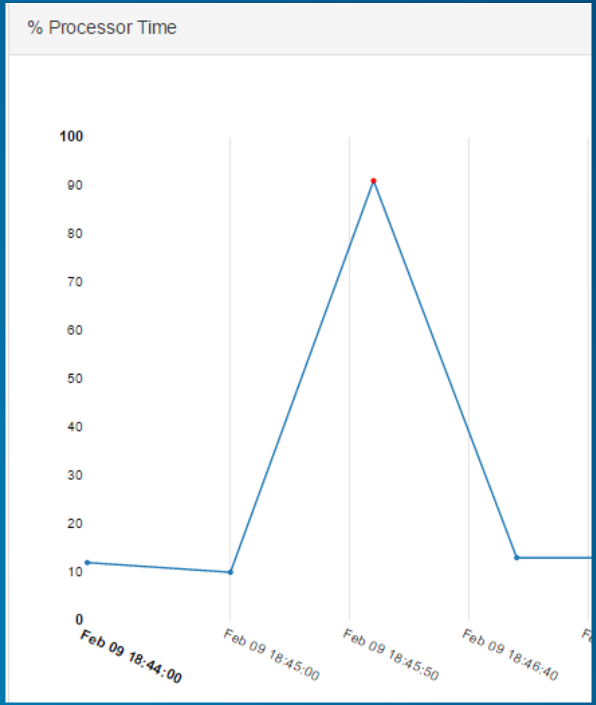


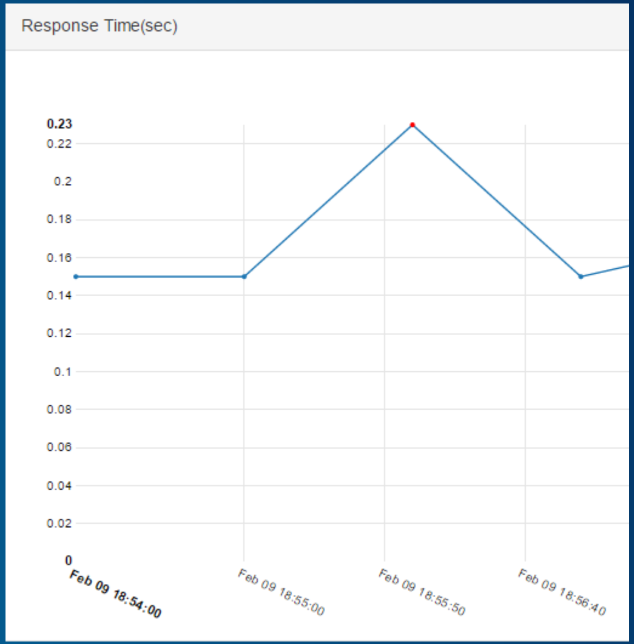
Use Cases

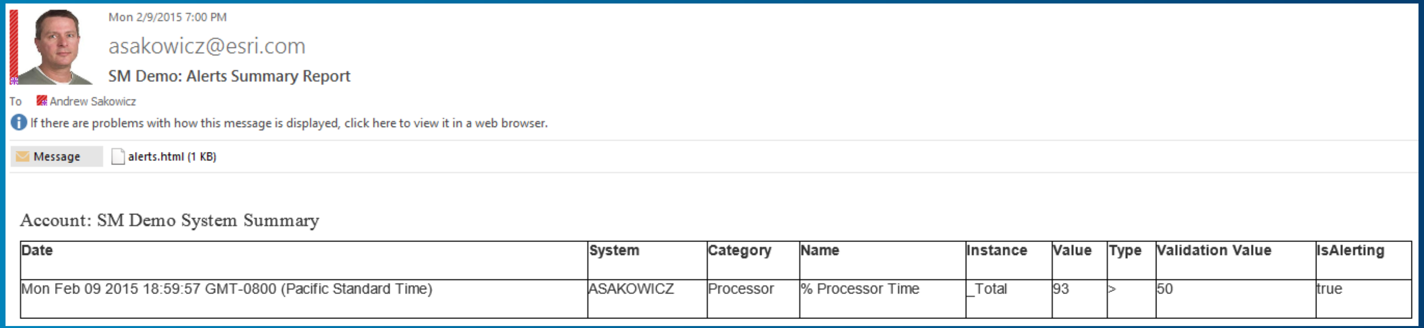
Applied use of System Monitor and Test tools

Demo

Simulate CPU spike (e.g. Antivirus scan)







Mon 2/9/2015 7:00 PM

asakowicz@esri.com

SM Demo: Alerts Summary Report

To Andrew Sakowicz

If there are problems with how this message is displayed, click here to view it in a web browser.

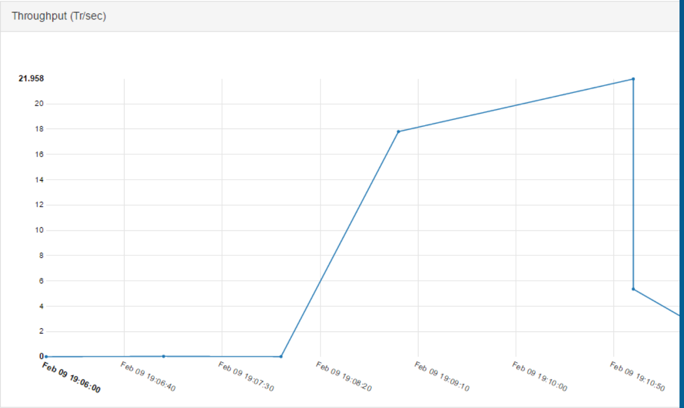
Message alerts.html (1 KB)

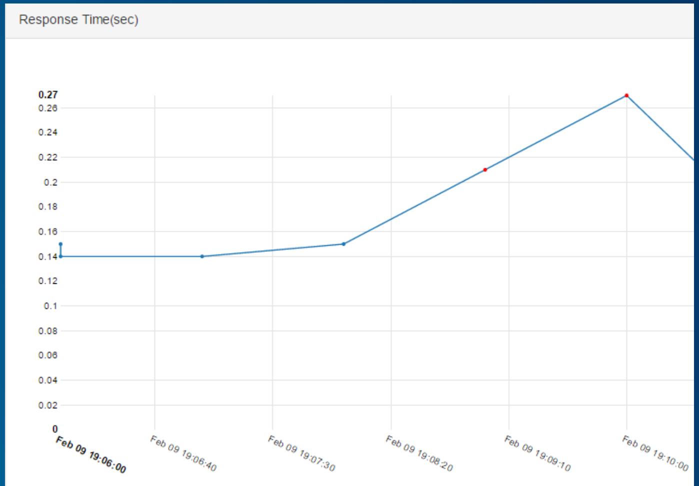
Account: SM Demo System Summary

Date	System	Category	Name	Instance	Value	Type	Validation Value	IsAlerting
Mon Feb 09 2015 18:59:57 GMT-0800 (Pacific Standard Time)	ASAKOWICZ	Processor	% Processor Time	_Total	93	>	50	true

Demo

Simulate ArcGIS user load





Mon 2/9/2015 7:10 PM

asakowicz@esri.com

SM Demo: Alerts Summary Report

To Andrew Sakowicz

If there are problems with how this message is displayed, click here to view it in a web browser.

Message | alerts.html (1 KB)

Account: SM Demo Http Summary

Date	System	Category	Name	Instance	Value	Type	Validation Value	IsAlerting
Mon Feb 09 2015 19:09:58 GMT-0800 (Pacific Standard Time)	asakowicz_SampleWorldCities	Url	Response Time(sec)	asakowicz_SampleWorldCities	0.21	≥	0.17	true

Case Study

Introduction

- Purpose – provide a practical case study describing how the System Monitor and System Test esri resources can be leveraged when implementing complex mission critical GIS platforms

- Case Study – Implementation of a GIS (Platform as a Service) PaaS in a large federal agency with mission critical user communities
  - Objectives, requirements, and unique challenges
  - High level architecture(s) and organizational context
  - System Monitor and System Test use case examples

Implementation Overview

- Private cloud service model – enable sponsors to efficiently provide content as standards based GIS services on appropriate infrastructure.
- COTS and Open Source technology
- Highly Available (HA) infrastructure

Implementation Overview

- Mature service features
  - Service Level Agreement (SLA)
  - Documented on-boarding procedures
  - Cost Sharing Model

- Dedicated GIS and IT support staff

Operational Environment and Organizational Considerations

- All GIS server systems are RHEL VMs (including RDBMS)
- Virtual environment is configured and managed using Puppet Labs software
- Domain expertise, system accesses, and roles are split between multiple organizations.

Challenges - GIS vs IT Roles

- The IT organization SA’s manage the infrastructure; VM’s, Puppet catalogs, classes, and scripts, software installation and licensing, web servers, and RDBMS including all tasks requiring root or DBA privileges. Windows domain admins are in a separate group
- The GIS support team interact with the GIS site(s) through the ArcGIS Desktop applications, or the ArcGIS Server Manager or Admin rest endpoints. The GIS team has some limited access to the RHEL ‘Compute Farm’ data ingestion servers through SSH shell connections

Technical Challenges – Complexity, the Usual Suspects

- High availability
- Fault Tolerance
- Scalability in a context of event driven traffic spikes
- Performance
- Security
- Interoperability
- Integration with existing policy and practice
- Infrastructure Environment

Technical Challenges – Project Specific

- Time enabled services based on continuously updating data feeds
- Scientific and environmental data sources require pre-processing to enable or optimize for dissemination as GIS web services
- These narrow performance optimization options (e.g. caching)

Representative Services and Update Cycles

Service	Update Frequency	Performance Workflow	Nominal Map/Image requests (Est)	Peak Map/Image requests (Est)
Watches\Warnings and Advisories	1 minute \ 10 minutes	Light Vector	10K Hr	100K Hr
Daily Global Precipitation	Daily	Light Raster	1K Hr	10K Hr
Radar (1x1 km base reflectivity)	5 minutes	Light Raster	20K Hr	200K Hr
HRRR	15 minutes 1 hour	Heavy Raster	UNK	UNK
Hurricane Tracks/Wind/Surge	10 minutes or less	Light Vector	1K Hr	100K Hr
AHPS gauges	15 minutes	Light Vector	1K Hr	10K Hr
Flood Outlook Product	Daily	Light Vector	1K Hr	10K Hr
CPC Weather Hazards	Daily	Light Vector	10K Hr	100K Hr
Quantitative Precipitation Forecast (QPF)	15 minutes	Light Vector	1K Hr	10K Hr
Weather Features	Daily	Light Raster	1K Hr	10K Hr
Sea Surface Temp	Daily	Light Raster	1K Hr	10K Hr
NDFD Wind Velocity Forecasts	1 hour	Light Raster	1K Hr	10K Hr

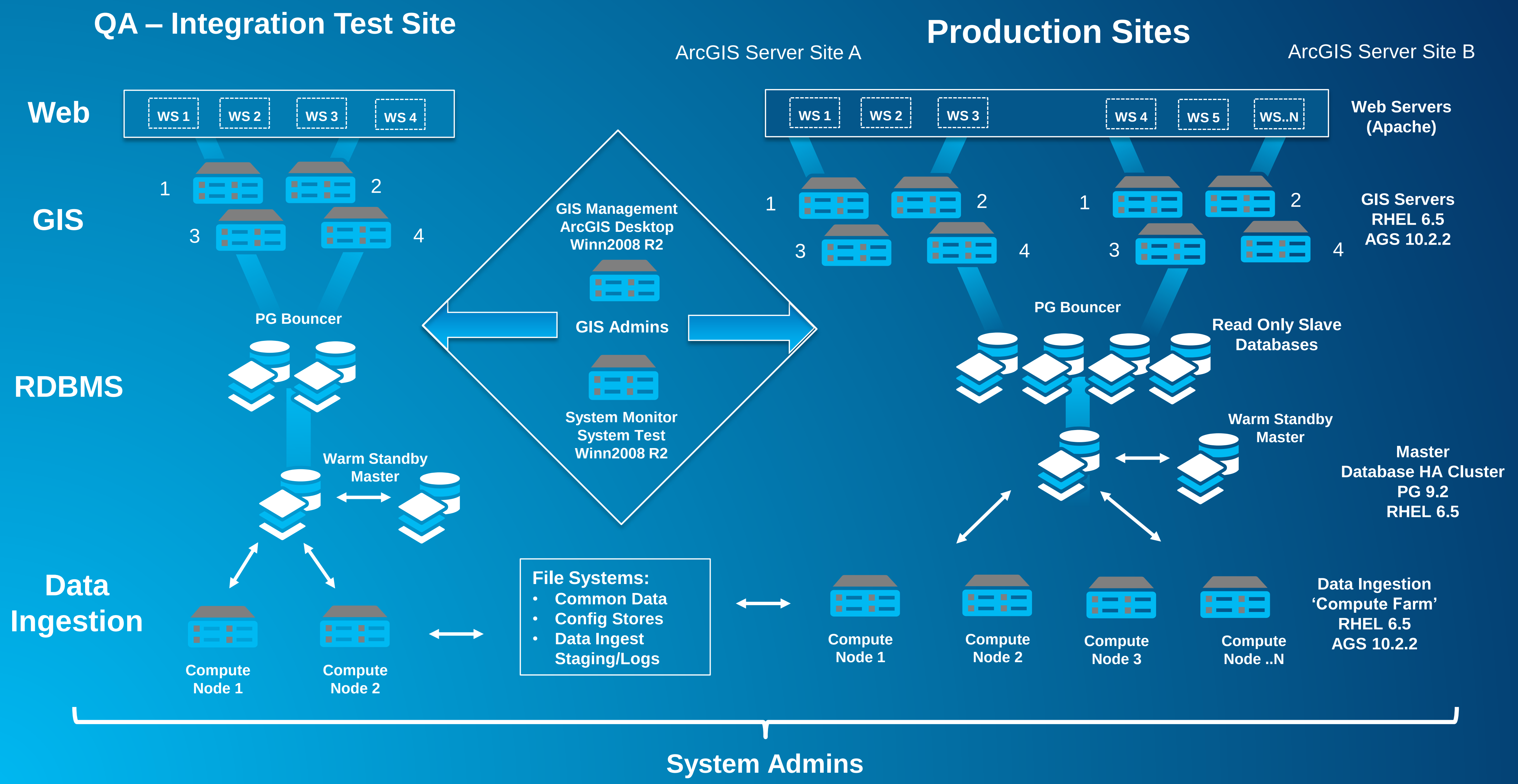
Data ingestion workflow for (gridded) scientific datasets

1. Poll/Pull Data
2. Extract Raster Bands, Project, Scale, Classify
3. Extract Metadata Headers
4. Add to Mosaic Dataset
5. Update Mosaic Dataset Metadata Fields

Data Ingestion workflow for time-stamped vector datasets

1. Poll/Pull Data
2. Extract, Project, and Generalize (if applicable)
3. Extract and Apply Forecast Date/Time (Issue and valid times)
4. Add Current Features
5. Purge Stale Features

Continuous Update Services High Level Architecture



System Monitor/Test Value Proposition

- Provide shared situational awareness for GIS support roles that may not typically have access to server infrastructure and associated monitoring software managed by IT organization

- Complement monitoring tools used by the IT organization. Simplify cross correlation of GIS domain specific settings, platform infrastructure resource constraints and/or events, and user load

System Monitor/Test Value Proposition

- Provide empirical basis for tuning service configuration and underlying resource requirements to maximize overall system performance while taking into consideration:
  - System memory and CPU resources
  - Number of Services
  - Min/Max instances per service
  - Individual service complexity (resources required per running instance / web request)
  - Service criticality, usage patterns and load
- Auditable logs to document SLA compliance and support formal service onboarding process

System Monitor/Test Value (cont.)

- The availability for both the GIS and IT teams to System Monitor KPI can help isolate the ‘signatures’ associated with adverse conditions associated with resource constraints, improper configurations, or component failures. This in turn can translate into:
  - Timely decision support to enable anticipation of and/or rapid response to events
  - Standardized and simplified role based procedures (SOPs) and situational responses.
  - Expedited identification of the appropriate change requests and support ticket items based on empirical, thresholds, and alerts.

System Test - Standard Procedure for Onboarding GIS Services

- Services are worked collaboratively between the content sponsor and the GIS support team on the Development Tier where cartography, data ingestion, and required service capabilities are defined.

- Service configurations graduate to the QA site where the service catalog mirrors the Production site(s). Once deployed on the QA site the service is subjected to load testing using the System Test application.

System Test - Standard Procedure for Onboarding GIS Services

- Service specific System Monitor KPI collectors are configured

- If test results are acceptable they are entered as benchmark artifacts in the program CM repository and the service is queued for Production.

System Test - Standard Procedure for Onboarding GIS Services

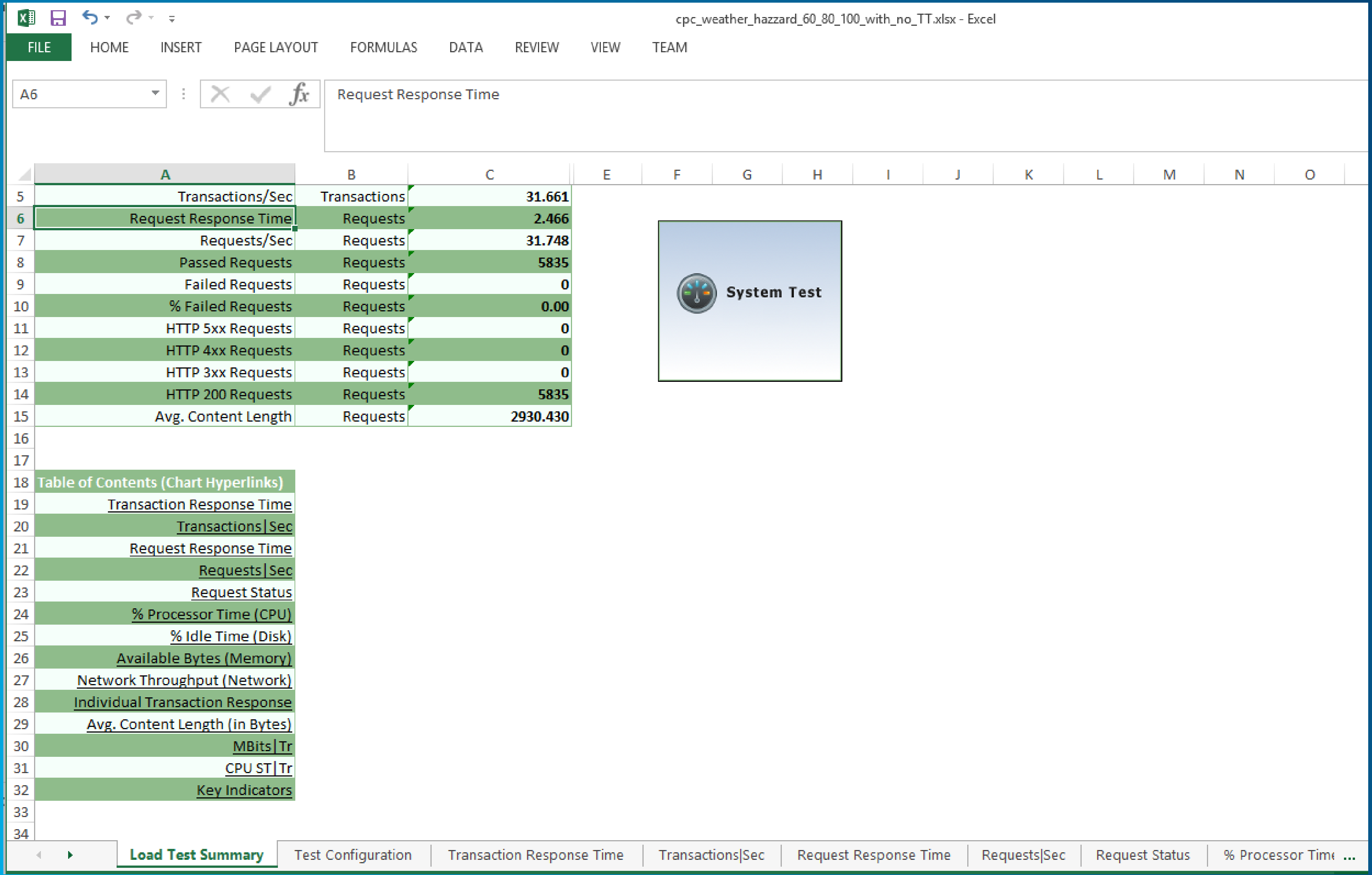
- If unit test performance is not acceptable in terms of response time, code, and content; further analysis is performed to isolate problematic layers, cartographic configurations, or underlying RDBMS queries.
- This may include leveraging additional tools such as mxdperfstat and/or PerfQAnalyzer.

System Test – Results as CM Artifacts

Output

Name	Date modified	Type	Size
cpc_weather_hazzard_60_80_100_with_no_TT.xlsx	10/9/2014 9:36 AM	Microsoft Excel W...	90 KB
cpc_weather_hazzard_60_80_100_with_TT.xlsx	10/9/2014 9:42 AM	Microsoft Excel W...	90 KB
qa_ahps_20_40_60_no_TT.xlsx	10/7/2014 10:07 AM	Microsoft Excel W...	91 KB
qa_ahps_60_80_100_no_TT.xlsx	10/7/2014 10:13 AM	Microsoft Excel W...	91 KB
qa_ahps_60_80_100_with_TT.xlsx	10/7/2014 10:17 AM	Microsoft Excel W...	90 KB
qa_cpc_610_precip_60_80_100_no_TT.xlsx	10/7/2014 11:05 AM	Microsoft Excel W...	90 KB
qa_cpc_610_precip_60_80_100_With_TT.xlsx	10/7/2014 11:10 AM	Microsoft Excel W...	90 KB
qa_cpc_610_temp_60_80_100_no_TT.xlsx	10/7/2014 1:04 PM	Microsoft Excel W...	90 KB
qa_cpc_610_temp_60_80_100_with_TT.xlsx	10/7/2014 1:10 PM	Microsoft Excel W...	90 KB
qa_cpc_814_precip_60_80_100_no_TT.xlsx	10/7/2014 1:53 PM	Microsoft Excel W...	90 KB
qa_cpc_814_precip_60_80_100_with_TT.xlsx	10/7/2014 2:06 PM	Microsoft Excel W...	90 KB
qa_cpc_814_temp_60_80_100_no_TT.xlsx	10/7/2014 2:14 PM	Microsoft Excel W...	90 KB
qa_cpc_814_temp_60_80_100_with_TT.xlsx	10/7/2014 2:17 PM	Microsoft Excel W...	90 KB
qa_cpc_monthly_drought_outlook_60_80_100_no_TT.xlsx	10/7/2014 2:24 PM	Microsoft Excel W...	90 KB
qa_cpc_monthly_drought_outlook_60_80_100_with_TT.xlsx	10/7/2014 2:27 PM	Microsoft Excel W...	90 KB
qa_cpc_monthly_precip_forecast_60_80_100_with_no_TT.xlsx	10/8/2014 3:00 PM	Microsoft Excel W...	89 KB
qa_cpc_monthly_precip_forecast_60_80_100_with_TT.xlsx	10/8/2014 3:56 PM	Microsoft Excel W...	89 KB
qa_cpc_monthly_precip_forecast_updated_60_80_100_with_no_TT.xlsx	10/9/2014 9:01 AM	Microsoft Excel W...	90 KB
qa_cpc_monthly_precip_forecast_updated_60_80_100_with_TT.xlsx	10/9/2014 9:09 AM	Microsoft Excel W...	90 KB
qa_cpc_monthly_temp_forecast_60_80_100_with_no_TT.xlsx	10/8/2014 4:13 PM	Microsoft Excel W...	90 KB

System Test Results

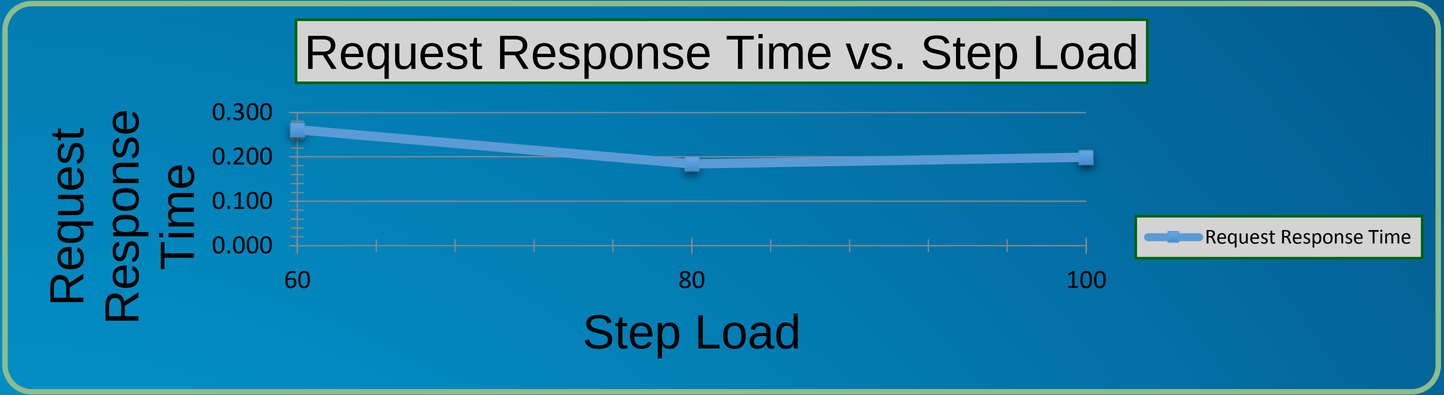


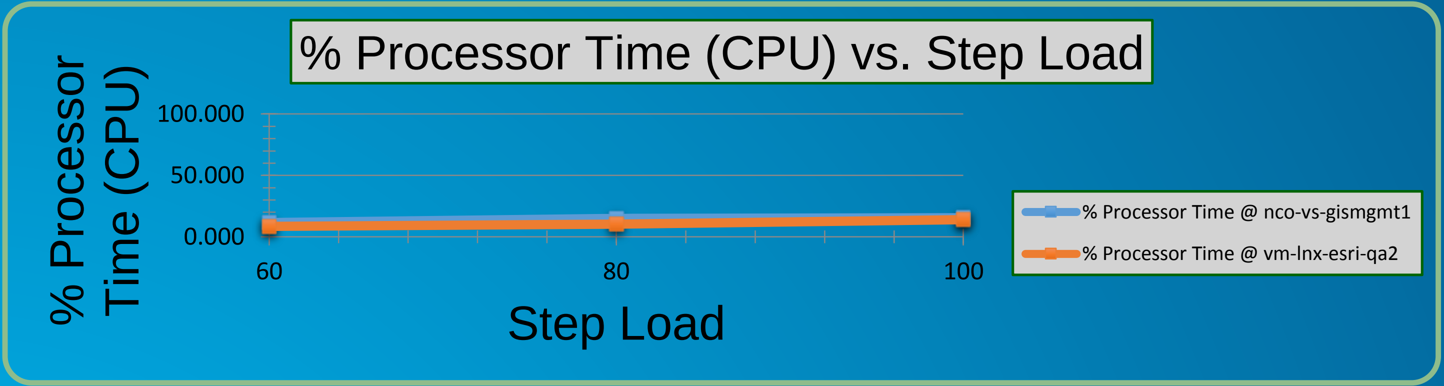
Transactions/Sec	Transactions	31.661
Request Response Time	Requests	2.466
Requests/Sec	Requests	31.748
Passed Requests	Requests	5835
Failed Requests	Requests	0
% Failed Requests	Requests	0.00
HTTP 5xx Requests	Requests	0
HTTP 4xx Requests	Requests	0
HTTP 3xx Requests	Requests	0
HTTP 200 Requests	Requests	5835
Avg. Content Length	Requests	2930.430

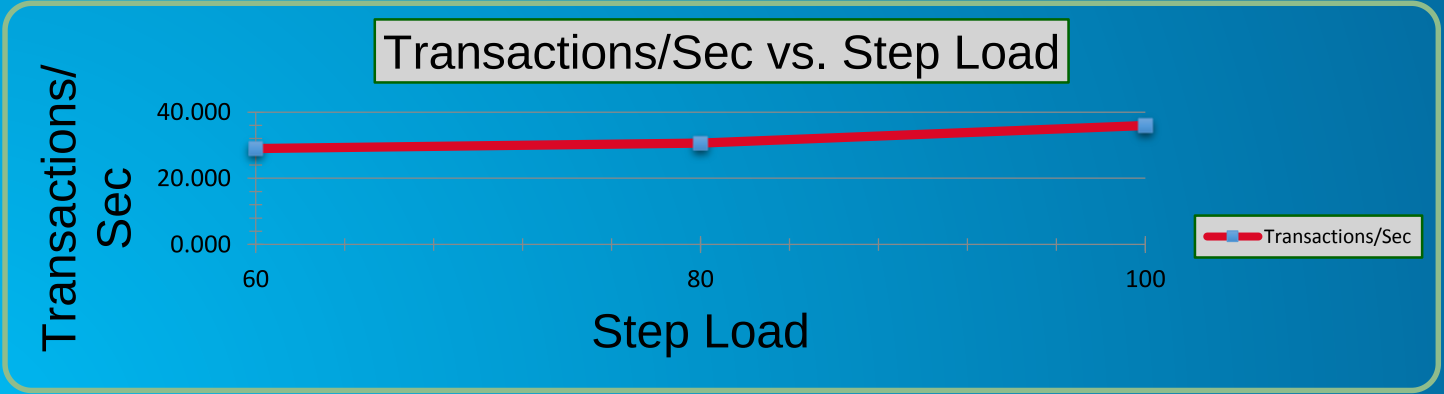
Table of Contents (Chart Hyperlinks)

Transaction Response Time
Transactions|Sec
Request Response Time
Requests|Sec
Request Status
% Processor Time (CPU)
% Idle Time (Disk)
Available Bytes (Memory)
Network Throughput (Network)
Individual Transaction Response
Avg. Content Length (in Bytes)
MBits|Tr
CPU ST|Tr
Key Indicators

System Test Results







Request Response Time @ nco-vs-gismgmt1		
Step Load	Avg. Value	Std. Deviation
60	0.261	0.358
80	0.184	0.213
100	0.199	0.154

% Processor Time @ nco-vs-gismgmt1		
Step Load	Avg. Value	Std. Deviation
60	11.750	8.731
80	15.110	7.871
100	15.647	11.192

% Processor Time @ vm-lnx-esri-qa2		
Step Load	Avg. Value	Std. Deviation
60	8.444	5.725
80	10.417	9.558
100	14.083	9.774

Transactions/Sec @ nco-vs-gismgmt1		
Step Load	Avg. Value	Std. Deviation
60	29.008	11.093
80	30.591	7.048
100	35.965	9.237

Testing and Monitoring of GIS Server(s) – Test Scenarios

- Normal operation under simulated load
- Shutdown and start up of one or more read only slave(s)
- Failover to warm stand by master
- Shutdown / restart up of one or more GIS servers

Testing and Monitoring of GIS Server(s)

- **Initial KPI and Thresholds – RDBMS Server(s)**
  - HTTP collector for selected services
    - Response Time > 2 seconds (will vary)
    - Response Code <> 200
    - Response Length (will vary)
  - System
    - CPU > 70%
    - Memory > 80%

ArcGIS Server Monitoring

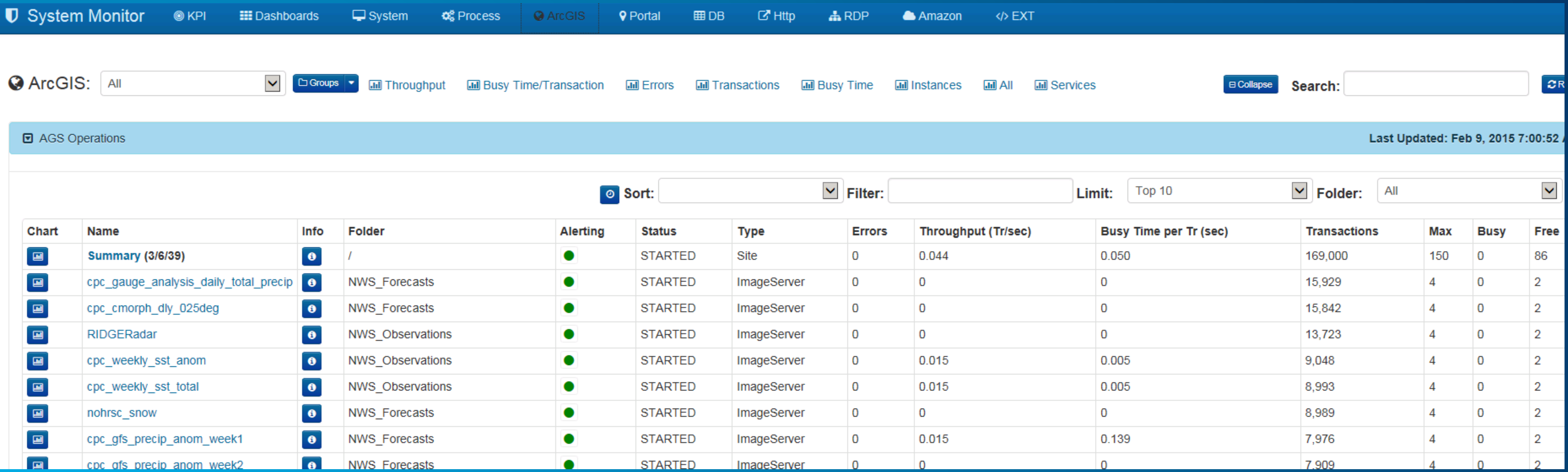


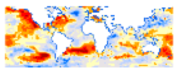
Chart	Name	Info	Folder	Alerting	Status	Type	Errors	Throughput (Tr/sec)	Busy Time per Tr (sec)	Transactions	Max	Busy	Free
	Summary (3/6/39)		/		STARTED	Site	0	0.044	0.050	169,000	150	0	86
	cpc_gauge_analysis_daily_total_precip		NWS_Forecasts		STARTED	ImageServer	0	0	0	15,929	4	0	2
	cpc_cmorph_dly_025deg		NWS_Forecasts		STARTED	ImageServer	0	0	0	15,842	4	0	2
	RIDGERadar		NWS_Observations		STARTED	ImageServer	0	0	0	13,723	4	0	2
	cpc_weekly_sst_anom		NWS_Observations		STARTED	ImageServer	0	0.015	0.005	9,048	4	0	2
	cpc_weekly_sst_total		NWS_Observations		STARTED	ImageServer	0	0.015	0.005	8,993	4	0	2
	nohrsc_snow		NWS_Forecasts		STARTED	ImageServer	0	0	0	8,989	4	0	2
	cpc_gfs_precip_anom_week1		NWS_Forecasts		STARTED	ImageServer	0	0.015	0.139	7,976	4	0	2
	cpc_gfs_precip_anom_week2		NWS_Forecasts		STARTED	ImageServer	0	0	0	7,909	4	0	2

HTTP Service Monitoring

cpc_weekly_sst_anom

Last Updated: Feb 9, 2015 6:22:24 AM

Chart	Name	Alerting	Value	Sample Interval
	Summary	●	None	60
	ResponseTime	●	0.071	60
	Content-Length	●	10,100	60
	Response-Code	●	200	60

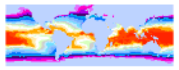


Preview

cpc_weekly_sst_total

Last Updated: Feb 9, 2015 6:26:27 AM

Chart	Name	Alerting	Value	Sample Interval
	Summary	●	None	60
	ResponseTime	●	0.046	60
	Content-Length	●	6,860	60
	Response-Code	●	200	60

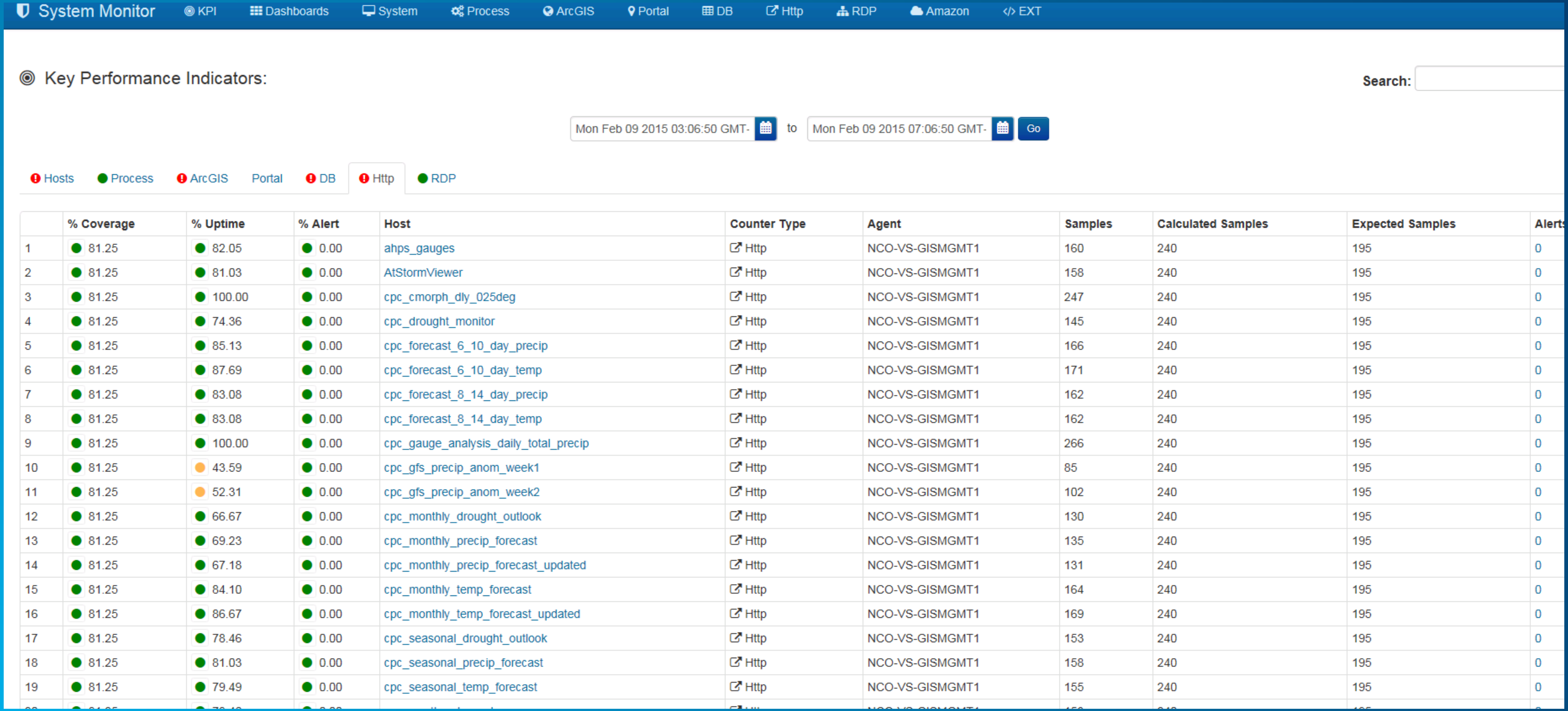


Preview

EpStormViewer

Last Updated: Feb 9, 2015 6:26:27 AM

Service Level KPI Overviews



	% Coverage	% Uptime	% Alert	Host	Counter Type	Agent	Samples	Calculated Samples	Expected Samples	Alerts
1	81.25	82.05	0.00	ahps_gauges	Http	NCO-VS-GISMGMT1	160	240	195	0
2	81.25	81.03	0.00	AtStormViewer	Http	NCO-VS-GISMGMT1	158	240	195	0
3	81.25	100.00	0.00	cpc_cmorph_dly_025deg	Http	NCO-VS-GISMGMT1	247	240	195	0
4	81.25	74.36	0.00	cpc_drought_monitor	Http	NCO-VS-GISMGMT1	145	240	195	0
5	81.25	85.13	0.00	cpc_forecast_6_10_day_precip	Http	NCO-VS-GISMGMT1	166	240	195	0
6	81.25	87.69	0.00	cpc_forecast_6_10_day_temp	Http	NCO-VS-GISMGMT1	171	240	195	0
7	81.25	83.08	0.00	cpc_forecast_8_14_day_precip	Http	NCO-VS-GISMGMT1	162	240	195	0
8	81.25	83.08	0.00	cpc_forecast_8_14_day_temp	Http	NCO-VS-GISMGMT1	162	240	195	0
9	81.25	100.00	0.00	cpc_gauge_analysis_daily_total_precip	Http	NCO-VS-GISMGMT1	266	240	195	0
10	81.25	43.59	0.00	cpc_gfs_precip_anom_week1	Http	NCO-VS-GISMGMT1	85	240	195	0
11	81.25	52.31	0.00	cpc_gfs_precip_anom_week2	Http	NCO-VS-GISMGMT1	102	240	195	0
12	81.25	66.67	0.00	cpc_monthly_drought_outlook	Http	NCO-VS-GISMGMT1	130	240	195	0
13	81.25	69.23	0.00	cpc_monthly_precip_forecast	Http	NCO-VS-GISMGMT1	135	240	195	0
14	81.25	67.18	0.00	cpc_monthly_precip_forecast_updated	Http	NCO-VS-GISMGMT1	131	240	195	0
15	81.25	84.10	0.00	cpc_monthly_temp_forecast	Http	NCO-VS-GISMGMT1	164	240	195	0
16	81.25	86.67	0.00	cpc_monthly_temp_forecast_updated	Http	NCO-VS-GISMGMT1	169	240	195	0
17	81.25	78.46	0.00	cpc_seasonal_drought_outlook	Http	NCO-VS-GISMGMT1	153	240	195	0
18	81.25	81.03	0.00	cpc_seasonal_precip_forecast	Http	NCO-VS-GISMGMT1	158	240	195	0
19	81.25	79.49	0.00	cpc_seasonal_temp_forecast	Http	NCO-VS-GISMGMT1	155	240	195	0

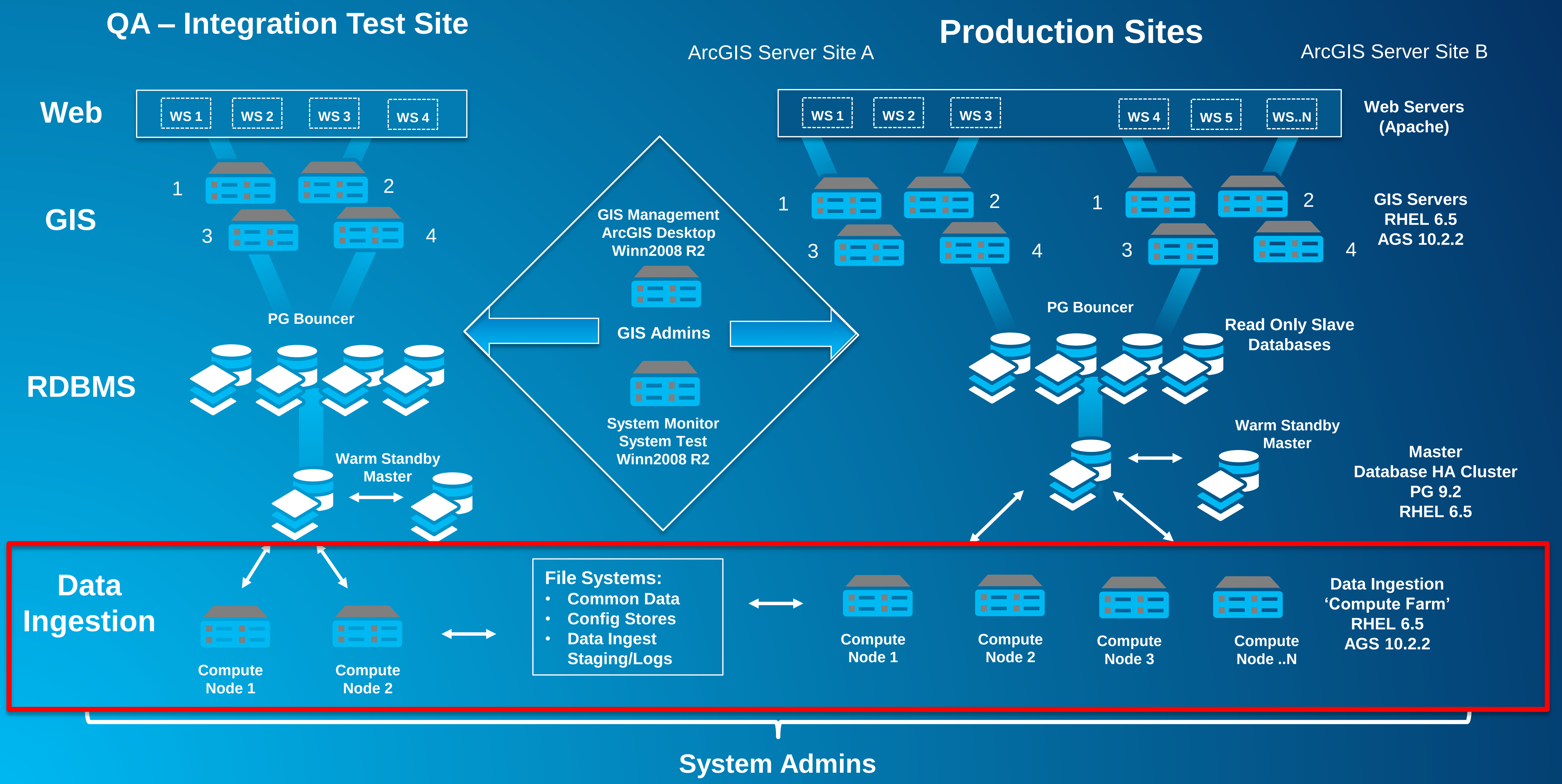
Testing and Monitoring of PostgreSQL RDBMS HA Cluster Test Scenarios

- Normal operation under simulated load
- Failover to warm stand by master
- Shutdown of one or more read only slave(s)
- Addition or start up of read only slave(s)

Initial KPI and Thresholds – RDBMS Server(s)

- Processor utilization > 70%
- Memory utilization > 80% of physical
- Storage utilization > 80% of storage capacity
- Average Disk Seconds / Read > 10ms
- Average Disk Seconds / Write > 10ms

Continuous Update Services – Data Ingestion Tier



Data Ingestion Process Description

Table

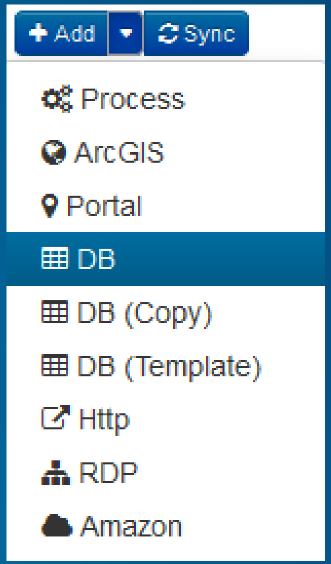
noaa.noaa.IDPDataFlowCluster

df_clust	df_config	df_node	df_server	df_activity	df_status	df_runstate	df_activity_timeout	srvr_mem	df_proc_mem	df_cpu	df_stage_dsk	df_scratch_dsk	df_proc_pid
1	idp_cpc1	2	noaaidp01.esri.com	2/6/2015 4:54:30 PM	1	1	90	32	231.765499	51	34	34	3411
1	idp_cpc1	3	noaapostgredb.esri.com	2/6/2015 4:54:30 PM	1	1	90	41	372.119874	60	34	34	8162
1	HRRR	5	mhamann.esri.com	2/6/2015 4:54:30 PM	1	1	90	62	126.679688	4	19	19	15196
1	idp_t1247	4	noaapostgredb.esri.com	2/6/2015 4:54:30 PM	1	1	90	41	406.146576	60	34	34	7726
1	idp_t1247	1	noaaidp01.esri.com	2/6/2015 4:54:30 PM	1	1	90	32	275.234544	51	34	34	3426

- Data scripts/processes run against configuration tables in RDBMS that define groups of servers concurrently updating specific sets of source data
- Each process logs process/status metrics to the ‘cluster’ table every 60 seconds

Data Ingestion Process Description

- **System Monitor can in turn be configured with DB/Query counters against ingest process tables to track data ingestion process status and associated resource usage.**



Monitoring of Data Ingestion Processes - Scenarios

- Compute Node shutdown (one and/or all)
- Unexpected shutdown/exception in data ingestion program/process
- Master database failover to warm standby
- Missing data in common data repository

Monitoring of Data Ingestion Processes - KPI

- Compute Node(s) overall CPU, memory
- Number of running data ingest processes
- Number of RDBMS connections (master)
- For each data ingest process:
  - Process run status
  - Server CPU, memory
  - Process memory
  - Time elapsed since last data update (in units as configured for that data source)
  - Number of features/images added and/or deleted during the last update
  - Available disk space on ‘data staging’ folders/mounts

Looking Forward

Continue refinement of KPI’s, thresholds, and alerts

- Continue tuning service performance based on KPI findings
- Isolate and document KPI event/condition ‘signatures’ and identify appropriate responses, procedures, CR’s and support tickets, etc.
- Identify appropriate integration points with NCO’s existing monitoring/alerting systems and associated response protocols

Don’t forget to complete a session evaluation form!

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