Transitioning from a Physical to Virtual Production Environment

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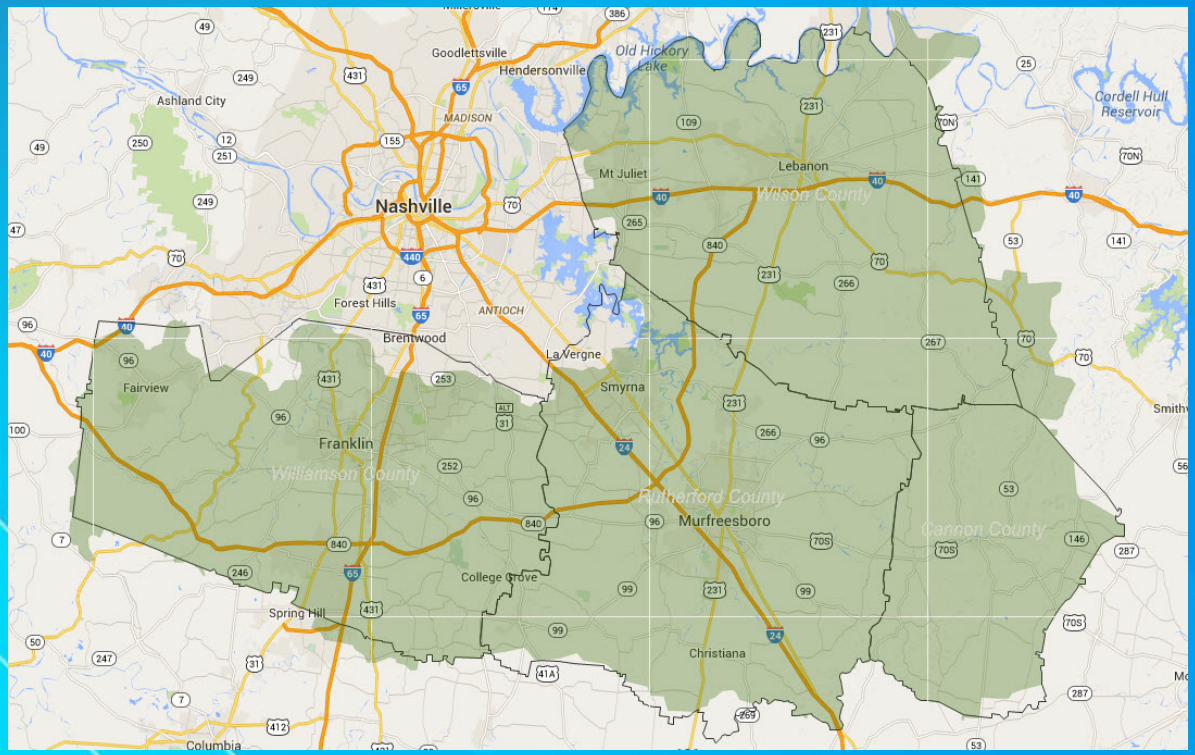
Middle Tennessee Electric Membership Corp

Introduction – MTEMC

- Distribute electricity to ~200,000 residential & business members
- TN's largest electric cooperative and 6th largest in U.S.
- Service area ~2,100 sq miles

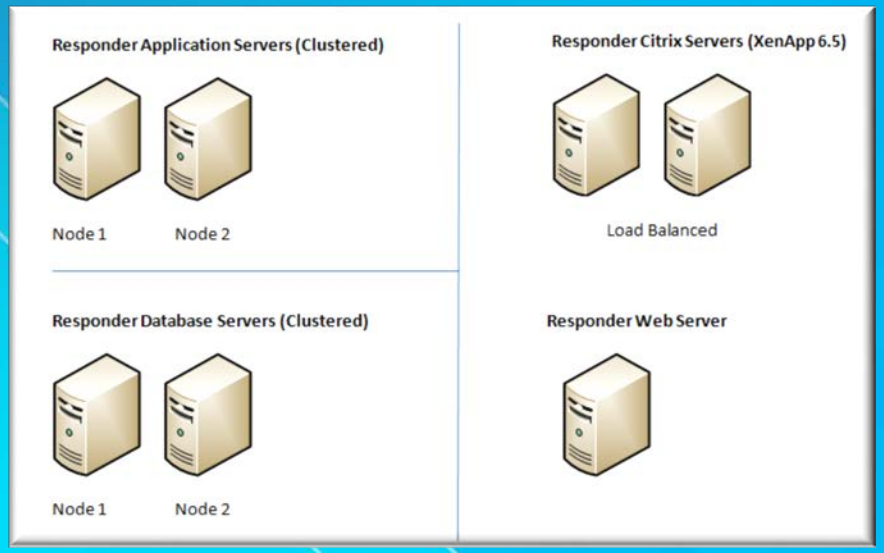


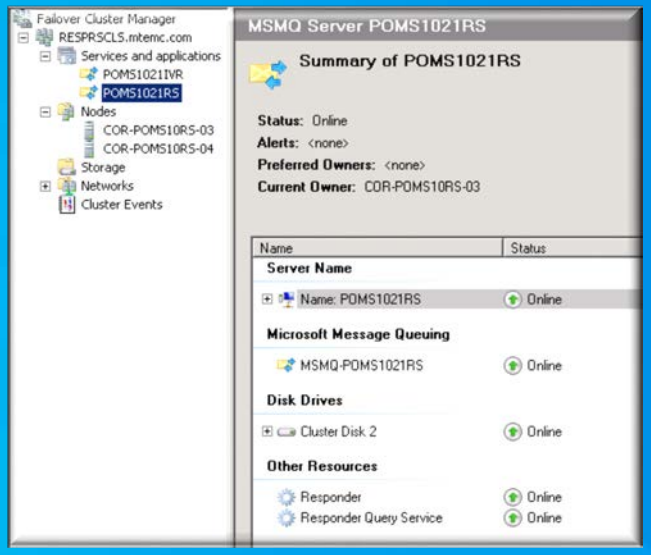
Introduction – MTEMC GIS Usage

- Esri and ArcFM client for 10 years
- Currently using Esri 10.2.1 / ArcFM 10.2.1a
- GIS used for Engineering (ArcFM Designer), Joint Use (ArcFM Inspector), Outage Management (ArcFM Responder), Vegetation Management (Clearion), Member Services (custom Web Dashboard)
- Every department has GIS users in some capacity
- The number of Applications and Services built off our Esri foundation increases each year

Introduction – MTEMC GIS Landscape

- Environments include Development, Test, Production, and Disaster Recovery
- >40 GIS servers
- Citrix XenApp 6.5 used to deliver most applications
- Database and Application servers clustered





Introduction – MTEMC Physical vs. Virtual

- Historically, GIS Production servers were physical
  - Virtual servers for Development and Test
  - Physical preference for Production due to Performance, ArcFM recommendations, proven technology
- Currently, Production servers moving into virtual realm
  - Cost benefits
  - Easier system provisioning and deployment
  - No need to build from scratch with imaging
  - Monitoring and reviewing information faster
  - Improve disaster recovery/ lower downtime

Introduction – Esri Hardware Specs

Hardware requirements

http://resources.arcgis.com/en/help/system-requirements/10.2/

	Advanced, Basic, Standard
CPU Speed	2.2 GHz minimum ; Hyper-threading (HHT) or Multi-core recommended
Processor	Intel Pentium 4, Intel Core Duo, or Xeon Processors; SSE2 minimum Run this Microsoft utility from your Windows command prompt to check your processor. See Dual or dual-core support policy.
Memory/RAM	2 GB minimum
Display properties	24-bit color depth
Screen resolution	1024 x 768 recommended minimum at normal size (96 dpi)
Swap space	Determined by the operating system; 500 MB minimum.
Disk space	2.4 GB In addition, up to 50 MB of disk space may be needed in the Windows System directory (typically, C:\Windows\System32). You can view the disk space requirement for each of the 10.1 components in the Setup program. If using ArcGlobe, additional disk space may be required. ArcGlobe will create cache files when used.
Video/Graphics adaptor	64 MB RAM minimum, 256 MB RAM or higher recommended. NVIDIA, ATI, and Intel chipsets supported. 24-bit capable graphics accelerator OpenGL version 2.0 runtime minimum is required, and Shader Model 3.0 or higher is recommended. Be sure to use the latest available driver.
Networking Hardware	Simple TCP/IP, Network Card, or Microsoft Loopback Adapter is required for the license manager.

Introduction – ArcFM Hardware Specs

Minimum Responder server hardware required:

- Dual-processors, 2.4 GHz (3 GHz or higher recommended)
- 4 GB RAM
- 60 GB available hard drive space
- Full duplex 100 Mbps LAN port

https://infrastructurecommunity.schneider-electric.com/docs/DOC-2667

Virtual Server Specs – Load Testing & Analysis

- Will describe load testing and analysis tools
  - ArcGIS PerfQA Analyzer
  - SQL Server 2008 R2 Analyses
  - ArcFM TroubleMaker and Telemetry – Load Testing
  - Perfmon
  - Standard Performance Test Steps
  - Transitioning from subjective to objective performance measures
  - Final Specifications
  - Lessons Learned

Virtual Server Specs – Load Testing & Analysis

- ArcGIS PerfQA Analyzer 10.2 Tool
  - Captures render and edit times in ArcGIS
  - User can generate custom scripts
  - Basic ArcMap functions can be listed in script
  - Not able to do advanced ArcFM functions (ex: manage out a Responder incident; create a new job in Designer).
  - Configured on Citrix XenApp servers so that it runs as a "user"
  - Unsupported by Esri Technical Support

  - http://blogs.esri.com/esri/supportcenter/2014/02/03/calibrating-arcgis-performance-with-perfqanalyzer-new-build-available-for-download/

Virtual Server Specs – Load Testing & Analysis

TestResults_Under Load.log - Notepad

File Edit Format View Help

```
STEP#5: Zoom to scale 1:3000
Arg:[0]3000
SETSCALE:154
Untitled
Rendering Start Time: [2015-02-02 15:42:43,329]
Layer, Background, Geography, Annotation, Selection, GeoSelection, Total
Service Area, na, 0.00916, 0.00028, 0.00011, na, 0.00954
Service Point_w/Address&MeterLabels, na, 0.01530, 0.00100, 0.00013, na, 0.01643
Responder_cached, na, 0.26359, 0.00772, 0.00093, na, 0.27224
Annotations, na, 0.08343, 0.00011, 0.00082, na, 0.08435
Electric, na, 0.23751, 0.03059, 0.00235, na, 0.27044
Landbase, na, 0.04599, 0.00332, 0.00057, na, 0.04987
OS_County, na, 0.00000, 0.00000, 0.00000, na, 0.00000
County, na, 0.01148, 0.00603, 0.23344, na, 0.25096
All Layers, 0.00057, na, na, na, 0.00007, 0.95447

Pausing for 2000 milliseconds...

STEP#6: Select by Attribute: Light=50
Arg:[0]Light
Arg:[1]OBJECTID=50
SelectByAttribute Features:1 Time:9
Pausing for 2000 milliseconds...

STEP#7: Zoom to Selected
Arg:[0]{AB073B49-DE5E-11D1-AA80-00C04FA37860}
COMMANDCLICK:155
Untitled
Rendering Start Time: [2015-02-02 15:42:48,852]
Layer, Background, Geography, Annotation, Selection, GeoSelection, Total
Service Area, na, 0.00818, 0.00029, 0.00011, na, 0.00857
Service Point_w/Address&MeterLabels, na, 0.02082, 0.00100, 0.00013, na, 0.02195
Responder_cached, na, 0.11179, 0.00781, 0.00092, na, 0.12052
Annotations, na, 0.00014, 0.00010, 0.00009, na, 0.00033
Electric, na, 0.30970, 0.03144, 0.00260, na, 0.34373
Landbase, na, 0.04856, 0.00314, 0.00078, na, 0.05247
OS_County, na, 0.00000, 0.00000, 0.00000, na, 0.00000
County, na, 0.00966, 0.00610, 0.33436, na, 0.35012
All Layers, 0.00073, na, na, na, 0.00006, 0.89848

Pausing for 2000 milliseconds...

Clear Selection
ClearSelection Time:7
Untitled
Rendering Start Time: [2015-02-02 15:42:52,034]
Layer, Background, Geography, Annotation, Selection, GeoSelection, Total
Service Area, na, 0.00809, 0.00028, 0.00011, na, 0.00847
Service Point_w/Address&MeterLabels, na, 0.02019, 0.00100, 0.00013, na, 0.02132
Responder_cached, na, 0.09908, 0.00818, 0.00092, na, 0.10818
Annotations, na, 0.00013, 0.00012, 0.00010, na, 0.00035
Electric, na, 0.30892, 0.03365, 0.00241, na, 0.34498
```

Virtual Server Specs – Load Testing & Analysis

Load - Notepad

File Edit Format View Help

```
$sleep = 15
$howmany = 15

$DataCollectorSet = new-object -COM Pla.DatacollectorSet
$DataCollectorSet.Query("User\ArcGIS Performance Test", $null)
$DataCollectorSet.Start(0)

for ($i=1; $i -le $howmany; $i++)
{
    Write-Host "Starting [$i]"
   & 'C:\Program Files (x86)\ArcGIS\Desktop10.2\bin\ArcMap.exe' C:\PerfQAnalyzer\Pathfinder\blank.mxd /scr:c:\PerfQAnalyzer\Pathfinder
\Perfq_NFR.scr /log:c:\perfqanalyzer\pathfinder\perfq_nfr_$i.log /sr /m /hwa
   sleep -seconds $sleep
}
```

Delay (secs) between starting instances

# of Instances that will be started

Name of PerfMon file

Initial .mxd that will be loaded (should be an empty .mxd)

Verify ArcMap path

Name of log file. (Each instance will create a new file. Leave the $i suffix in place to allow file name to increment.)

C:\PerfQAnalyzer\bin

Computer ▸ Local Disk (C:) ▸ PerfQAnalyzer ▸ bin

Organize ▾ Open with... New folder

Favorites
Desktop
Downloads
Recent Places

Libraries
Documents
Music
Pictures
Videos

Computer
Local Disk (C:)
nathanieleverett (\\mt
infosys (\\mtemc.com\
common (\\mtemc.com

Network

Name	Date modified	Type	Size
ArcFM_PerfQ_Tools.dll	10/23/2014 4:41 AM	Application extension	34 KB
ARCFMLOGINOBJECT.CFG	11/7/2014 8:49 AM	CFG File	1 KB
ArcFMLoginObject.dll	10/24/2014 9:23 PM	Application extension	72 KB
CommandPrompt.cmd	7/10/2014 10:31 AM	Windows Command ...	1 KB
ESRI.DisplayCommand.dll	7/10/2014 10:31 AM	Application extension	9 KB
ESRI.EditCommand.dll	7/10/2014 10:31 AM	Application extension	63 KB
ESRI.ScriptEngine.dll	7/10/2014 10:31 AM	Application extension	34 KB
Esri_PerfQ_Tools1.dll	10/23/2014 2:34 PM	Application extension	53 KB
InstallHelper.dll	7/10/2014 10:31 AM	Application extension	8 KB
InstallHelper.InstallState	11/6/2014 2:40 PM	INSTALLSTATE File	3 KB
PerfQAnalyzer.esriAddIn	7/10/2014 10:31 AM	Esri AddIn File	587 KB
PerfQAnalyzer.exe	7/10/2014 10:31 AM	Application	1,146 KB
PerfQAnalyzerNM.exe	7/10/2014 10:31 AM	Application	1,151 KB

ryan_ScriptDes1.txt - Notepad

File Edit Format View Help

```
SETARCFMWORKSPACE
// ---------------------------------------------------------------
Pause 2000
WriteLine STEP#1: Open Designer System Stored Display
OPENSTOREDDISPLAY Responder Desktop - TOMS,SYSTEM
startrendering

// ---------------------------------------------------------------

Pause 2000
WriteLine STEP#2: Zoom to full extent
COMMANDBUTTON {0830FB35-7EE6-11D0-87EC-080009EC732A}

// ---------------------------------------------------------------

Pause 2000
WriteLine STEP#3: Zoom to scale 1:1200
SETSCALE 1200

// ---------------------------------------------------------------


Pause 2000
WriteLine STEP#4: Select by Attribute: Light=50
SELECTLAYERBYATTRIBUTE Light,OBJECTID=50

Pause 2000
WriteLine STEP#5: Zoom to Selected
COMMANDBUTTON {AB073B49-DE5E-11D1-AA80-00C04FA37860}

Pause 2000
WriteLine Clear Selection
CLEARSELECTION

// ---------------------------------------------------------------

Pause 2000
WriteLine STEP#6: Select by Attribute: Light=51114
SELECTLAYERBYATTRIBUTE Light,OBJECTID=51114
```

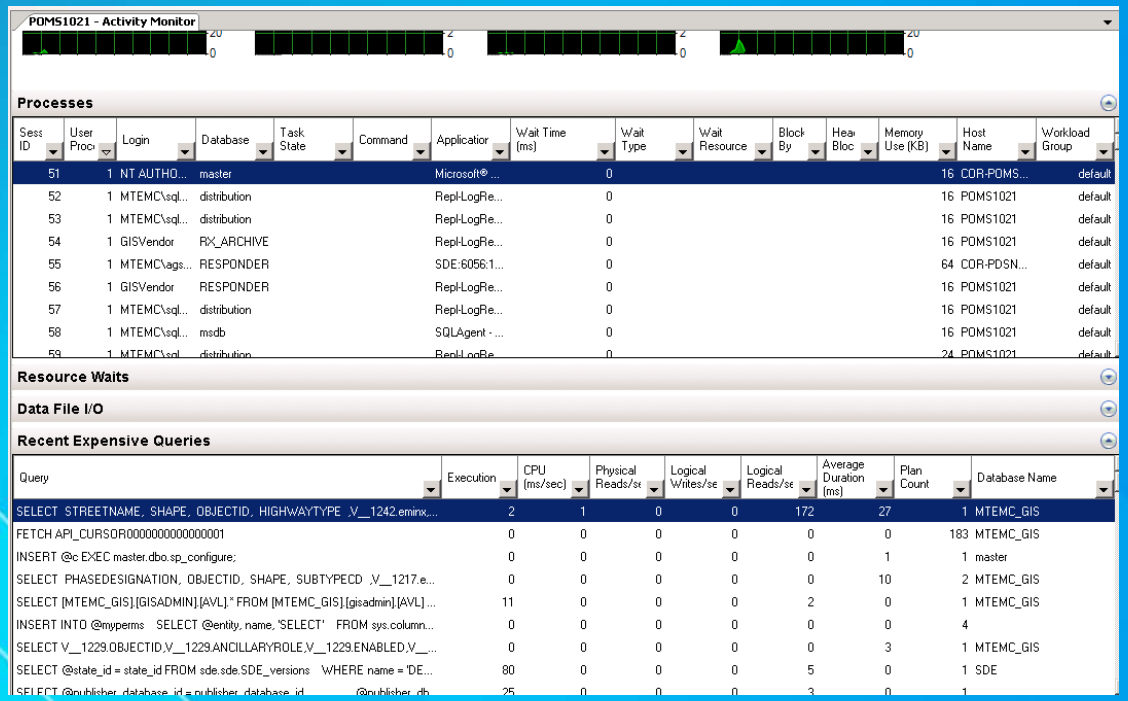
Virtual Server Specs – Load Testing & Analysis

- **ArcGIS PerfQA AnalyzerTool**
  - **Able to evaluate different components and associated impact on performance (Total Run Time of script)**

A	B	C	D	E	F	G	H	I	J	K
TEST RESPONDER 10.2.1 - PerfQA Tests										
Date	**Time**	**Script Name**	**Environment**	**Total Run Time**	**CTX CPU's**	**CTX RAM**	**DB CPU's**	**DB RAM**	**SQL Memory**	**# of Steps**
1/14/2015	3:11pm	TOMS_ScriptDes1	TEST	**12:08**	6 Cores	24GB	4 Cores	32GB	36 GB	100
1/14/2015	3:26pm	TOMS_ScriptDes1	TEST	**11:58**	6 Cores	24GB	4 Cores	32GB	36 GB	100
PROD RESPONDER 10.2.1 - PerfQA Tests										
Date	**Time**	**Script Name**	**Environment**	**Total Run Time**	**CTX CPU's**	**CTX RAM**	**DB CPU's**	**DB RAM**	**SQL Memory**	**# of Steps**
1/14/2015	3:27pm	POMS_ScriptDes1	PROD	**6:44**	12 Cores	24GB	8 Cores	48GB	36 GB	100
1/14/2015	3:37pm	POMS_ScriptDes1	PROD	**6:42**	12 Cores	24GB	8 Cores	48GB	36 GB	100

Virtual Server Specs – Load Testing & Analysis

- SQL Server 2008 R2
- DBA Analysis using Activity Monitor and traces with SQL Server Profiler
  - Impactful queries and outliers
  - Missing indexes



POMS1021 - Activity Monitor

Processes

Sess ID	User Proc	Login	Database	Task State	Command	Applicatior	Wait Time (ms)	Wait Type	Wait Resource	Block By	Heav Bloc	Memory Use (KB)	Host Name	Workload Group
51	1	NT AUTHO...	master			Microsoft® ...	0					16	COR-POMS...	default
52	1	MTEMC\sql...	distribution			Repl-LogRe...	0					16	POMS1021	default
53	1	MTEMC\sql...	distribution			Repl-LogRe...	0					16	POMS1021	default
54	1	GISVendor	RX_ARCHIVE			Repl-LogRe...	0					16	POMS1021	default
55	1	MTEMC\ags...	RESPONDER			SDE:6056:1...	0					64	COR-PDSN...	default
56	1	GISVendor	RESPONDER			Repl-LogRe...	0					16	POMS1021	default
57	1	MTEMC\sql...	distribution			Repl-LogRe...	0					16	POMS1021	default
58	1	MTEMC\sql...	msdb			SQLAgent - ...	0					16	POMS1021	default
59	1	MTEMC\sql...	distribution			Repl-LogRe...	0					24	POMS1021	default

Resource Waits

Data File I/O

Recent Expensive Queries

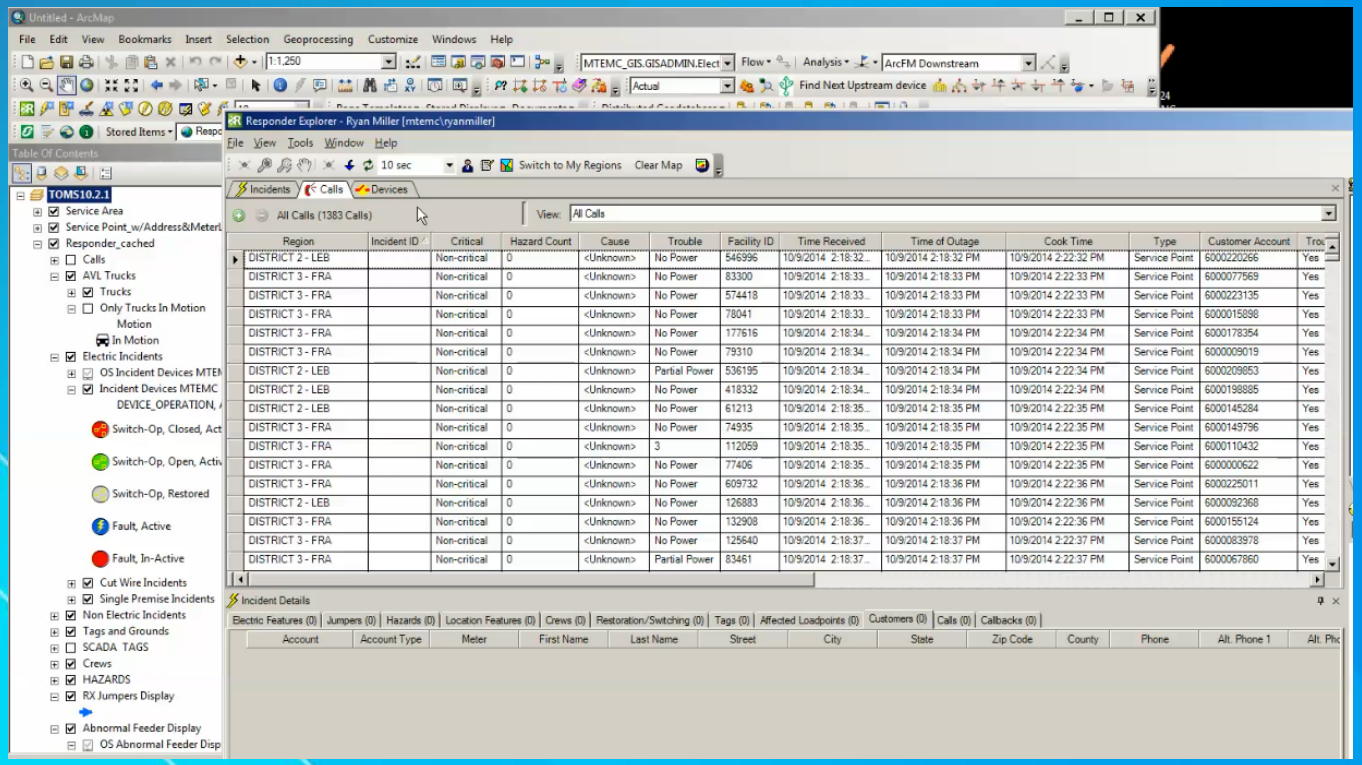
Query	Execution	CPU (ms/sec)	Physical Reads/se	Logical Writes/se	Logical Reads/se	Average Duration (ms)	Plan Count	Database Name
SELECT STREETNAME, SHAPE, OBJECTID, HIGHWAYTYPE ,V__1242.eminx,...	2	1	0	0	172	27	1	MTEMC_GIS
FETCH API_CURSOR0000000000000001	0	0	0	0	0	0	183	MTEMC_GIS
INSERT @c EXEC master.dbo.sp_configure;	0	0	0	0	0	1	1	master
SELECT PHASEDESIGNATION, OBJECTID, SHAPE, SUBTYPECD ,V__1217.e...	0	0	0	0	0	10	2	MTEMC_GIS
SELECT [MTEMC_GIS].[GISADMIN].[AVL].* FROM [MTEMC_GIS].[gisadmin].[AVL] ...	11	0	0	0	2	0	1	MTEMC_GIS
INSERT INTO @myperms SELECT @entity, name, 'SELECT' FROM sys.column...	0	0	0	0	0	0	4	
SELECT V__1229.OBJECTID,V__1229.ANCILLARYROLE,V__1229.ENABLED,V__...	0	0	0	0	0	3	1	MTEMC_GIS
SELECT @state_id = state_id FROM sde.sde.SDE_versions WHERE name = 'DE...	80	0	0	0	5	0	1	SDE
SELECT @publisher_database_id = publisher_database_id @publisher_db...	25	0	0	0	3	0	1	

Virtual Server Specs – Load Testing & Analysis

- DB Findings
  - Rebuild spatial indexes
  - Rebuild spatial extents
  - Update statistics
  - Raise SQL server memory allocation
  - MDOP value = 1 (http://support.esri.com/cn/knowledgebase/techarticles/detail/38871)

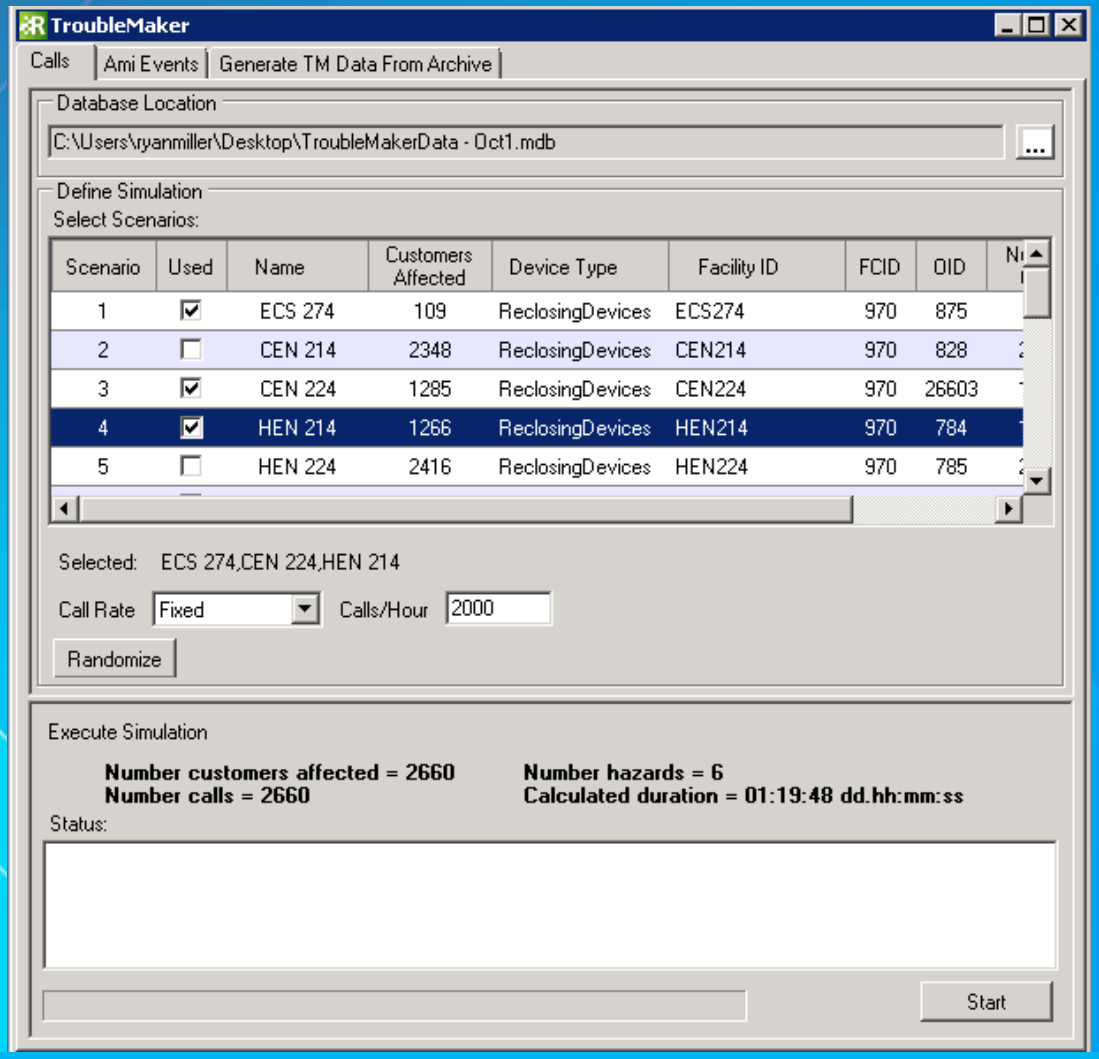
Virtual Server Specs – Load Testing & Analysis

- ArcFM Responder “TroubleMaker” Application
  - Simulation of large scale outages
  - Customizable on devices, call rates, etc
  - Reduces need for extra technicians to assist in testing



Virtual Server Specs – Load Testing & Analysis

- **ArcFM Responder "TroubleMaker" Application**



Virtual Server Specs – Load Testing & Analysis

- ArcFM Responder “Telemetry” Application
  - Gathers statistical info on the processing of Rx data

Item Catgeories

- Database: Metric capturing time to perform an insert, update, delete, or read on the database
- Detail: Metric capturing one specific element of a process in the code
- Service: Metric capturing service performance on a server machine
- User: Metric based on performance of a specific Responder function that an end user would experience

Virtual Server Specs – Load Testing & Analysis

- **ArcFM Responder "Telemetry" Application**

DB Browser for SQLite - C:/Users/ryanmiller/Desktop/APRIL_MAY 2015/completed/PATCH 1229/Telemetry Analysis of Patch/pre patch install/telemetry.2015-04-16-1050-5377.db

File Edit View Help

New Database | Open Database | Write Changes | Revert Changes

Database Structure | Browse Data | Edit Pragmas | Execute SQL

SQL 1

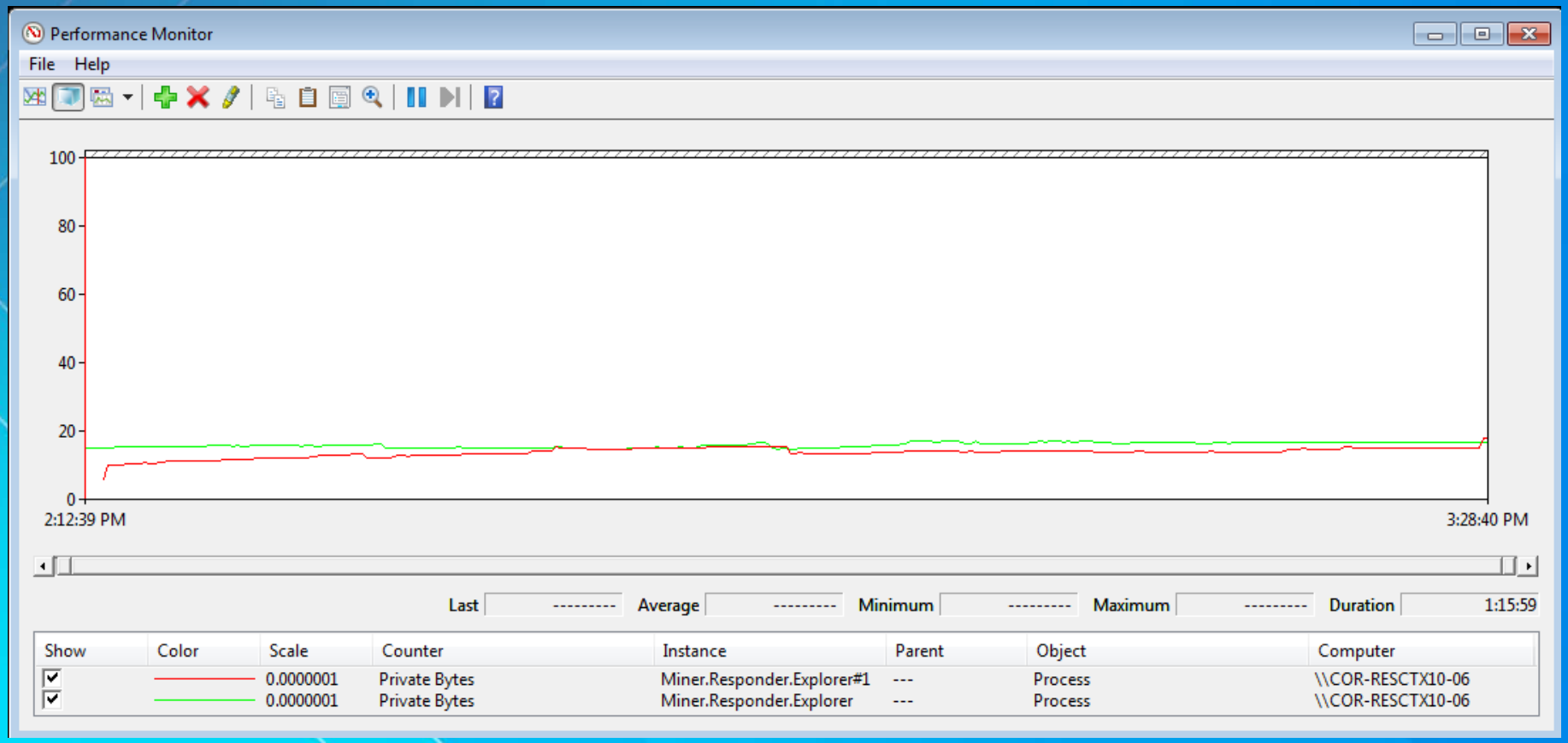
```
1 select eventname, count(*), min(telemetry), max(telemetry), avg(telemetry) from rx_telemetry group by eventname order by avg(telemetry)
2
```

	EventName	count(*)	min(telemetry)	max(telemetry)	avg(telemetry)
17	QueryServicesProxy.ExecuteRequest	14	0.0100609	1.4140693	0.228849642857143
18	DataServices.ApplyPostSubmitRules	8	0.0053405	2.0684603	0.3030863
19	IDM.SharedIncidentLoadpoints	1	0.3227386	0.3227386	0.3227386
20	DataWriter.Write.Deleted	6	0.0013273	1.9673592	0.335164966666667
21	DataWriter.Write.ModifiedCurrent	8	0.0018167	3.3024107	0.415771225
22	Tracing.FindFeedPath	1	0.4482696	0.4482696	0.4482696
23	SubmitDataWriter.Write	8	0.0031587	3.3192871	0.6710972625
24	IDMLoadpointsHelper.ProcessLoadpointsAndTransformers	1	1.12433	1.12433	1.12433
25	DataServices.ExecuteRequest	16	2.24e-05	21.6882634	1.57682895
26	DataServices.ApplyPreSubmitRules	8	0.0132118	13.3339332	1.74622995
27	IDM.ProcessDevice	1	1.8182592	1.8182592	1.8182592

```
31 Rows returned from: select eventname, count(*), min(telemetry), max(telemetry), avg(telemetry) from rx_telemetry group by eventname
order by avg(telemetry) (took 26ms)
```

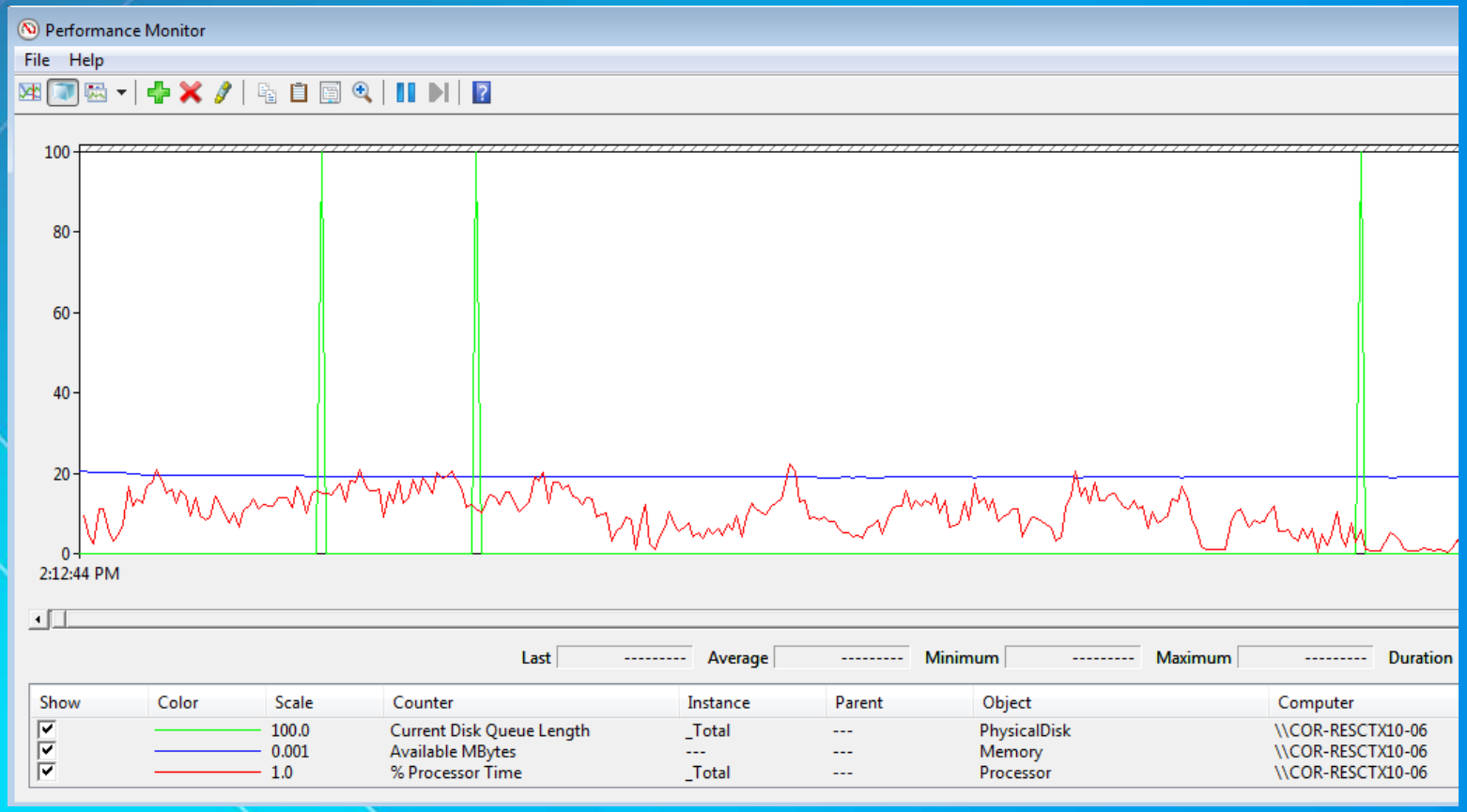
Virtual Server Specs – Load Testing & Analysis

- PerfMon Analysis: performed under “normal” and “load testing” scenarios
- Responder Explorer – primary Dispatcher application



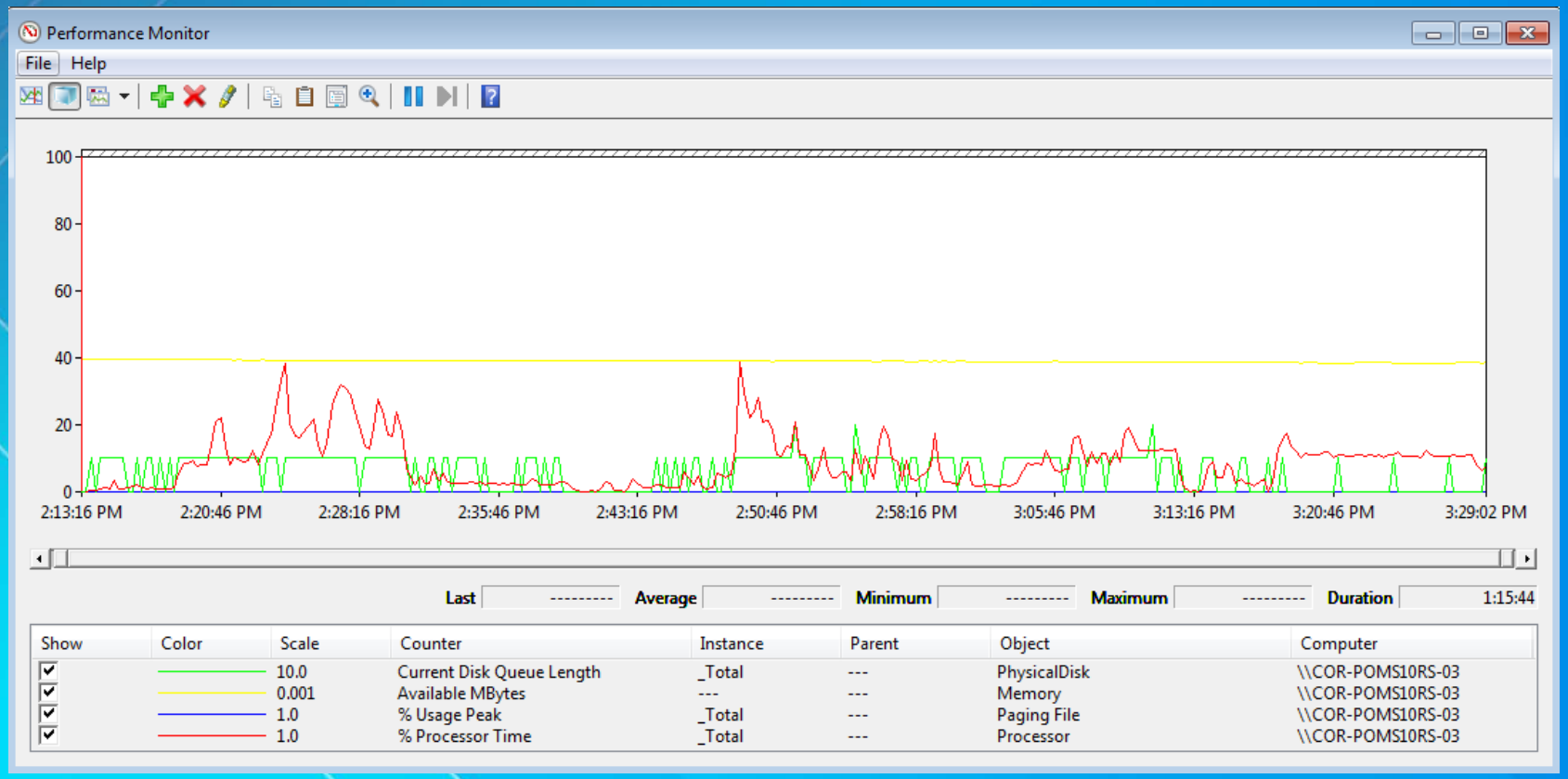
Virtual Server Specs – Load Testing & Analysis

- **PerfMon Analysis**
  - **Citrix Servers - Current Disk Queue Length, Available Mbytes, % Processor Time**



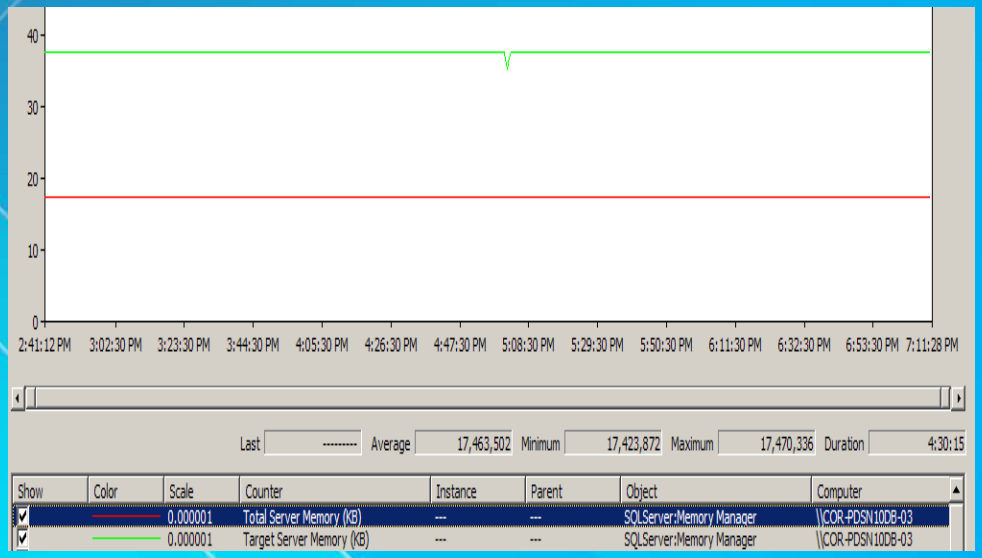
Virtual Server Specs – Load Testing & Analysis

- Perfmon Analysis
- Application Servers - Current Disk Queue Length, Available Mbytes, % Usage Peak, % Processor Time



Virtual Server Specs – Load Testing & Analysis

- Perfmon Analysis
- Database servers - TOTAL SERVER MEMORY is the amount of memory SQL Server is consuming, while the TARGET SERVER MEMORY is the amount it thinks is “optimal”. In this case, the total consumed is well under the target, meaning that SQL Server is using all the memory that it thinks it should.



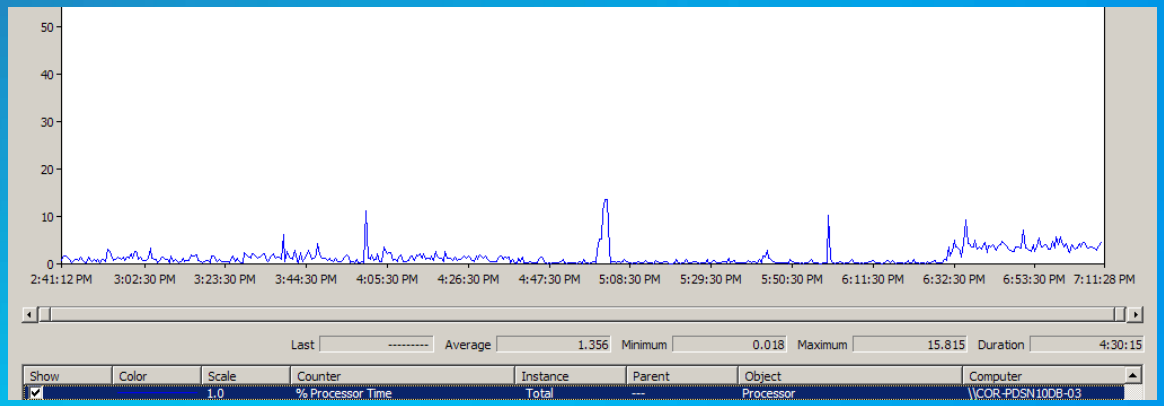

```
SELECT  OBJECT_NAME
 ,counter_name
 ,CONVERT(VARCHAR(10),cntr_value) AS cntr_value
 FROM sys.dm_os_performance_counters
 WHERE ((OBJECT_NAME LIKE '%Manager%')
 AND(counter_name like '%Server Memory%'))
```

Results | Messages

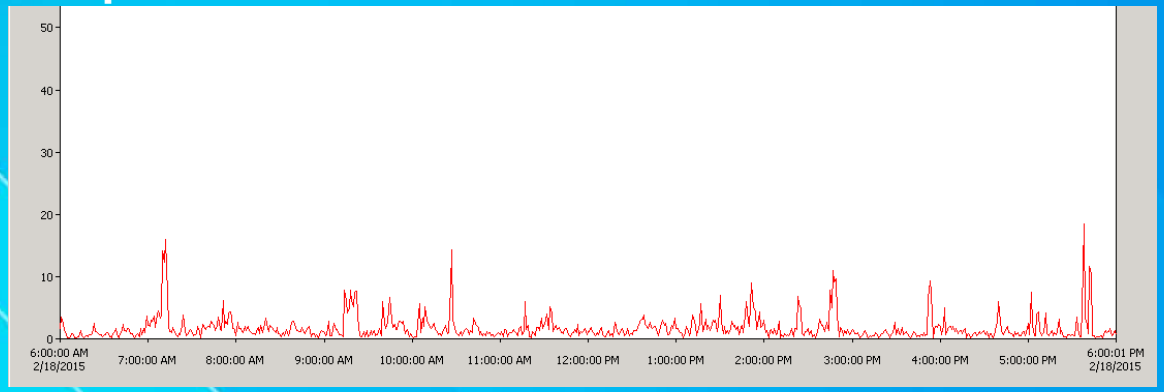
	OBJECT_NAME	counter_name	cntr_value
1	SQLServer:Memory Manager	Target Server Memory (KB)	37748736
2	SQLServer:Memory Manager	Total Server Memory (KB)	12532608

Virtual Server Specs – Load Testing & Analysis

- Perfmon Analysis
- Database servers – CPU UTILIZATION
  - ArcFM Designer DB ~less than 25% utilization

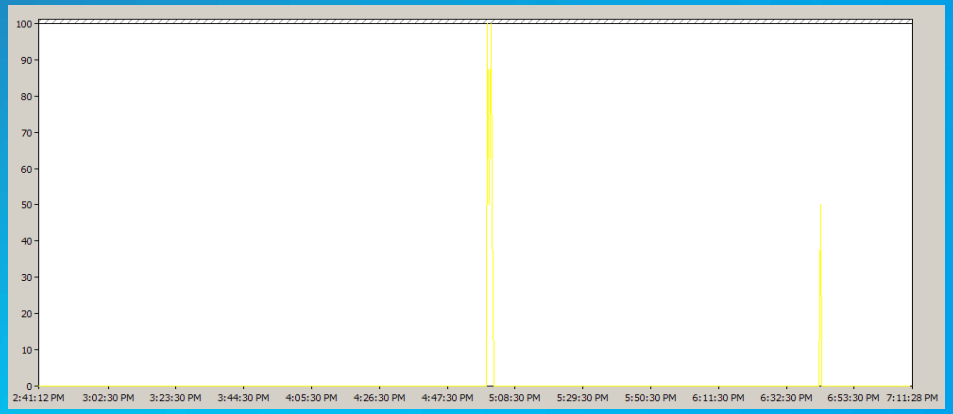


  - ArcFM Responder DB ~less than 25% utilization

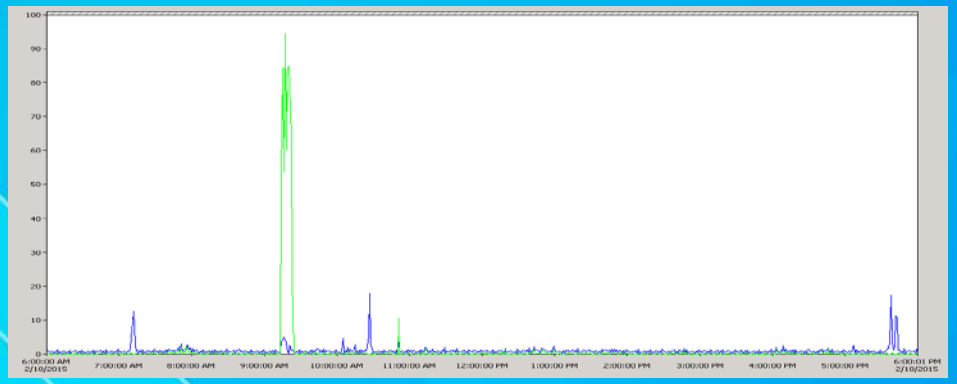


Virtual Server Specs – Load Testing & Analysis

- Perfmon Analysis
- Database servers – DISK UTILIZATION
  - ArcFM Designer DB ~low with some expected peaks



  - ArcFM Responder DB ~low with some expected peaks



Final Specifications: Virtual Production Servers

- 2 HP DL580's
- Dedicated to GIS servers

580 #1				580 #2		
CPUs	GB RAM	Server		CPUs	GB RAM	Server
8	48	COR-POMS10RS-03		8	48	COR-PDSN10DB-03
12	24	COR-DESCTX10-01		12	24	COR-DESCTX10-02
12	24	COR-DESCTX10-03		12	24	COR-DESCTX10-04
12	24	COR-RESCTX10-05		12	24	COR-RESCTX10-06
8	48	COR-PDSN10DB-04		8	48	COR-POMS10RS-04
8	24	COR-PDSN10AP-04		8	24	COR-PDSN10AP-03
8	24	COR-PDSN10IM-02		12	48	COR-PDSN10WB-02
8	48	COR-POMS10DB-03		8	48	COR-POMS10DB-04
8	16	COR-POMS10WS-02				
84	**280**			**80**	**288**	

Final Specifications: Virtual Production Servers

- SQL Server Memory Allocation set to 36GB out of 48GB available on our DB servers
- Database servers have 8 cores and 48GB RAM.
- Citrix servers have 12 cores and 48GB RAM.

  [Avg. Virtual Bytes(max 4) – 1.5GB(shared)] * # of Users] + 2GB(OS) +1.5GB shared

  - So our equation looked like the following(we are expecting 15 max users per citrix server):

$$[(2.5 – 1.5) * 15]+2 +1.5$$

$$[(1)*15]+2 + 1.5$$

15 + 2 + 1.5 = 18.5GB…..start with 24 GB

- Designer Application servers have 8 cores and 24GB RAM.
- OMS Application servers have 8 cores and 48GB RAM.

Lessons Learned

- There is a need for expertise at each level – DBA, server architecture, application, etc. TEAM EFFORT
- Stand alone performance testing is not enough, you must do LOAD TESTING
- Application minimum hardware specs are generic, need to CUSTOMIZE YOUR SOLUTION based on size of user group, what custom processes your applications do, network limits, and landscape design
- CONSISTENT TESTING for each variable is necessary to provide proper analysis
- Having and sharing OBJECTIVE METRICS will increase the “buy-in” of functional users
- DOCUMENTATION of functional users’ acceptable performance level

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