

# Why is My Map So Slow?

Image Storage Techniques to Improve ArcIMS Draw Speed

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## INTRODUCTION

[Raster](#) data is often a large consumer of bandwidth in a dynamic mapping environment. Imagery also happens to be highly requested and often forms the foundation for many interactive mapping sites. Having the ability to place abstract vector data over an image that closely matches what we perceive, enhances our understanding of what the map is trying to say.

Effectively managing the storage and retrieval of raster data is paramount to providing a fast-drawing, usable and effective web mapping site (WMS). We will examine varying methods for storing raster data including storage within a directory structure environment (flat file) as well as within a relational database management system (RDBMS). This study aims to provide guidance to those wishing to attain the best performance from their raster based ArcIMS web mapping site.

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## KEY FINDINGS

The overall performance winner was an ArcSDE / Oracle backend, serving out imagery via an ArcXML (AXL) image service. For those not employing ArcSDE, the

Performance Results	
<b>1. Zoom to Extent</b> Winner: ArcSDE / Oracle	ERDAS Imagine format (.img) was the flat file winner. At small sizes (approx < 500MBs), the
<b>2. Zoom to Location:</b> Winner: ERDAS .IMG format (small files), ArcSDE (large files)	Imagine format is a valid
<b>3. Panning:</b> Winner: ArcSDE / Oracle	alternative to ArcSDE / Oracle. When the file sizes are pushed larger, 10 GB, in our tests, the Imagine format lagged severely compared to imagery stored within ArcSDE. It should be noted that AXL map services beat ArcMap Document (MXD) services in all but one head to head test. The AXL image service was on average 25% faster than the ArcMap MXD services.



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### CRITERIA

The following categories were used to rank the varying storage formats. In addition to the performance related issues listed previously, consideration for file size, administrative overhead and image quality were also factored into the analysis. An in-depth explanation of each criterion follows.

**1. Zoom To Extent**

Time taken to zoom to the full extent of the image

**2. Zoom to Location**

Time taken to zoom to a specific location on the image

**3. Pan**

Time taken to pan image

**4. Size on Disk**

Storage space for image and all associated files

**5. Overhead**

Additional consideration for implementation

**6. Image Quality**

Visual quality of the image format

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### OVERALL PERFORMANCE RATINGS

**1. Zoom to Extent**

Zooming to the extent of the image was performed three times. This test was administered not only because it is a common request when using a WMS but also to determine how effectively caching was being used. Predictably, those sites using the ArcSDE / Oracle showed not only excellent results on the zoom to extent test, they also rendered substantially faster with each successive request. It is theorized that this is due in large part to the caching component within Oracle. In our tests, Oracle's [buffer cache](#) was set to 1GB.



*Zoom to Extent Results*

	<i>Storage</i>	<i>Format</i>	<i>Speed (sec)</i>
Small Image Winner (tie)	SDE	LZ77 Bilinear Pyramids	0.151
	SDE	JPEG 75% Bilinear Pyramids	0.151
Large Image Winner	<i>Storage</i>	<i>Format</i>	<i>Speed (sec)</i>
	SDE	JPEG 75% Bilinear Pyramids	0.317666667

This category showed the largest disparity between tested formats and is also where the ArcSDE / Oracle combination truly excelled. It is also worth noting that those formats tested without pyramids performed poorly during this test.

**2. Zoom to Location**

The zoom to location tests involved zooming to three predetermined spots on each image. Each spot was only zoomed to once. The winner from the first round test was the ERDAS Imagine flat file format out performing the other 27 first round tests. This particular Imagine file had no pyramids built and had no compression.

*Zoom to Location Results*

	<i>Storage</i>	<i>Format</i>	<i>Speed (sec)</i>
Small Image Winner	FF	ERDAS Imagine	0.117666667
Large Image Winner	<i>Storage</i>	<i>Format</i>	<i>Speed (sec)</i>
	SDE	LZ77 Bilinear Pyramids	0.422

Another interesting discovery from the first round tests was that those images without pyramids rendered on average 5% faster than their counterparts with pyramids built. It is hypothesized that having to retrieve the additional pyramid information actually slowed the performance for this test.



### 3. Panning

The pan test included panning east, south and then west from a predefined spot on the image. The three times were averaged. This test showed the most similarity between formats. In fact, the top eight first round winners were all within 1 / 100<sup>th</sup> of a second of each other. Predictably pyramids made no difference with this test.

*Pan Results*

	<i>Storage</i>	<i>Format</i>	<i>Speed (sec)</i>
Small Image Winner (tie)	<b>SDE</b>	<b>LZ77 Bilinear Pyramids</b>	<b>0.093</b>
	<b>SDE</b>	<b>No Compression Bilinear Pyramids</b>	<b>0.093</b>
Large Image Winner	<i>Storage</i>	<i>Format</i>	<i>Speed (sec)</i>
	<b>SDE</b>	<b>JPEG 75% Pyramids</b>	<b>0.5</b>

### 4. Size on Disk (smallest)

The smallest footprint on disk of the varying formats tested will go to either a flat file MrSID or JPEG format. Since it is infinitely possible to decrease the size on disk via each format's native compression techniques, the issue of disk space comes down to quality vs. size. This category was not heavily factored into the final recommendations because of the low cost of disk space. Nevertheless, disk size may factor into your decision if you are transferring data or have limited storage space.

Even within ArcSDE, the size on disk between varying image formats can be dramatic. For example, the second round test image, a 10GB orthophoto of Minot Air Force Base, when loaded into ArcSDE with no compression, balloons to 24GB on disk. This same image, when loaded into ArcSDE as a JPEG with 50% compression, with pyramids and statistics built, shrinks down to 1 GB.



5. Overhead

This category was intended to factor in the costs associated with implementing an Oracle / ArcSDE solution vs. the relatively simple flat file setup. There is no doubt that implementing an Oracle/ArcSDE system is a complex task and compared to serving out flat file data can be extremely burdensome. In contrast, converting flat file raster data into the tested formats can often be done via open source applications (GDAL) or using software that most organizations already have. Many of the flat file formats tested can also be the standard deliverable format for data purchases.

Flat File	ArcSDE
TIFF	No Compression
ERDAS IMAGINE	LZ77
MrSID	JPEG
JPEG	

6. Image Quality

While it is possible to compress an image to such a small size that it performs very well, this must be balanced with the associated loss of information. Our testing was not concerned with performing analysis (classification etc.) on the loaded raster formats, rather simply using them as a visualization tool. We did test some ArcSDE JPEGs loaded at 30% compression but ended up throwing them out because of the poor visual display. The JPEG with 50% compression was the most compressed ArcSDE image that we still found acceptable for our viewing needs. Pixiliar resolution also influences how compressed an image can be before being unusable.

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**METHODOLOGY**

There were two stages of testing to determine the optimal storage format. The first round of testing used a small 66.2 MB image of Crater Lake, Oregon and the second round of testing used a larger 10 GB image of Minot Air Force Base, North Dakota. The first round of testing compared over 28 unique combinations of raster storage loading from the smaller raster's native .TIFF format. The second round tested fewer combinations but with a much larger



dataset. Flat file (non-SDE) conversions were performed using ERDAS Imagine Workstation. ArcSDE loads were performed using ArcCatalog.

The hardware configuration for our testing included one Dell 2650 web server and one Dell 2650 database server (see appendix B for an in-depth server specification sheet). Both servers were dedicated to this test and had no other external processes being tasked to them during the time of the analysis. All tested imagery was loaded on the database server and accessed by the web server via the Langley Air Force Base non-classified network. The ArcSDE tests were performed using ArcSDE 8.3 running on Oracle 9i. The rasters were loaded into ArcSDE using ArcCatalog, accepting all defaults except compression format and name. Since both rounds of tests were performed on a single image, no ArcSDE raster cataloging was tested.

The flat files were loaded on the database server within a shared directory. For the first round test, an ArcIMS 4.0.1 AXL image service was created using ArcIMS Administrator; the ArcIMS services used the default 'ImageService' virtual server. ArcIMS Designer was used to build a standard HTML browser, again accepting all defaults. The actual performance testing consisted of passing commands to the ArcIMS engine via the HTML browser. The website was accessed through a third Dell workstation connected to the Langley domain.

ArcIMS was preconfigured for verbose logging enabled for the spatial server. This allows for log files to be created for each action passed to the ArcIMS engine. The log files are very detailed and include time required to process the request. The 'total request time' component was used as the quantitative measurement for performance testing.



### Logfile Example:

```
31 [May 22, 2005 10:04:25 AM][2728 1416 INF01] GET_IMAGE: crater_sde_lz77_nopyr
32 [May 22, 2005 10:04:25 AM][2728 1416 INF02] AXL Parse Time: 0.000000s
33 [May 22, 2005 10:04:25 AM][2728 1416 INF02] RENDERER SETUP: 0.000000s
34 [May 22, 2005 10:04:25 AM][2728 1416 INF02] IMAGE LAYER: CRATER_LZ77_NOPYR
35 [May 22, 2005 10:04:25 AM][2728 1416 INF02] IMAGE SEARCH TIME: 0.000000s
36 [May 22, 2005 10:04:29 AM][2728 1416 INF02] BLOCKS RETRIEVED: 1
37 [May 22, 2005 10:04:29 AM][2728 1416 INF02] IMAGE RETRIEVAL TIME: 3.921000s
38 [May 22, 2005 10:04:29 AM][2728 1416 INF02] TOTAL PROCESSING TIME: 3.937000s
39 [May 22, 2005 10:04:29 AM][2728 1416 INF02] OUTPUT TIME: 0.063000s
40 [May 22, 2005 10:04:29 AM][2728 1416 INF03] RESPONSE: <?xml version="1.0" encoding="UTF-8"?>
41 <ARCXML version="1.1">
42 <RESPONSE>
43 <IMAGE>
44 <ENVELOPE minx="-2.1446377875673" miny="0.000833333333333524" maxx="10.1446377875673" maxy="8.0325" />
45 <OUTPUT url="http://accgiodev/output/crater_sde_lz77_nopyr_LFI-FSCHEWEB01272814160.jpg" />
46 </IMAGE>
47 </RESPONSE>
48 </ARCXML>
49
50 [May 22, 2005 10:04:29 AM][2728 1416 INF01] Total Request Time: 4.000000s
51 [May 22, 2005 10:04:29 AM][2728 1416 INF01] End Request
```

Each raster format had “3 zoom to extents”, “3 zoom to objects” and “3 pans” performed against them. The times for each task were recorded and then averaged to determine the final number. The first round of testing was performed on a small raster of Crater Lake, Oregon. This test image sample was approximately 70MBs in size in its native .TIFF format. The second round of testing was performed using a 10GB image; the processing time required to convert and load that image into all of the formats present in the first round would have been tremendous, therefore the first round was used to weed out the non-contenders.

Using the first round as guidance, a smaller second round grouping was compiled. The second round test image was a 6 inch pixilar resolution orthophoto of Minot Air Force Base in ERDAS Imagine format (.img). The Minot image was loaded into ArcSDE using different compression methods, all with bilinear pyramids and statistics built. The .img was also converted into a 20:1 MrSID and a 50% compressed JPEG. A conversion to SID and JPEG was also performed even though first round tests showed that these formats were expected to perform poorly. This hypothesis was ultimately substantiated with those formats performed very poorly on a sample this large or not being compatible with the ArcIMS services.





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As with the first round, AXL image services and new web sites were created, one at a time, for each raster type. For this round, it was also decided to create ArcMap MXD image services as well. It should be noted that for the three large flat file tests, the AXL image services could be created however when attempting to connect to the site with the HTML viewer, the ArcIMS engine threw a "Server not available" error. Oddly enough, an ArcMAP MXD service based site did not time out when accessed, although it was very slow for the flat files tested.



After each test was performed, the three ArcIMS services were stopped and all log files were deleted. The client browser (IE 6 SP 4) had all cached content purged before each test. Despite consistency being the primary goal, it should be noted that because of testing on a network, some results were obvious network issues. When there was an extremely slow result that obviously did not reflect the true nature of the test, that test was rerun with the intent of getting as accurate of an answer as possible.

After all results were tabulated a clear winner emerged. The ArcSDE/Oracle JPEG 75% compression image possessed the best all around characteristics for what will be the likely need of most ArcIMS users and administrators (speed balanced with visual quality). It performs well in all tests, requires a relatively small amount of disk space, maintains a usable level of image quality and although requiring the overhead of ArcSDE and Oracle, the tests speak for themselves as far as performance.



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## FLAT FILE CONSIDERATIONS

For those that either do not have access to ArcSDE or have chosen not to store imagery within this format, the following charts will hopefully lend some guidance for decision making about how to best store your raster imagery. All results are from the first round tests. It should be noted that in some of the tests the winners (ie. JPEG D – Zoom to Extent) will be unusable for most applications due to the loss of image quality due in part to the amount of compression applied. For metadata about what each format name means, please see appendix A.

### *Zoom to Extent*

<i>Format</i>	<i>Speed (sec)</i>
CraterLK JPEG D	0.646
CraterLK IMG E	0.687333333
CraterLK JPEG C	0.703
CraterLK IMG B	0.770333333
CraterLK JPEG B	0.818
CraterLK TIF C	1.296666667
CraterLK SID C	1.312333333
CraterLK TIF D	1.327666667
CraterLK TIF A	1.375333333
CraterLK IMG A	1.395666667
CraterLK IMG C	1.422333333
CraterLK TIF B	1.427333333
CraterLK IMG D	1.469
CraterLK SID A	1.479333333
CraterLK TIF E	1.495
CraterLK TIF F	1.588333333
CraterLK JPEG A	1.776333333
CraterLK SID B	2.302



*Zoom to Object*

<i>Format</i>	<i>Speed (sec)</i>
CraterLK IMG A	0.117666667
CraterLK IMG B	0.145333333
CraterLK IMG E	0.145666667
CraterLK IMG D	0.146
CraterLK IMG C	0.151333333
CraterLK TIF C	0.213666667
CraterLK TIF A	0.218666667
CraterLK TIF D	0.229333333
CraterLK TIF E	0.234666667
CraterLK TIF B	0.25
CraterLK TIF F	0.271
CraterLK JPEG D	0.338666667
CraterLK JPEG C	0.38
CraterLK SID C	0.536333333
CraterLK SID A	0.599
CraterLK SID B	0.682333333
CraterLK JPEG B	0.739666667
CraterLK JPEG A	0.770666667

*Size on Disk*

<i>Format</i>	<i>Size(MBs)</i>
CraterLK SID C	0.796
CraterLK JPEG D	1.45
CraterLK JPEG C	1.96
CraterLK SID A	2.2
CraterLK JPEG B	3.08
CraterLK TIF E	8.99
CraterLK TIF F	9.26
CraterLK SID B	9.69
CraterLK JPEG A	17
CraterLK IMG B	58.8
CraterLK TIF C	59.6
CraterLK TIF D	59.9
CraterLK IMG E	63.54
CraterLK TIF A	66.1
CraterLK TIF B	66.8
CraterLK IMG A	67
CraterLK IMG C	67
CraterLK IMG D	72.88

*Pan*

<i>Format</i>	<i>Speed (sec)</i>
CraterLK IMG A	0.109
CraterLK IMG C	0.109
CraterLK IMG B	0.11
CraterLK IMG E	0.11
CraterLK IMG D	0.11
CraterLK TIF E	0.125
CraterLK JPEG D	0.125
CraterLK TIF C	0.141
CraterLK TIF A	0.141
CraterLK TIF B	0.141
CraterLK TIF F	0.141
CraterLK JPEG C	0.141
CraterLK TIF D	0.156
CraterLK JPEG B	0.156
CraterLK SID C	0.203
CraterLK SID A	0.235
CraterLK JPEG A	0.235
CraterLK SID B	0.25



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### LIMITATIONS

As with any test there are limitations inherent within the methodology. This holds true for this test. We hope to highlight some of the more important shortcomings of the test:

#### 1. Network

The network not only affects viewing the site but more importantly bridges the web server and the database server. Testing was performed in off peak hours but results are still at the mercy of the utilization of the network at the time a request was made.

#### 2. Database Tuning

Oracle is a complicated RDBMS with many configuration settings. How the database is configured dramatically affects the I/O of data and thus affecting the parse time of the raster requests.

#### 3. Additional Load Configurations

While there were many combinations evaluated, not all configurations were put through the test. Many load options were accepted as default and may have an impact on draw speed. The following is a list of some of the defaults and other settings:

- a. Tile Size: All SDE rasters were loaded using the default 128 x 128 tile size setting
- b. Pyramids: All SDE rasters (using pyramids) were calculated with bilinear pyramids
- c. Raster Catalogs: Raster catalogs were not tested

#### 4. Combining Raster and Vector

In the real world, your raster data will not be displayed alone. It will most likely be used in conjunction with vector data. Combining raster and vector data and serving it out was not tested but the hope is that having a fast drawing raster can act as the building blocks of your overall site.

#### 5. We only tested ArcIMS

The raster storage formats were not tested in an ArcGIS desktop environment nor with other web mapping software (MapServer, MapGuide).



### 6. ArcIMS output

The ArcIMS services were created using JPEG as the output image format. This may affect overall draw speeds

### 7. We did not test SQL server (or any other databases)

...maybe next year

### 8. Oracle Tablespaces

The dbtune file was created whereby the pixel (blk) information was deposited in its own 120 GB Oracle tablespace and all associated indices were deposited in their own 12 GB index tablespace. See Appendix C for the dbtune configuration.

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## CONCLUSION

This test should by no means be considered exhaustive, rather an examination of the most common raster types used within GIS. As with anything, those taking guidance from this paper should perform their own testing. Networks, hardware, software and configuration play heavily into the optimal scenario and the results here may not apply to your situation. It should also be noted that the Oracle environment we tested has had many hours of testing and configuration so that it may perform at an optimal level. If you plan to store your geospatial data in an RDBMS, make sure it is performing optimally or all the raster storage tuning will be moot.

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## EPILOGUE

Thank you to the folks that helped me with this testing; Chris Busskohl and Richard Olivieri for technical assistance and to the Air Force and the GeoBase program for allowing me to pursue these professional interests. Also thanks to [3Di West](#) for supplying the Crater Lake image. By completing this testing, I in many ways have more questions than when I started. I wonder how exotic formats: ECW, NUI etc. will change the playing field. I am also very intrigued by



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the SQL Server vs. Oracle vs. Open source RDBMS (PostGIS) that extends beyond the GIS world. I am optimistic that in future years I will have the opportunity to build upon this testing and examine more and better ways to serve the map hungry public at large. Thanks!

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## APPENDIX A



## Why is My Map So Slow?

<b>Test Sample</b>	<b>name = craterlk_img_a.img</b>	<b>name = craterlk_img_b.img</b>
name = craterlk.tiff	width = 4800 pxls	width = 4800 pxls
width = 4800 pxls	heights = 4820 pxls	heights = 4820 pxls
heights = 4820 pxls	type= unsigned 8 bit	type= unsigned 8 bit
type= unsigned 8 bit	pyramids = none	pyramids = none
pyramids = none	compression = none	compression = run length encoding / ESRI
compression = none	format = .img	format = .img
format = .tiff	Size on Disk = 67.0 MBs	Size on Disk = 58.8 MBs
Size on Disk = 66.2 MBs	Comments: very slight color differences compared to original	Comments: a bit darker and very slight noticeable loss
<b>name = craterlk_img_c.img</b>	<b>name = craterlk_img_d.img</b>	<b>name = craterlk_img_e.img</b>
width = 4800 pxls	width = 4800 pxls	width = 4800 pxls
heights = 4820 pxls	heights = 4820 pxls	heights = 4820 pxls
type= unsigned 8 bit	type= unsigned 8 bit	type= unsigned 8 bit
pyramids = none	pyramids = yes	pyramids = yes
compression = ERDAS default	compression = none	compression = run length encoding / ESRI
format = .img	format = .img	format = .img
Size on Disk = 67.0MBs	Size on Disk = 67.0MBs for .img / 5.88MBs for RRD file (pyramid)	Size on Disk = 58.5MBs for .img / 5.04MBs for RRD file (pyramid)
Comments: very similar to original	Comments: Same as A	Comments: Same as A
<b>Output filename: d:/temp/image_workspace/craterlk_sid_a.sid</b>	<b>Output filename: d:/temp/image_workspace/craterlk_sid_b.sid</b>	<b>Output filename: d:/temp/image_workspace/craterlk_sid_c.sid</b>
Input filesize: 66.19 Mb (69,408,000 bytes)	Input filesize: 66.19 Mb (69,408,000 bytes)	Input filesize: 66.19 Mb (69,408,000 bytes)
Output filesize: 2.20 Mb (2,311,202 bytes)	Output filesize: 9.69 Mb (10,164,399 bytes)	Output filesize: 796.13 Kb (815,239 bytes)
Input BitRate: 8	Input BitRate: 8	Input BitRate: 8
Input Wordlength (in bits): 8	Input Wordlength (in bits): 8	Input Wordlength (in bits): 8
Target compression ratio: 20.00	Target compression ratio: 5.00	Target compression ratio: 50.00
Actual compression ratio: 30.03	Actual compression ratio: 6.83	Actual compression ratio: 85.14
File type: ERDAS Image	File type: ERDAS Image	File type: ERDAS Image
Georeferencing: Geo TIFF	Georeferencing: Geo TIFF	Georeferencing: Geo TIFF
Start time: Wed Mar 23 14:51:31 2005	Start time: Wed Mar 23 15:03:45 2005	Start time: Wed Mar 23 15:33:46 2005
Completion time: Wed Mar 23 14:53:06 2005	Completion time: Wed Mar 23 15:05:39 2005	Completion time: Wed Mar 23 15:35:17 2005
Intensity weight: 4.00	Intensity weight: 4.00	Intensity weight: 4.00
Gamma: 2.00	Gamma: 2.00	Gamma: 2.00

## APPENDIX A cont.



## Why is My Map So Slow?

<b>name = craterlk_jpeg_a.jpeg</b>	<b>name = craterlk_jpeg_b.jpeg</b>	<b>name = craterlk_jpeg_c.jpeg</b>
width = 4800 pxls	width = 4800 pxls	width = 4800 pxls
heights = 4820 pxls	heights = 4820 pxls	heights = 4820 pxls
type= unsigned 8 bit	type= unsigned 8 bit	type= unsigned 8 bit
pyramids = none	pyramids = none	pyramids = none
image_quality = 100	image_quality = 75	image_quality = 50
format = .jpeg	format = .jpeg	format = .jpeg
Size on Disk = 17.0 MBs	Size on Disk = 3.08 MBs	Size on Disk = 1.96 MBs
Comments: negligible degradation compared to original	Comments: Noticeable but slight degradation compared to original / shading and shadowing are not as smooth	Comments: Noticeable degradation at zoomed out levels. More pronounced the further you zoom in.
<b>name = craterlk_jpeg_d.jpeg</b>	<b>name = craterlk_tif_a.tif</b>	<b>name = craterlk_tif_b.tif</b>
width = 4800 pxls	width = 4800 pxls	width = 4800 pxls
heights = 4820 pxls	heights = 4820 pxls	heights = 4820 pxls
type= unsigned 8 bit	type= unsigned 8 bit	type= unsigned 8 bit
pyramids = none	pyramids = none	pyramids = yes (tiling)
image_quality = 30	compression = non	compression = non
format = .jpeg	format = .tif	format = .tif
Size on Disk = 1.45 MBs	Size on Disk = 66.1 MBs	Size on Disk = 66.8 MBs
Comments: Noticeable degradation at zoomed out levels. Substantial degradation when focusing on any hard object.	Comments: Same as original	Comments: Same as original
<b>name = craterlk_tif_c.tif</b>	<b>name = craterlk_tif_d.tif</b>	<b>name = craterlk_tif_e.tif</b>
width = 4800 pxls	width = 4800 pxls	width = 4800 pxls
heights = 4820 pxls	heights = 4820 pxls	heights = 4820 pxls
type= unsigned 8 bit	type= unsigned 8 bit	type= unsigned 8 bit
pyramids = no	pyramids = yes (tiling)	pyramids = no
compression = packed bits	compression = packed bits	compression = jpeg
format = .tif	format = .tif	format = .tif
Size on Disk = 59.6 MBs	Size on Disk = 59.9 MBs	Size on Disk = 8.99 MBs
Comments: Very similar to original with slight darkening	Comments: Very similar to original with slight darkening	Comments: Noticeable degradation when zoomed on hard objects
<b>name = craterlk_tif_e.tif</b>		
width = 4800 pxls		
heights = 4820 pxls		
type= unsigned 8 bit		
pyramids = yes (tiling)		
compression = jpeg		
format = .tif		
Size on Disk = 9.26 MBs		
Comments: Noticeable degradation when zoomed on hard objects		

## APPENDIX B – Server Specs





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Database Server	
Base Unit:	PowerEdge 2650,3.2GHz/2MB Cache/533MHz FSB Xeon (221-4490)
Processor:	2nd Processor, Xeon, 3.2GHz, 2MB Cache, 533MHz FSB, PowerEdge 2650 (311-3505)
Memory:	4GB DDR,266MHZ,2x2GB DIMMS, PE26xx,PE650 (311-2738)
Keyboard:	No Keyboard Option (310-3281)
Monitor:	No Monitor Option (320-0058)
Hard Drive:	73GB 15K RPM Ultra 320 SCSI Hard Drive, PowerEdge (340-8582)
Hard Drive Controller:	Raid on Motherboard,PERC3-DI 128MB,with Documentation,for Dell PowerEdge 2650 (340-3943)
Floppy Disk Drive:	1.44MB,3.5 in,Floppy Drive Dell PowerEdge Servers (340-3961)
Operating System:	Dell OpenManage Kit,32-Bit (310-1261)
Operating System:	No Operating System,For Dell PowerEdge Servers,No Windows 2000 (420-5100)
Mouse:	Mouse Option None (310-0024)
NIC:	Dual On-Board NICS ONLY (430-8991)
CD-ROM or DVD-ROM Drive:	24X IDE CD-RW/DVD ROM Drive for PowerEdge Servers (313-1999)
Sound Card:	Bezel Option for Dell PowerEdge 2650 (310-1487)
Additional Storage Products:	73GB 15K RPM Ultra 320 SCSI Hard Drive, PowerEdge (340-8582)
Feature	MR5, ROMB 0, C4, for PowerEdge2650 (340-3946)
Misc:	73GB 15K RPM Ultra 320 SCSI Hard Drive, PowerEdge (340-8582)
Misc:	73GB 15K RPM Ultra 320 SCSI Hard Drive, PowerEdge (340-8582)

Web Server	
Base Unit:	PowerEdge 2650,3.2GHz/2MB Cache/533MHz FSB Xeon (221-4490)
Processor:	2nd Processor, Xeon, 3.2GHz, 2MB Cache, 533MHz FSB, PowerEdge 2650 (311-3505)
Memory:	3GB DDR SDRAM 266MHZ (6X512) PowerEdge (311-2734)
Keyboard:	No Keyboard Option (310-3281)
Monitor:	No Monitor Option (320-0058)
Hard Drive:	73GB 15K RPM Ultra 320 SCSI Hard Drive, PowerEdge (340-8582)
Hard Drive Controller:	Raid on Motherboard,PERC3-DI 128MB,with Documentation,for Dell PowerEdge 2650 (340-3943)
Floppy Disk Drive:	1.44MB,3.5 in,Floppy Drive Dell PowerEdge Servers (340-3961)
Operating System:	Dell OpenManage Kit,32-Bit (310-1261)
Operating System:	No Operating System,For Dell PowerEdge Servers,No Windows 2000 (420-5100)
Mouse:	Mouse Option None (310-0024)
NIC:	Dual On-Board NICS ONLY (430-8991)
Additional Storage Products:	73GB 15K RPM Ultra 320 SCSI Hard Drive, PowerEdge (340-8582)
Feature	MR1,ROMB 0,C3,for Dell PowerEdge 2650 (340-3945)
Installation:	Server Install Quantity 1 (980-7617)
Misc:	Redundant Power Supply 125V, without Y-cord for PE 2650 (310-4719)

## APPENDIX C – dbtune Defaults Keyword

##DEFAULTS



## Why is My Map So Slow?

```
ATTRIBUTE_BINARY "LONGRAW"  
AUX_INDEX_COMPOSITE "TABLESPACE RASTER_INDEX PCTFREE 10 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4) NOLOGGING"  
AUX_STORAGE "TABLESPACE RASTER PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4)"  
BLK_INDEX_COMPOSITE "TABLESPACE RASTER_INDEX PCTFREE 10 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4) NOLOGGING"  
BLK_STORAGE "TABLESPACE RASTER PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4)"  
BND_INDEX_COMPOSITE "TABLESPACE RASTER_INDEX PCTFREE 10 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4) NOLOGGING"  
BND_INDEX_ID "TABLESPACE RASTER_INDEX PCTFREE 10 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4) NOLOGGING"  
BND_STORAGE "TABLESPACE RASTER PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE ( MINEXTENTS 1  
MAXEXTENTS 200 PCTINCREASE 0 FREELISTS 4)"  
B_INDEX_ROWID "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
B_INDEX_SHAPE "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
B_INDEX_USER "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
B_STORAGE "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1  
PCTINCREASE 0)"  
D_INDEX_DELETED_AT "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
D_INDEX_STATE_ROWID "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
D_STORAGE "TABLESPACE VECTOR PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0)"  
F_INDEX_AREA "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
F_INDEX_FID "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
F_INDEX_LEN "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
F_STORAGE "TABLESPACE VECTOR PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0)"  
GEOMETRY_STORAGE "SDEBINARY"  
RAS_INDEX_ID "PCTFREE 10 INITRANS 4 STORAGE ( MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0  
FREELISTS 4) NOLOGGING"  
RAS_STORAGE "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE ( MINEXTENTS 1 MAXEXTENTS 200  
PCTINCREASE 0 FREELISTS 4)"  
S_INDEX_ALL "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
S_INDEX_SP_FID "TABLESPACE VECTOR_INDEX PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0) NOLOGGING"  
S_STORAGE "TABLESPACE VECTOR PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4  
MINEXTENTS 1 PCTINCREASE 0)"  
UI_TEXT ""  
END
```

---

## APPENDIX D – Oracle Specs via OEM

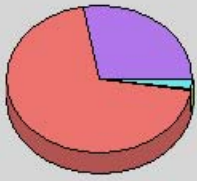


# Why is My Map So Slow?

General Memory Recovery Resource Monitors Undo


SGA

Shared Pool :	400	MB	Advice...
Buffer Cache :	1000	MB	Advice...
Large Pool :	8	MB	
Java Pool :	32	MB	
Total SGA :	1440.936	MB	
SGA Max Size :	1505.073	MB	



PGA

Aggregate PGA Target:	100	MB	Advice...
Current PGA Allocated:	17486	KB	
Maximum PGA Allocated (since startup):	22271	KB	
Cache Hit Percentage:	100%		

 The sum of PGA and SGA should be less than the total system memory minus memory required by the OS and other applications.

