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Banner

Banner XE Sizing and Configuration

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Abstract

Banner XE customers need hardware sizing, software requirements, and recommended configuration documentation in order to successfully plan for their future Banner XE deployments. Ellucian is committed to delivering the following information:

- Ellucian will provide all hardware, software, and configuration information for all of the performance tests run to determine memory and CPU usage for each application.
- Ellucian will provide tables for memory and CPU core usage for each application for given numbers of concurrent users.
- Ellucian will provide formulas to determine hardware and configuration based upon information provided in the tables.
- Ellucian will provide recommended configuration information for optimal performance for the database, application server, and each application.

Introduction

Banner XE is based on a new architecture that provides an evolutionary path to a new web 2.0-based user interface, optimized delivery, and an extendable platform. This document provides the necessary application server sizing and configuration information for running the various Banner XE applications depending on the expected concurrent usage at a given institution. The key intent of this document is to be able to answer the following questions:

- How many CPU cores do we need for the application servers to run the Banner XE applications we are planning to implement?
- How much memory do we need for the application servers to run these Banner XE applications?
- What would be the recommended grouping of applications per application server?
- What are the recommended configuration settings to achieve optimal performance?

Application Server Sizing

Note: The following are hardware requirements for peak usage for each application. Obviously not all applications will undergo peak usage at the same time. Therefore, deploying a system capable of performing at peak usage for every Banner XE application (administrative and self-service) would not be the best use of system resources and could lead to environments with under-utilized memory and CPUs.

The number of CPU cores, memory, and configuration for application servers running Banner XE applications is completely dependent on the number of expected concurrent users working on the system and which Banner XE applications are being deployed. The following information is meant to give institutions the tools necessary to be able to plan for and ultimately deploy their Banner XE applications to meet their institutional demands. Again, optimal performance sizing and configuration self-service vary per institution, but the following information provides a good place to start.

The Banner XE architecture moves business logic that was originally executed in the Oracle Database server tier to the application server tier in modular deployments. Since this reduces the resource requirements from the Oracle database tier, it allows additional room for growth at the database tier and allows Oracle RAC technology to support higher user loads.

This modular deployment allows customers more flexibility to support higher user loads and upgrade smaller modules independent of the entire Banner Student product. This reduces the dependencies on application upgrades.

Banner XE technology scales horizontally in the application server tier using lower cost commodity hardware, allowing higher performance for increased user loads. Multiple XE applications can be deployed to the same application server instance to support low usage patterns. High usage applications such as Banner XE Registration Self-Service can be deployed to multiple application servers on multiple VMs or physical hardware to support higher user loads.

The following two tables will be used to determine the necessary amount of memory and the number of CPU cores needed for the application servers when running Banner XE applications under concurrent user loads. These tables must be used in conjunction with the formulas that follow.

The following sizing and configuration information is based on performance testing by Ellucian. The criteria for all tests is that each user transaction (i.e., user interacts with the system, waits for the action to complete, and it completes) must return within 3 seconds at least 90% of the time. Read below in the Banner XE Performance Testing section for more information on the testing environment. Although this information was created using a WebLogic environment, please note that subsequent numbers will follow based on a Tomcat environment. Ellucian does not expect the numbers to vary greatly.

Applications per Application Server Recommendations

The number of applications per application server will vary depending on the applications' expected concurrent usage, which determines the memory and CPU usage. Customers will need to refer to the "Allocated Java Heap Memory per Application" on page 7 and the "CPU Core Usage per Application" on page 9. Multiple low usage type applications such as Catalog, Schedule, etc. can be deployed to one application server (e.g., 3-5 low usage applications per application server instance). On the other hand, a high usage application, like Registration, will likely be deployed in its own application server, and for the largest of our institutions, Registration might actually be deployed across multiple servers on multiple boxes.

See "Sizing and Deployment Example" on page 10 for an example of how this might work.

Allocated Java Heap Memory per Application

The following two rules of thumb are very conservative and meant to provide more than adequate performance per application given a concurrent user load requirement. As can be seen in the table that follows, these two rules of thumb can be overly conservative depending on the application and the number of concurrent users.

- Banner XE administrative applications require 2GB minimum of memory, plus an additional 2GB per 100 current users.
- Banner XE self-service applications require 1GB minimum of memory, plus an additional 1GB per 100 current users.

Note: CUs = Concurrent Users working on the system simultaneously. Values for memory requirements between 50–1000 users are the observed values used during performance testing. Values for 5000–11000 users are estimated and will be refined in future performance tests.

Banner XE Applications	GB for 50 CUs	GB for 100 CUs	GB for 200 CUs	GB for 500 CUs	GB for 1k CUs	GB for 5k CUs	GB for 11k CUs
Banner XE Course Catalog 9.2 (Admin)							
Banner XE Class Schedule 9.2 (Admin)							
Faculty Grade Entry 9.2 (Self- Service)			3GB				
Banner XE Attendance Tracking 9.1 (Admin)							

Banner XE Applications	GB for 50 CUs	GB for 100 CUs	GB for 200 CUs	GB for 500 CUs	GB for 1k CUs	GB for 5k CUs	GB for 11k CUs
Banner XE Attendance Tracking 9.1 (Self-Service)							
Banner XE Event Management 9.2 (Admin)	5GB						
Banner XE Event Management 9.2 (Self-Service)	1.5GB	2GB	2.5GB				
Banner XE Registration (Admin) Beta I		4GB		10GB			
Banner XE Registration (Self-Service) Beta I		2GB		4GB	6GB	30GB	60GB

Allocated Memory per WebLogic Server Requirements

Allocated Java Heap Memory per WebLogic Server >= Sum of All of the Recommended Application Java Heap Memory for the Expected Concurrent Users for Each of the Applications in the WebLogic Server

Memory allocated for the heap of each WebLogic server will vary depending on the applications loaded in that application server. Customers will need to refer to the "Allocated Java Heap Memory per Application" on page 7.

Physical or VM Memory Requirements

Physical or VM Memory >= (Sum of All of the Allocated Java Heap Memory for Each of the WebLogic Servers on the Box * 1.33) + X GB Reserved for OS

In other words, allocate no more than 75% of physical or VM memory to all WebLogic servers running on the same machine. For example, an 8 GB server or VM should only have 6 GB of memory allocated to one or more WebLogic servers.

See "Allocated Memory per WebLogic Server Requirements" on page 8.

CPU Core Usage per Application

The following two rules of thumb are very conservative and meant to provide more than adequate performance per application given a concurrent user load requirement. As can be seen in the table that follows, these two rules of thumb can be overly conservative depending on the application and the number of concurrent users. **This CPU core sizing information is based on a 3GHz Xeon processor.**

- Banner XE administrative applications can support 125 concurrent users per CPU core
- Banner XE self service applications can support 200 concurrent users per CPU core

Note: CUs = Concurrent Users working on the system simultaneously. Values for number of CPU requirements for 50–1000 users are the observed values used during performance testing. Values for 5000–11000 users are estimated and will be refined in future performance tests.

Banner XE Applications	Cores for 50 CUs	Cores for 100 CUs	Cores for 200 CUs	Cores for 500 CUs	Cores for 1k CUs	Cores for 5k CUs	Cores for 11k CUs
Banner XE Course Catalog 9.2 (Admin)							
Banner XE Class Schedule 9.2 (Admin)							
Faculty Grade Entry 9.2 (Self Service)	1	2	4				
Banner XE Attendance Tracking 9.1 (Admin)							
Banner XE Attendance Tracking 9.1 (Self Service)							
Banner XE Event Management 9.2 (Admin)	2	3	4				
Banner XE Event Management 9.2 (Self Service)	1	2	4				
Banner XE Registration (Admin) Beta I		2		4	8		
Banner XE Registration (Self Service) Beta I		2		3	5	25	55

Physical or VM CPU Core Requirements

Allocated Cores per WebLogic Server >= Sum of Recommended Cores for each Application

Customers will need to refer to the "CPU Core Usage per Application" on page 9 and sum are all application core recommendations based on expected number of concurrent users.

CPU Core Requirements per Box

Number of Cores per Box >= Sum of Allocated Cores for each WebLogic Server on Box + 1

For example, at a minimum, to effectively run 3 WebLogic servers (assuming only one core for each server), one would need a quad core machine.

Sizing and Deployment Example

The following is an example showing two physical-boxes or VMs containing three WebLogic servers. This gives the sense of the possible for a fictional institution running Course Catalog, Class Schedule, Event Management, Faculty Grade Entry, Attendance Tracking, and Registration. This fictional institution has approximately 21,000 SSB and 150 INB users on Banner 8. The following is their expected peak current usage for each application:

- Banner XE Course Catalog (Admin) = 25 peak current users
- Banner XE Class Schedule (Admin) = 75 peak current users
- Faculty Grade Entry (Self Service) = 100 peak current users
- Banner XE Attendance Tracking (Admin) = 10 peak current users
- Banner XE Attendance Tracking (Self Service) = 100 peak current users
- Banner XE Event Management (Admin) = 10 peak current users
- Banner XE Event Management (Self Service) = 200 peak current users
- Banner XE Registration (Admin) = 50 peak current users
- Banner XE Registration (Self Service) = 1500 peak current users

Physical Box or VM A (contains 16GB and a quad core CPU)

WebLogic Server A1 port 7003 (12GB and 3 cores are allocated)

- Banner XE Course Catalog (Admin) – 2.5 GB, .2 core

- Banner XE Class Schedule (Admin) – 3.5GB, .6 core
- Banner XE Attendance Tracking (Admin) – 2.2GB, .1 core
- Banner XE Event Management (Admin) – 2.2GB, .1 core
- Banner XE Registration (Admin) – 3GB, .4 core

Physical Box or VM B (contains 24GB and 3 quad core CPUs)

WebLogic Server B1 port 7003 (10GB and 6 cores are allocated)

- Banner XE Event Management (Self Service) - 3GB, 1 core
- Faculty Grade Entry (Self Service) - 2GB, .5 core
- Banner XE Registration (Self Service) - 5GB, 4 cores

WebLogic Server B2 port 7004 (6GB and 5 cores are allocated)

- Banner XE Attendance Tracking (Self Service) – 1.5GB, .5 core
- Banner XE Registration (Self Service) - 5GB, 4 cores

Application Server Software Requirements

The latest information for the application server software can be found in the Commons.

Supported Application Servers

- Oracle Fusion Middleware 11gR1 using WebLogic 10.3.4, 10.3.5, and 10.3.6. Higher 10.x versions will be supported after Oracle supports them.
- Apache Tomcat 6

Supported Operating Systems for Application Server Mid Tier

Note: The following application server and operating system combinations are the minimum requirements that are supported. Higher versions will be supported after Oracle supports them.

- Red Hat Linux 5.3 on WebLogic (64 bit)
- Red Hat Linux 5.3 on Tomcat (64 bit)
- Windows Server 2008 on WebLogic (64 bit)
- Windows Server 2008 on Tomcat (64 bit)
- Solaris 10 on WebLogic (64 bit)

- Solaris 10 on Tomcat (64 bit)
- AIX 6.1 (JDK 1.6.0 SR10 or higher) on WebLogic (64 bit)
- AIX 6.1 (JDK 1.6.0 SR10 or higher) on Tomcat (64 bit)
- HP-UX 11iV3 (11.31) on WebLogic (64 bit)
- HP-UX on Tomcat (64 bit) (Version not specified)

Application Server Configuration Recommendations

Unix OS configuration changes in support of running the Tomcat and WebLogic Application Server for Banner XE applications

Test

Running a performance test with a large number of users exceeded the OS open file limit for the OS Tomcat or Oracle user account.

Resolution

Increase the open file limit for the OS Tomcat user account.

As the Unix root user, edit /etc/security/limits.conf and add the following lines:

```
tomcat soft nofile 10240
tomcat hard nofile 655360

tomcat2 soft nofile 10240
tomcat2 hard nofile 655360

oracle soft nofile 10240
oracle hard nofile 655360
```

Save the /etc/security/limits.conf file and have the OS Tomcat or Oracle account logout and then login to affect the OS resource limit change. Then start the application server to avoid “too many open files” error, which can be seen in the application server log file.

Tomcat Web Application Server Configuration Changes

Issue

Banner XE web applications issue many http requests to render a page asynchronously which is similar for all Web 2.0 style applications. The Tomcat application server needs to be configured to accept a higher number of http requests. A single Banner XE self-service user requires 20+ http requests to render the full page and then subsequent requests will be issued asynchronously to retrieve data. The Web Browser will issue multiple http requests which increases the server load.

Resolution

Increase the Tomcat HTTP max threads parameter and connector thread count parameter to avoid the application server rejecting or delaying the http request when running a performance test.

As the OS Tomcat user account, edit $CATALINA_HOME/conf/server.xml and configure the HTTP connector to increase these parameters.

```
 <Connector port="8080"
protocol="HTTP/1.1"
maxThreads="500"
acceptorThreadCount="4"
connectionTimeout="20000"
redirectPort="8443"/>
```

Note: WebLogic server threads are self-tuning and do not require manual configuration to specify an upper limit.

Tomcat Application Server Database Connection Pool Sizing and Configuration

Issue

Banner XE applications use 2 datasource definitions to support Administrator access and Self Service access. Connection pool sizing is important to achieve optimum performance for Banner XE applications. Depending on the performance test criteria such as the maximum user load, size the connection pool to pre-instantiate an initial set of connections, which will be connected to the Oracle database. Do not oversize the pool to support the maximum user load.

Resolution

For the Banner XE Administration datasource (jdbc/bannerDataSource), set the initial connection size to the expected administration user load. This is necessary to obtain a

connection from the pool immediately, so that the additional overhead of opening an Oracle Proxy session as the real Oracle user and elevating the Oracle role overhead will be incurred only once during login. The Proxy connection is then cached and reused by the same user for the duration of their web session until they logout or until their session times out. For the Banner XE Self Service datasource (jdbc/bannerSsbDataSource), an initial size of 25% of the maximum user load should be sufficient to support high performance for database access. Set the maximum number of connections to a higher value to allow the connection pool to grow if needed. Below are examples of the Tomcat application server datasource definitions in support of a Banner XE performance tests.

As the OS Tomcat user edit $CATALINA_HOME/conf/server.xml and add the following Resource definitions inside the <GlobalResource> element.

```
<GlobalNamingResources>
<Resource name="jdbc/bannerDataSource"
auth="Container"
type="javax.sql.DataSource"
driverClassName="oracle.jdbc.OracleDriver"
url="jdbc:oracle:thin:@dctsrv17.ellucian.com:1521:DPD2"
username="banproxy" password="u_pick_it"
initialSize="50"
maxActive="300"
maxIdle="-1"
maxWait="30"
validationQuery="select 1 from dual"
testOnBorrow="true"/>

<Resource name="jdbc/bannerSsbDataSource"
auth="Container"
type="javax.sql.DataSource"
driverClassName="oracle.jdbc.OracleDriver"
url="jdbc:oracle:thin:@dctsrv17.ellucian.com:1521:DPD2"
username="ban_ss_user"
password="u_pick_it"
initialSize="80"
maxActive="300"
maxIdle="-1"
maxWait="30"
```

```
validationQuery="select 1 from dual"
testOnBorrow="true"/>

</GlobalNamingResources>
```

Issue

Many test scripts (including many of those supplied by Ellucian), are written so that the pseudo-user logs in and logs out for each user operation performed. This unrealistic situation can cause an invalid number of inactive user sessions to accumulate.The test directs the virtual user session to the Banner XE URL, logs in, executes the test steps using the designed input data, saves the data, and then logs out of the XE application. After the logout occurs the virtual user is redirected to the Banner XE login page and the virtual user browser is terminated leaving an active Tomcat session. For a 50 user load test we observed there were over 1000+ idle Tomcat user sessions caused by the logout redirection to the login page. This inflates memory requirements and causes severe degradation for the performance test. Tomcat has a default idle session timeout of 30 minutes which allows many idle sessions to accumulate during a performance test.

Resolution

For a performance testing environment, reduce the Tomcat idle session timeout down to 1 minute. This allows the application server to remove idle sessions quicker and reduce session overhead and reduce memory requirements.

As the OS, Tomcat user edit $CATALINA_HOME/conf/web.xml and change the session timeout value from 30 to 1 minute.

```
<session-config>

<session-timeout>1</session-timeout>

</session-config>
```

Save the change and restart the Tomcat application server.

Tomcat Application Server Logging

Issue

Tomcat default logging would create many FINE log entries in localhost.YYYY-MM-DD.log

This is caused by Tomcat default logging properties set to FINE and increases the logging level which can create huge log files and slow down performance tests.

Resolution

Edit $CATALINA_HOME/conf/logging.properties.

Change all occurrences of FINE to ERROR.

Save the change and restart the Tomcat application server

WebLogic Configuration Changes

Access WebLogic console and modify the managed server settings

1. Select “Domain Structure”->”Environments”->”Servers”->[server name]->”Configuration Tab”->”Server Start Tab”
2. Modify the arguments box to include

```
-server

-Xms1g

-Xmx8g

-XX:MaxPermSize=512m

-Dservertype=wlx
```

3. Select “Save to Activate Changes”
4. Modify the max heap and MaxPermSize to support the number of deployed applications. Increase MaxPermSize by 128m for each additional XE application deployed to the same WebLogic server. The -Dservertyp=wlx specifies to not start the WebLogic EJB, JMS, and JCA containers creating a very light weight servlet container similar to Tomcat.
5. Select “Domain Structure”->“Deployments”->“ApplicationName”->“Configuration Tab”
6. Change “Session Timeout (in seconds)” to the maximum wait time defined for a performance test step. For RegistrationSSB, Ellucian specified 90 seconds.
7. Select “Save and Activate Changes”

Issue

Attempting to enable JMX remoting on WebLogic causes the WebLogic MBean Self Tuning management monitor to not function. This causes WebLogic to limit resources such as threads and memory, and makes the application server unstable. This is caused by defining a Java System property -Dcom.sun.management.jmxremote.

Resolution

To enable JMX remoting without overriding the WebLogic MBean self- tuning management functionality you also need to define the following Java System property:

```
-
Djavax.management.builder.initial=weblogic.management.jmx.mbeanserver.WLSMBeanServerBuilder
```

This can be defined in the WebLogic Admin Console Server Start Tab for the WebLogic server. Here is an example that enables JMX remoting and corrects the Weblogic MBean self tuning management issue:

```
-Dcom.sun.management.jmxremote

-Dcom.sun.management.jmxremote.port=8999
```

```
-Dcom.sun.management.jmxremote.ssl=false

-Dcom.sun.management.jmxremote.authenticate=false

-Djava.rmi.server.hostname=dctvm154.sungardhe.com

-
Djavax.management.builder.initial=weblogic.management.jmx.mb
eanserver.WLSMBeanServerBuilder
```

Oracle Database Version Requirements

Supported Oracle Database Versions

- Minimum Version for 11gR1 : 11.1.0.7
- Minimum Version for 11gR2 : 11.2.0.2

Note: Higher versions will be supported after Oracle supports them.

You can find more information about Banner databases on Oracle at the following location. (Does anyone have a link to this document?)

Ellucian Banner XE Performance Test Condition Parameters

The above sizing and configuration information is based on performance testing by Ellucian. The following information details the test environment. This allows customers to compare their planned production environment to the environment used to create the above sizing information. The criteria for all tests is that each user transaction (for example, user interacts with the system, waits for the action to complete, and it completes) must return within 3 seconds 90% of the time.

Banner XE Performance Test Oracle 11GR2 Database Server Configuration

The following information details the database server test environment. The box itself contained 32 x 2.7GHz cores, 128GB memory, and a SAN Disk Farm.

XE Performance Database Server CPU Information

```
processor: 0

vendor_id: GenuineIntel

cpu family: 6

model: 46

model name: Intel(R) Xeon(R) CPU           X7560  @ 2.27GHz

stepping: 6

cpu MHz: 2261.140

cache size: 24576 KB

physical id: 0

siblings: 16

core id: 0

cpu cores: 8

apicid: 0

initial apicid: 0

fpu: yes

fpu_exception: yes

cpuid level: 11

wp: yes

flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge
mca cmov pat pse36 clflush dts acpi mmx fxsr sse sse2 ss ht
tm pbe syscall nx rdtscp lm constant_

tsc arch_perfmon pebs bts rep_good xtopology nonstop_tsc
aperfmperf pni dtes64 monitor ds_cpl vmx est tm2 ssse3 cx16
xtpr pdcm dca sse4_1 sse4_2 x2apic popcnt lahf_lm i

da tpr_shadow vnmi flexpriority ept vpid

bogomips: 4522.28

clflush size: 64

cache_alignment: 64
```

```
address sizes: 44 bits physical, 48 bits virtual
power management:

processor: 1
vendor_id: GenuineIntel
cpu family: 6
model: 46
model name: Intel(R) Xeon(R) CPU           X7560  @ 2.27GHz
stepping: 6
cpu MHz: 2261.140
cache size: 24576 KB
physical id: 1
siblings: 16
core id: 0
cpu cores: 8
apicid: 32
initial apicid: 32
fpu: yes
fpu_exception: yes
```

XE Performance Database Server Memory Information

```
MemTotal: 132278492 kB
MemFree: 75807660 kB
Buffers: 359348 kB
Cached: 38800676 kB
SwapCached: 0 kB
Active: 34131088 kB
```

```
Inactive: 6790636 kB

Active(anon): 3874212 kB

Inactive(anon): 6247468 kB

Active(file): 30256876 kB

Inactive(file): 543168 kB

Unevictable: 35340 kB

Mlocked: 35392 kB

SwapTotal: 67108856 kB

SwapFree: 67108856 kB

Dirty: 20 kB

Writeback: 0 kB

AnonPages: 1797212 kB

Mapped: 1857732 kB

Shmem: 8354136 kB

Slab: 3529048 kB

SReclaimable: 1079232 kB

SUnreclaim: 2449816 kB

KernelStack: 14776 kB

PageTables: 960724 kB

NFS_Unstable: 0 kB

Bounce: 0 kB

WritebackTmp: 0 kB

CommitLimit: 128005220 kB

Committed_AS: 14051684 kB

VmallocTotal: 34359738367 kB

VmallocUsed: 548420 kB

VmallocChunk: 34256993900 kB
```

```
HugePages_Total: 5120

HugePages_Free: 5120

HugePages_Rsvd: 0

HugePages_Surp: 0

Hugepagesize: 2048 kB

DirectMap4k: 6368 kB

DirectMap2M: 134201344 kB
```

XE Performance Database Server Disk Configuration

```
Filesystem      Size Used Avail Use% Mounted on

/dev/mapper/VolGroup00-LogVol00209G  4.4G  193G   3% /

/dev/sda1 97M   41M   52M  44% /boot

tmpfs                 64G  8.0G   56G  13% /dev/shm

149.24.55.9:/SANcdcache133G  125G  954M 100% /SANcdcache

/dev/mapper/mp_dctsrv18_oraclep147G   37G  8.3G  82% /u01

/dev/mapper/mp_dctsrv18_oraclep2150G   33G  110G  23% /u02

/dev/mapper/mp_dctsrv18_oracle_disk2p1   296G   29G  252G
11%

/u02/oradata/DPD6
```

Oracle 11GR2 Database Initialization Parameter Configuration

```
DPD6.__db_cache_size=28051505152

DPD6.__java_pool_size=1G

DPD6.__large_pool_size=1G

DPD6.__oracle_base='/u01/app/oracle'#ORACLE_BASE set from
environment

DPD6.__pga_aggregate_target=1G

DPD6.__shared_io_pool_size=0

DPD6.__shared_pool_size=2G

*.sga_max_size=9G

*.sga_target=8G

*.audit_file_dest='/u01/app/oracle/admin/DPD6/adump'

*.audit_trail='db'

*.compatible='11.2.0.2.0'

*.control_files='/u02/oradata/DPD6/control01.ctl','/u02/
oradata/DPD6/control02.ctl'

*.db_block_size=8192

*.db_domain=''

*.db_name='DPD6'

*._complex_view_merging=FALSE

*.aq_tm_processes=4

*.db_file_multiblock_read_count=32

*.db_recovery_file_dest='/u01/app/oracle/fast_recovery_area'

*.db_recovery_file_dest_size=4227858432

*.diagnostic_dest='/u01/app/oracle'

*.dispatchers='(PROTOCOL=TCP) (SERVICE=DPD6XDB)'

*.memory_target=54179921920
```

```
*.remote_login_passwordfile='EXCLUSIVE'
*.undo_tablespace='UNDOTBS1'
*.job_queue_processes=10
*.nls_language='AMERICAN'
*.nls_length_semantics='CHAR'
*.O7_DICTIONARY_ACCESSIBILITY=TRUE
*.open_cursors=2048
*.optimizer_index_caching=90
*.optimizer_index_cost_adj=30
*.optimizer_mode='FIRST_ROWS_10'
*.optimizer_dynamic_sampling=2
*.processes=5000
*.query_rewrite_enabled='FALSE'
*.remote_login_passwordfile='EXCLUSIVE'
*.resource_manager_plan=''
*.session_cached_cursors=500
*.session_max_open_files=20
*.sessions=10000
*.star_transformation_enabled='TRUE'
*.streams_pool_size=50331648
*.undo_management='AUTO'
*.undo_retention=3600
*.global_names='TRUE'
*.filesystemio_options='ASYNCH'
*._disable_fast_validate='TRUE'
*.dml_locks=10000
*._ash_enable=FALSE
```

```
*._spin_count=5000

*._latch_class_0=5000

*.log_buffer=460226560
```

Banner XE Performance Test Application Server Configuration

The following information details the application server testing environments. One server configuration supported 2 x 2.67GHz with 16GB of memory. The other configuration supported 4 x 2.67GHz cores, 16GB memory, and a SAN Disk Farm. Testing was conducted on both 2 core and 4 core servers.

XE Application Server CPU Configuration

```
processor: 0

vendor_id: GenuineIntel

cpu family: 6

model: 44

model name: Intel(R) Xeon(R) CPU           X5650  @ 2.67GHz

stepping: 2

cpu MHz: 2660.434

cache size: 12288 KB

physical id: 0

siblings: 1

core id: 0

cpu cores: 1

apicid: 0

initial apicid: 0

fpu: yes

fpu_exception: yes

cpuid level: 11
```

```
wp: yes

flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge
mca cmov pat clflush mmx fxsr sse sse2 ht syscall nx rdtscp
lm constant_tsc rep_good pni pclmulqdq ssse3 cx16 sse4_1
sse4_2 x2apic popcnt aes hypervisor lahf_lm

bogomips: 5320.86

clflush size: 64

cache_alignment: 64

address sizes: 40 bits physical, 48 bits virtual

power management:


processor: 1

vendor_id: GenuineIntel

cpu family: 6

model: 44

model name: Intel(R) Xeon(R) CPU           X5650  @ 2.67GHz

stepping: 2

cpu MHz: 2660.434

cache size: 12288 KB

physical id: 2

siblings: 1

core id: 0

cpu cores: 1

apicid: 2

initial apicid: 2

fpu: yes

fpu_exception: yes

cpuid level: 11
```

```
wp: yes

flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge
mca cmov pat clflush mmx fxsr sse sse2 ht syscall nx rdtscp
lm constant_tsc rep_good pni pclmulqdq ssse3 cx16 sse4_1
sse4_2 x2apic popcnt aes hypervisor lahf_lm

bogomips: 5319.32

clflush size: 64

cache_alignment: 64

address sizes: 40 bits physical, 48 bits virtual

power management:
```

processor: 2

```
vendor_id: GenuineIntel

cpu family: 6

model: 44

model name: Intel(R) Xeon(R) CPU           X5650  @ 2.67GHz

stepping: 2

cpu MHz: 2660.434

cache size: 12288 KB

physical id: 4

siblings: 1

core id: 0

cpu cores: 1

apicid: 4

initial apicid: 4

fpu: yes

fpu_exception: yes

cpuid level: 11
```

```
wp: yes

flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge
mca cmov pat clflush mmx fxsr sse sse2 ht syscall nx rdtscp
lm constant_tsc rep_good pni pclmulqdq ssse3 cx16 sse4_1
sse4_2 x2apic popcnt aes hypervisor lahf_lm

bogomips: 5319.36

clflush size: 64

cache_alignment: 64

address sizes: 40 bits physical, 48 bits virtual

power management:
```

processor: 3

```
vendor_id: GenuineIntel

cpu family: 6

model: 44

model name: Intel(R) Xeon(R) CPU           X5650  @ 2.67GHz

stepping: 2

cpu MHz: 2660.434

cache size: 12288 KB

physical id: 6

siblings: 1

core id: 0

cpu cores: 1

apicid: 6

initial apicid: 6

fpu: yes

fpu_exception: yes

cpuid level: 11
```

```
wp: yes

flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge
mca cmov pat clflush mmx fxsr sse sse2 ht syscall nx rdtscp
lm constant_tsc rep_good pni pclmulqdq ssse3 cx16 sse4_1
sse4_2 x2apic popcnt aes hypervisor lahf_lm

bogomips: 5319.17

clflush size: 64

cache_alignment: 64

address sizes: 40 bits physical, 48 bits virtual

power management:
```

XE Application Server Memory Configuration

```
MemTotal: 16460216 kB

MemFree: 9054576 kB

Buffers: 260056 kB

Cached: 1859988 kB

SwapCached: 0 kB

Active: 5797800 kB

Inactive: 855184 kB

Active(anon): 4537464 kB

Inactive(anon): 396 kB

Active(file): 1260336 kB

Inactive(file): 854788 kB

Unevictable: 31572 kB

Mlocked: 31624 kB

SwapTotal: 2064376 kB

SwapFree: 2064376 kB

Dirty: 40 kB

Writeback: 0 kB
```

```
AnonPages: 4564520 kB

Mapped: 70176 kB

Shmem: 524 kB

Slab: 653064 kB

SReclaimable: 328208 kB

SUnreclaim: 324856 kB

KernelStack: 2104 kB

PageTables: 15832 kB

NFS_Unstable: 0 kB

Bounce: 0 kB

WritebackTmp: 0 kB

CommitLimit: 10294484 kB

Committed_AS: 6380364 kB

VmallocTotal: 34359738367 kB

VmallocUsed: 40996 kB

VmallocChunk: 34359694156 kB

HugePages_Total: 0

HugePages_Free: 0

HugePages_Rsvd: 0

HugePages_Surp: 0

Hugepagesize: 2048 kB

DirectMap4k: 6144 kB

DirectMap2M: 16771072 kB
```

XE Application Server Disk Configuration

```
Filesystem  1K-blocks Used Available Use% Mounted on

/dev/mapper/vg_00-lv_root 27968240 22119628   4404980  84% /

/dev/xvda149782928501    443626   7% /boot

tmpfs82301080   8230108   0% /dev/shm

/dev/xvdb51606140184140  48800560   1% /u02
```

Banner XE Performance Tests

The following information details the results of some of the specific performance tests. The criteria for all tests is that each user transaction (i.e., user interacts with the system, waits for the action to complete, and it completes) must return within 3 seconds 90% of the time.

StudentRegistration Admin Search Term

This test used a 500 Administrative user load on a 1 dual core server with a 16MB of memory. The average user response time was below 1 second.

Search - Term/ Key-word	dctvm 172, 2 Core	500 users	Avg Response 0.98	90% Response 1.29	App Server CPU 91%	DB Server CPU 3%	Search_Term_Keyword_Increment_Test_500_Users_July_22.zip

StudentRegistrationSsb -Register for 5 classes and then drop 5 class

This test used a 2400 user load distributed on 3 quad core servers with 16MB of memory. Each server supported 800 concurrent users supporting average user response times below 3 seconds.

SSB Mix	dctvm173,174,175, 4 Cores	2000 total			App Server CPU 88%	SSB_Group_Test_2000_Users_July_24_Three_Servers.zip
Search/ Add/Drop		1050	1.9	2.6		
Search - Term/ Keyword		600	0.8	1		
Direct CRN Add/ Drop		350	1.9	2.5		

StudentRegistrationSsb - Register for 5 classes and drop 5 classes

This test used a 2000 user load distributed on 2 quad core servers with 16MB of memory. Each server supported 1000 concurrent users supporting an average web registration add and drop for 5 classes in 4 seconds.

EventsManagement Self Service - Register for multiple events

This test used a 200 user load on 1 quad core server with 16MB of memory and JVM heap 2.5GB.

Events SSB standalone	dctvm176	200	Avg Response	90% Response	Events_Grouped_SSB_200users.zip
Events - Authenticated Reg			2.83	4.87	
Events - Anonymous Reg			2.5	4.07	
Events - Browse Events			1.2	1.86	
Events - Cancel Reg			1.4	2.46	
Login			3	5	

StudentRegistrationSsb and StudentRegistration Administrators mixed run

This test used 2000 self-service users distributed on 3 quad core servers with 16MB of memory. Additionally the test included 500 Registration Administrator users on 1 quad core server with 16MB of memory. The average user response time was below 3 seconds.

Group Test - Admin & SSB		2500 total	Avg Response	90% Response	Admin_SSB_Group_Test_2500_Users_Aug_05_4_Servers_4_Cores_Each.zip
Admin	dctvm172, 4 Core	500	1.264	1.189	
SSB	dctvm173,174,175, 4 Cores	2000			
Search/Add/Drop		350	2.46	3.163	
Search - Term/ Keyword		200	1.062	1.183	
Direct CRN Add/Drop		116/117	2.412	3.281	

StudentRegistrationSsb, StudentRegistration Administrators, EventsManagement Self Service

These tests were for a 2500 users load consisting of Registration, Events SSB and Registration administrator use cases. Note that all response times are well below the required 3 seconds, with all average times being below 2 seconds.

Group Test - Reg Admin & Events & Reg SSB	dctvm172, 173,174,175, 176; 4 Cores	2500 total	Avg Response	90% Response	App Server CPU 60-80% avg	173, 174, 175: 7GB; 176: 4GB	Group_SSB_Events_2000_Admin_500_Sep_25.zip
Admin							
ID Search		300					
Name Search		200					
SBB							
Search/Add/Drop		945	1.6	1.9			
Search - Term/ Keyword		540	0.7	0.8			
Direct CRN Add/Drop		315	1.6	1.9			
Events - Authenticated Reg		30	0.5	0.6			
Events - Anonymous Reg		60	0.3	0.3			
Events - Browse Events		100	0.2	0.3			
Events - Cancel Reg		10	0.3	0.3			

FacultyGradeEntry

These tests were for a 200 user load test on a quad core server. Transaction mix included Final Grades-50%, Mid Term Grades-35%, Incomplete Grades-15% Class size was 25 students. JVM heap 2.5 GB

Faculty Grade Entry 200 user	Dctvm176, 4 Cores	200 Users	Avg Response	90% Response	App Server CPU	DB Server CPU 0.5%	FGE Grouped 200users 22ndOct.zip
Final Grades Save		1.99	2.31				
Mid Term Grades Save		2.12	2.47				
Incomplete Grades Save		.99	1.16				

BannerGeneralEventsManagementAdmin

- 50 user test on 2 Core servers
- Administrator checking functions for a registrant (GEIIDFN) – 10%
- Administrator checking in registrants & guests for a function (GEAATID) – 20%
- Administrator checking in registrants & guests for a function (GEAATTD) – 20%
- Administrator checking in registrants & guests for a function (GEAATRK) – 50%
- JVM Heap 5GB

Events Admin	Dctvm177, 2 Cores	50 Users	Avg Response	90% Response	App Server CPU 80%	DB Server CPU 8%	Events_Admin_Grouped_50users_2Cores_28th Oct.zip
Login			1.46	2.03			
Checking Functions			0.28	0.37			
Check in registrants and guests for function GEAATID			0.23	.034			
Check in registrants and guests for function GEAATTD			0.33	0.45			
Check in registrants and guests for function GEAATRK			0.52	.075			

FAQ

Here are some questions and answers about the set up for Banner XE.

Question: How many additional CPUs do we need for the Banner XE applications we are planning to implement?

Answer: This depends on the concurrent user load. For example a 4 CPU server using 6GB of memory can support 800 Registration Self Service users. Please see “CPU Core Usage per Application” for further details.

Question: How much additional memory do we need for the Banner XE applications we are planning to implement?

Answer: The minimum JVM memory requirement is 1GB for a small number of self service users. 2GB minimum is required for XE Administration applications. 500 Registration Administrative concurrent users require 10GB of memory on a quad core server. Please see “Allocated Java Heap Memory per Application” on page 7 for further details.

Note: The total JVM memory requirements should not exceed 75 – 80% of total system memory. Additional memory will be required by the OS to support other processing.

Question: What would be the recommended grouping of applications per application server?

Answer: Separate XE Self Service applications from XE Administrative applications. Deploy to separate application servers sized to support the expected user load. Please see an example of this in the “Sizing and Deployment Example” on page 10.

Question: What are the recommended configuration settings for the database, the applications, and each application to achieve optimal performance?

Answer: Application server JVM memory settings are the most important. Set the initial heap size -Xms:2G and set the max heap size -Xmx:8G for most applications. If you are using the Oracle Hotspot JVM then you also need to increase MaxPermSize setting. -XX:MaxPermSize=256m. For additional XE applications deployed to this server increase MaxPermSize by 128m. For example, 2 XE apps would need -XX:MaxPermSize=384m, 3 apps would need 512m.

Question: Do I need a new server or VM for each Banner XE Web application?

Answer: No, multiple Banner XE Web applications can be deployed to the same application server instance.

Question: How many Banner XE Web applications can I deploy to the same WebLogic or Tomcat server?

Answer: This depends on the available memory and the expected usage needed to support each Web application.

Question: How many WebLogic or Tomcat instances can I run on the same server or VM?

Answer: 1 less than the number of CPU's or Cores on the server (e.g., quad core machine can run 3 application server instances).

Question: Do I have to hold to these recommendations for a test environment?

Answer: No, you can "load up" a testing environment, but you will not be able to judge performance based on such a system.

Question: Are there other configurations that I must pay attention to?

Answer: Datasource connection pool sizing is important to performance. See recommendations above.

Question: Are there any critical ongoing tuning, maintenance, or monitoring that I must do to the application servers running Banner XE to ensure optimal performance?

Answer: Application server log file monitoring and maintenance is required. Log files should be rolled over and purged to avoid unlimited growth.

Question: What are the recommended ways to scale the application for peak performance periods – in advance of a critical event for example, a registration deadline, event registration, or prior to grading?

Answer: Customers have the ability to deploy multiple instances of the application to additional servers to increase performance for expected higher usage patterns.

Question: When scaling horizontally, deploying a Banner XE application in another VM, do I have to bring that application server down? Do I need to bring Banner down to scale it?

Answer: No, you can add additional application servers and or VMs dynamically without shutting down other application servers or the Banner database.

Question: How do I determine the number of concurrent users for each Banner XE application?

Answer: You can compare your current Banner 8 INB usage by reviewing the table data in bansecr.guraces. This table contains information for INB users accessing Banner 8 Forms. For Banner 8 SSB you can review the table data in wtailor.twgraces which tracks self-service users accessing pages. SSB also provides self-service access information in wtailor.tggbwses. These tracking tables will provide information on how many users are currently using the system over a period to time.

Question: How many applications are there in Banner XE Student?

Answer: The number of Banner XE Student modules will be identified by product management but the total module count is not expected to exceed 15 – 20.