



## Blackboard Academic Suite

### Hardware Sizing Guide

#### Introduction

The goal of this document is to serve as a tool for planning your hardware needs based on anticipated load on the *Blackboard Academic Suite™*. The *Blackboard Academic Suite* consists of the *Blackboard Learning System™*, *Blackboard Portal System™*, and *Blackboard Content System™*. Because the processing overhead of adding the *Blackboard Portal System* and/or *Blackboard Content System* to the *Blackboard Learning System* is minimal, we focus on the *Blackboard Academic Suite* as a whole.

Other Blackboard documents referred to in this document can be found on the Behind the Blackboard extranet. Use the following URL to access Behind the Blackboard:

<http://www.blackboard.com/products/services/support.htm>

A login is required to access Behind the Blackboard. Users may create their own login for roles other than Administrator. Administrators must receive their Behind the Blackboard login from their Blackboard Account Manager.

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## **Choosing the Right Hardware to Support the Blackboard Academic Suite**

Outlined below and detailed on the following pages you will find three hardware sizing models. Each model includes a separate set for the Intel® processor chip set (Windows® and Linux® operating systems) and the SPARC® processor chip set (Solaris® operating system). The models outline hardware needs based on your performance goals:

- **Cost Performance Model** - for cost-conscious learning institutions looking for the best performing model at an affordable pricing structure. It is not a minimum recommendation, but rather a recommendation that will support your cost concerns while efficiently supporting their usage and load.
- **High-Performance/Watermark Model** - for institutions primarily concerned with performance over cost. Most configurations consist of highly-available recommendations. The purpose for multiple servers at the various tiers within the technology stack is to support distributed, parallel processing.
- **High-Availability Model** - for institutions primarily concerned with uptime and availability. Highly-available models can be cost conscientious and/or high-performing.

Blackboard does not make separate recommendations for the Linux operating system and the Windows operating system because both operating systems use the same Intel chip set. This is a change from past hardware guides in which recommendations were separated by operating system.

## **How to Choose a Model**

Choosing a sizing model can be a challenging task. Here are some important things to consider:

- Growth within the learning institution (users and courses)
- Adoption rates (growth within the existing community)
- Archive strategy (removal of data from the system that no longer applies)
- Lease or purchase terms on equipment (hardware is typically turned over every 2 years commercially and 4 years academically)
- Concurrency of user community
- Performance expectations
- Availability/Redundancy expectations

Blackboard suggests two approaches to sizing. The first is intended for new clients unfamiliar with the *Blackboard Academic Suite*. The second is intended for existing clients ready to upgrade.

### **New Clients**

Blackboard recommends that new clients go through a formal audit of how they plan to deploy from year 1 to as far as year 3. This audit should include metrics regarding the number of courses, enrollments, potential usage expectations (ex: students taking assessments in a computer lab concurrently versus in their free time) and an archive strategy for managing courses semester to semester.

### **Existing Clients**

For existing clients ready to upgrade, there is a considerable amount of data available for review: capacity metrics (courses, enrollments, database size and file system size), growth rates from the beginning of the implementation to the current state (important, since a learning institution might have already grown to a mature size and growth rates might decline.) as well as an understanding of the infrastructure required to support the existing and future implementation.

## **How to Read Each Model**

The breakout within each model detail and chip set is identical. Recommendations are distinguished by:

### **Characteristics**

- Users: Number of users enrolled at the institution.
- Concurrent Users: Number of users sending requests to the servers at peak load.
- Courses: Number of courses in the *Blackboard Learning System*.
- Enrollments: Number of user enrollment records. An enrollment record associates a user with a course. Therefore, if there are 5,000 users and each user averages 4 courses, enrollments could be estimated as 20,000.

### **Web/Application Layer**

- Processors: Number and type of processors in each Web/application server.
- RAM: Amount of memory in each Web/application server.
- Internal Storage: Amount of internal disk space in each Web/Application server.
- Network Card: Number and type of Network Interface Cards (NIC).
- Server Quantity: Number of Web/application servers.

### **Database Layer**

- Processors: Number and type of processors in each database server.
- RAM: Amount of memory in each database server.
- Internal Storage: Amount of internal disk space in each database server.
- Network Card: Number and type of NICs.
- Controllers: Number of controllers to manage the transfer of data.
- Server Quantity: Number of database servers.
- Oracle® RAC: Recommendation for Oracle Real Application Cluster. Oracle RAC is a solution for clustering database servers for redundancy and performance.

### **External Storage**

- NAS: Recommendation for Network Attached Storage.
- JBOD: Recommendation for Just a Bunch of Disks. JBOD is a storage system not configured for RAID.
- SAN: Recommendation for Storage Area Network, a collection of interconnected storage devices.

Please note that all models are interchangeable. Institutions interested in a highly-available, cost-performance model can work with their Account Manager or Technical Support Manager to create a custom model that represents features and components from both models, focused on their performance and availability needs. The same could be said for any combination of the three models.

### **Sizing Blackboard Learning System—Basic Edition**

The *Blackboard Learning System* –Basic Edition has historically been sized for one machine (typically a 2 CPU system using outdated processors). Since *Blackboard Learning System*—Basic Edition™ is sized for less than 3,000 users, the cost performance model should be used for sizing. Based on the cost performance model, the recommendation is a 4-way server since the *Blackboard Learning System*—Basic Edition is only supported on one server.

**Cost Performance Model: Intel Processor (Linux and Windows)**

	<b>Components</b>	<b>Small Institution</b>	<b>Moderate Institution</b>	<b>Large Institution</b>
<b>Characteristics</b>	<i>Users</i>	1,000 – 5,000	10,000 – 25,000	50,000 – 100,000
	<i>Concurrent Users</i>	500	1,500 – 4,500	4,800 – 6,000
	<i>Courses</i>	500	5,000	50,000
	<i>Enrollments</i>	5,000	60,000	195,000
<b>Web/Application Layer</b>	<i>Processors</i>	(2) 2.8 GHz Xeon®	(2 – 4) 2.8 GHz Xeon	(4) 2.8 GHz Xeon
	<i>RAM</i>	4GB	4GB – 6GB (PAE)	6GB – 8GB (PAE)
	<i>Internal Storage</i>	(4) 72 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Server Quantity</i>	1	2 – 3	4 – 6
	<i>Notes:</i>	Assumes non-database content stored locally.	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.
	<b>Database Layer</b>	<i>Processors</i>	(2) 2.8 GHz Xeon	(2) 2.8 GHz Xeon or (4) 2.8 GHz Xeon
<i>RAM</i>		4 GB	4GB	4GB
<i>Internal Storage</i>		(4) 73GB 10K RPM	(5) 73 – 146 GB 10K RPM	(2) 36 GB 10K RPM
<i>Network Card</i>		(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
<i>Controllers</i>		1	1 – 2	2 – 4
<i>Server Quantity</i>		1	1 – 2	1 – 3
<i>Oracle RAC</i>		No	Depends	Depends
<i>Notes:</i>		Assumes database storage local.	Internal storage applies if not using attached storage.	Internal storage applies if not using attached storage.
<b>External Storage</b>	<i>NAS</i>	Not Applicable	Content	Content
	<i>JBOD</i>	Not Applicable	Content or Data Files	Content or Data Files
	<i>SAN</i>	Not Applicable	Content or Data Files (RAC)	Content or Data Files (RAC)

### Summary Notes: Cost Performance Model (Linux and Windows)

**Small Institution:** Important points to note about a small institution within a cost performance model:

- Content from a file system perspective is stored locally on the Web/application server.
  - Raid Controllers should be considered but are not necessary if adequate back-ups are performed.
  - No less than four disks should be configured.
- Content from a relational database perspective is stored locally on the database server.
  - No less than four disks should be configured or the result will be sub-optimal performance.
  - Recommend a RAID-5 configuration for most institutions.

**Moderate Institution:** Important points to note about a moderate institution within a cost performance model:

- Greater application usage and thus recommend additional memory DIMs up to 6GB.
  - Linux will address the memory without configuration.
  - Windows will require a change to the boot.ini referencing Physical Address Extension (PAE). See the following Web site for more information:  
<http://www.microsoft.com/whdc/hwdev/platform/server/pae/PAEmem.msp>
- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- 4-way servers do not correlate 2:1 to a 2-way server, but rather 1 ½:1.
- Oracle data files are positioned for internal storage, network attached storage, or on a SAN.
  - Blackboard does not recommend the deployment of Oracle® on a network attached device at this time.

**Large Institution:** Important points to note about a large institution within a cost performance model:

- 2-way Web/application servers can be deployed in lieu of 4-way Web/application servers when using the 1 ½:1 formula.
- Similar principles apply as referenced in the moderate institution as it relates to storage.
- At this amount of usage, RAC may be the most viable solution to manage performance during peak usage.

**High-Watermark/Performance Model: Intel Processor (Linux and Windows)**

	<b>Components</b>	<b>Small Institution</b>	<b>Moderate Institution</b>	<b>Large Institution</b>
<b>Characteristics</b>	<i>Users</i>	1,000 – 5,000	10,000 – 25,000	50,000 – 100,000
	<i>Concurrent Users</i>	1,000 – 1,750	1,800 – 6,000	6,000 – 12,000
	<i>Courses</i>	500	5,000	50,000
	<i>Enrollments</i>	5,000	60,000	195,000
<b>Web/Application Layer</b>	<i>Processors</i>	(2) 3.2+ GHz Xeon	(2) 3.2+ GHz Xeon or (4) 3.0+ GHz Xeon	(4) 3.0+ GHz Xeon
	<i>RAM</i>	4GB	4GB – 6GB (PAE)	4GB – 6GB (PAE)
	<i>Internal Storage</i>	(2) 36 GB 15K RPM	(2) 36 GB 15K RPM	(2) 36 GB 15K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Server Quantity</i>	2 – 3	3 – 6	4 – 8
	<i>Notes:</i>	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.
<b>Database Layer</b>	<i>Processors</i>	(2) 3.2+ GHz Xeon	(4) 3.0+ GHz Xeon	(4) 3.0+ GHz Xeon
	<i>RAM</i>	4 GB	4GB – 6GB	4GB – 6GB
	<i>Internal Storage</i>	(2) 36 GB 15K RPM	(2) 36 GB 15K RPM	(2) 36 GB 15K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Controllers</i>	2	2 – 3	3 – 4
	<i>Server Quantity</i>	1	1 – 2	2 – 3
	<i>Oracle RAC</i>	No	Depends	Yes
<i>Notes:</i>	Data File Attached Storage	Data File Attached Storage	Data File Attached Storage	
<b>External Storage</b>	<i>NAS</i>	Content	Content	Content
	<i>JBOD</i>	Content	Content	Content
	<i>SAN</i>	Content and Data Files	Data Files (RAC)	Data Files (RAC)

**Summary Notes: High-Performance/Watermark Model (Linux and Windows)**

**Small Institution:** Important points to note about a small institution within a high-performance/watermark model:

- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- Oracle data files are positioned for internal storage, network attached storage, or on a SAN.
  - Blackboard does not recommend the deployment of Oracle® on a network attached device at this time.

**Moderate Institution:** Important points to note about a moderate institution within a high-performance/watermark model:

- Greater application usage and thus recommend additional memory DIMs up to 8GB.
  - Linux will address the memory without configuration.
  - Windows will require a change to the boot.ini referencing Physical Address Extension (PAE). See the following Web site for more information:  
<http://www.microsoft.com/whdc/hwdev/platform/server/pae/PAEmem.mspx>
- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- 4-way servers do not correlate 2:1 to a 2-way server, but rather 1 ½:1.
- Oracle data files are positioned for a SAN (FC).
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.
- For parallel processing, RAC may be the most viable solution to manage performance during peak usage.

**Large Institution:** Important points to note about a large institution within a high-performance/watermark model:

- 2-way Web/application servers can be deployed in lieu of 4-way Web/application servers when using the 1 ½:1 formula.
- Similar principles apply as referenced in the moderate institution as it relates to storage.
- At this amount of usage, RAC may be the most viable solution to manage performance during peak usage.

**High-Availability Model: Intel Processor (Linux and Windows)**

	<b>Components</b>	<b>Small Institution</b>	<b>Moderate Institution</b>	<b>Large Institution</b>
<b>Characteristics</b>	<i>Users</i>	1,000 – 5,000	10,000 – 25,000	50,000 – 100,000
	<i>Concurrent Users</i>	1,000 – 1,800	2,000 – 6,000	9,000 – 15,000
	<i>Courses</i>	500	5,000	50,000
	<i>Enrollments</i>	5,000	60,000	300,000
<b>Web/Application Layer</b>	<i>Processors</i>	(2) 2.8 GHz Xeon	(2 – 4) 2.8 GHz Xeon or (4) 3.0+ GHz Xeon	(4) 2.8 GHz Xeon or (4) 3.0+ GHz Xeon
	<i>RAM</i>	4GB	6GB (PAE)	8GB (PAE)
	<i>Internal Storage</i>	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Server Quantity</i>	2 – 3	3 – 4	4 – 8
	<i>Notes:</i>	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.
<b>Database Layer</b>	<i>Processors</i>	(2) 2.8 GHz Xeon	(2 – 4) 2.8 GHz Xeon or (4) 3.0 GHz Xeon	(4) 2.8 GHz Xeon or (4) 3.0 GHz Xeon
	<i>RAM</i>	4GB	4GB – 6GB	4GB – 6GB
	<i>Internal Storage</i>	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Controllers</i>	2	2 – 4	2 – 4
	<i>Server Quantity</i>	1	1 – 2	1 – 3
	<i>Oracle RAC</i>	No	Yes	Yes
<i>Notes:</i>	Data File Attached Storage: (9) 73 GB 10K RPM	Data File Attached Storage: (9) 73GB 10K RPM	Data File Attached Storage: (18) 73 GB 10K RPM	
<b>External Storage</b>	<i>NAS</i>	Content	Content	Content
	<i>JBOD</i>	Content	Content	Content
	<i>SAN</i>	Data Files	Data Files (RAC)	Data Files (RAC)

**Summary Notes: High-Availability Model (Linux and Windows)**

**Small Institution:** Important points to note about a small institution within a high-available model:

- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- Oracle data files are positioned for JBOD attached storage or on a SAN.
  - We are not recommending the deployment of Oracle on a network attached device at this time.

**Moderate Institution:** Important points to note about a moderate institution within a high-available model:

- Greater application usage and thus recommend additional memory DIMs up to 6GB.
  - Linux will address the memory without configuration.
  - Windows will require a change to the boot.ini referencing Physical Address Extension (PAE). See the following Web site for more information:  
<http://www.microsoft.com/whdc/hwdev/platform/server/pae/PAEmem.mspix>
- The Web/application server quantity changes to as many as four, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- 4-way servers do not correlate 2:1 to a 2-way server, but rather 1 ½:1.
- Oracle data files are positioned for a SAN (FC).
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.
- For high-availability, RAC may be the most viable solution to manage uptime.

**Large Institution:** Important points to note about a large institution within a high-available model:

- 2-way Web/application servers can be deployed in lieu of 4-way Web/application servers when using the 1 ½:1 formula.
- Similar principles apply as referenced in the moderate institution as it relates to storage.
- For high-availability, RAC may be the most viable solution to manage uptime.

**Cost Performance Model: SPARC Processor (Solaris)**

	<b>Components</b>	<b>Small Institution</b>	<b>Moderate Institution</b>	<b>Large Institution</b>	
<b>Characteristics</b>	<i>Users</i>	1,000 – 5,000	10,000 – 25,000	50,000 – 100,000	
	<i>Concurrent Users</i>	400	1,200 – 2,400	3,000 – 7,200	
	<i>Courses</i>	500	5,000	50,000	
	<i>Enrollments</i>	5,000	60,000	195,000	
<b>Web/Application Layer</b>	<i>Processors</i>	(2) 1.0 – 1.28GHz US3	(2 – 4) 1.0 – 1.28GHz US3	(4 – 8) 1.0 – 1.28GHz US3	
	<i>RAM</i>	4GB	4GB – 6GB	6GB – 8GB	
	<i>Internal Storage</i>	(4) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM	
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	
	<i>Server Quantity</i>	1	2 – 3	4 – 6	
	<i>Notes:</i>	Assumes non-database content stored locally.	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.	
	<b>Database Layer</b>	<i>Processors</i>	(2 – 4) 1.0 – 1.28GHz US3	(4 – 8) 1.0 – 1.28GHz US3	(8 – 24) 1.0 – 1.28GHz US3
		<i>RAM</i>	4GB – 8GB	8GB – 12GB	16GB
<i>Internal Storage</i>		(4) 73GB 10K RPM	(6) 73GB with backplane (6) 73GB 10K RPM	(6) 73GB with backplane (6) 146GB 10K RPM	
<i>Network Card</i>		(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	
<i>Controllers</i>		1	2	4	
<i>Server Quantity</i>		1	1	1	
<i>Oracle RAC</i>		No	No	No	
<i>Notes:</i>		Assumes database storage local.	Internal storage applies if not using attached storage.	Internal storage applies if not using attached storage.	
<b>External Storage</b>	<i>NAS</i>	Not Applicable	Content	Content	
	<i>JBOD</i>	Not Applicable	Content or Data Files	Content or Data Files	
	<i>SAN</i>	Not Applicable	Content or Data Files	Content or Data Files	

**Summary Notes: Cost Performance Model (Solaris)**

**Small Institution:** Important points to note about a small institution within a cost performance model:

- Content from a file system perspective is stored locally within the Web/application server.
  - No less than four disks should be configured.
  - Most institutions will need to use volume management software.
- Content from a relational database perspective is stored locally within the database server.
  - No less than four disks should be configured.
  - Most institutions will likely need to use volume management software.

**Moderate Institution:** Important points to note about a moderate institution within a cost performance model:

- Greater application usage and thus recommend additional memory DIMs up to 6GB.
- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- For Solaris, 4-way servers do correlate 2:1.
- Oracle data files are positioned for internal storage, network attached storage, or on a SAN.
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.

**Large Institution:** Important points to note about a large institution within a cost performance model:

- 2-way Web/application servers can be deployed in lieu of 4-way Web/application servers when using the 2:1 formula.
- 8-way Web/application servers do not correlate 4:1 to 2-way servers.
- Similar principles apply as referenced in the moderate institution as it relates to storage.

**High-Watermark/Performance Model: SPARC Processor (Solaris)**

	<b>Components</b>	<b>Small Institution</b>	<b>Moderate Institution</b>	<b>Large Institution</b>
<b>Characteristics</b>	<i>Users</i>	1,000 – 5,000	10,000 – 25,000	50,000 – 100,000
	<i>Concurrent Users</i>	1,600 – 2,400	3,200 – 4,800	6,400 – 15,000
	<i>Courses</i>	500	5,000	50,000
	<i>Enrollments</i>	5,000	60,000	195,000
<b>Web/Application Layer</b>	<i>Processors</i>	(4) 1.28GHz US3	(4) 1.28GHz US3	(4) 1.28GHz US3
	<i>RAM</i>	4GB	8GB	8GB
	<i>Internal Storage</i>	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Server Quantity</i>	2 – 3	4 – 6	4 – 8
	<i>Notes:</i>	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.
	<i>Processors</i>	4	4 – 8	4 – 52
	<i>RAM</i>	4GB	8GB	8GB
<b>Database Layer</b>	<i>Internal Storage</i>	(4) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Controllers</i>	2	2 – 4	3 – 4
	<i>Server Quantity</i>	1	1 – 2	1 – 3
	<i>Oracle RAC</i>	Not Applicable	Depends	Depends
	<i>Notes:</i>	Assumes database storage local.	Assumes External Storage	Assumes External Storage
	<i>NAS</i>	Content	Content	Content
	<i>JBOD</i>	Content	Content	Content
<b>External Storage</b>	<i>SAN</i>	Content and Data Files	Data Files (RAC)	Data Files (RAC)

**Summary Notes: High-Performance/Watermark Model (Solaris)**

**Small Institution:** Important points to note about a small institution within a high-performance/watermark model:

- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- Oracle data files are positioned for internal storage, network attached storage, or on a SAN.
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.

**Moderate Institution:** Important points to note about a moderate institution within a high-performance/watermark model:

- Greater application usage and thus recommend additional memory DIMs up to 8GB.
- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- 4-way servers do correlate 2:1 to a 2-way server.
- Oracle data files are positioned for a SAN (FC).
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.
- For parallel processing, RAC may be the most viable solution to manage performance during peak usage.

**Large Institution:** Important points to note about a large institution within a high-performance/watermark model:

- 2-way Web/application servers can be deployed in lieu of 4-way Web/application servers when using the 2:1 formula.
- 8-way Web/application servers do not correlate 4:1 to 2-way servers.
- Similar principles apply as referenced in the moderate institution as it relates to storage.
- If using a scale-out strategy, RAC may be the most viable solution to manage performance during peak usage.
- If using a scale-up strategy, Solaris expands processor counts to 12, 16, 32 and upward.

**High-Availability Model: SPARC Processor (Solaris)**

Categories	Components	Small Institution	Moderate Institution	Large Institution
<b>Characteristics</b>	<i>Users</i>	1,000 – 5,000	10,000 – 25,000	50,000 – 100,000
	<i>Concurrent Users</i>	800 – 2,400	1,600 – 3,200	3,200 – 18,000
	<i>Courses</i>	500	5,000	50,000
	<i>Enrollments</i>	5,000	60,000	300,000
<b>Web/Application Layer</b>	<i>Processors</i>	(2 – 4) 1.0 – 1.28GHz US3	(2 – 8) 1.0 – 1.28GHz US3	(2 – 8) 1.0 – 1.28GHz US3
	<i>RAM</i>	4GB	4GB – 8GB	8GB
	<i>Internal Storage</i>	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Server Quantity</i>	2 – 3	3 – 6	4 – 8
	<i>Notes:</i>	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.	Assumes non-database content stored remotely.
	<i>Processors</i>	4	4 – 8	4 – 8
	<i>RAM</i>	4GB	4GB – 8GB	8GB
<b>Database Layer</b>	<i>Internal Storage</i>	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM	(2) 36 GB 10K RPM
	<i>Network Card</i>	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex	(2) 100/1000 Full Duplex
	<i>Controllers</i>	2	2 – 4	2 – 4
	<i>Server Quantity</i>	1	1 – 2	1 – 3
	<i>Oracle RAC</i>	Not Applicable	Yes	Yes
	<i>Notes:</i>	Assumes External Storage	Assumes External Storage	Assumes External Storage
	<i>NAS</i>	Content	Content	Content
<b>External Storage</b>	<i>JBOD</i>	Content	Content	Content
	<i>SAN</i>	Data Files	Data Files (RAC)	Data Files (RAC)

**Summary Notes: High-Availability Model (Solaris)**

**Small Institution:** Important points to note about a small institution within a high-available model:

- The Web/application server quantity changes to as many as three, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- Oracle data files are positioned for JBOD attached storage or on a SAN.
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.

**Moderate Institution:** Important points to note about a moderate institution within a high-available model:

- Greater application usage and thus recommend additional memory dims up to 6GB.
- The Web/application server quantity changes to as many as four, therefore, a shared storage solution is recommended.
  - Use of network filer.
  - Use of an attached array to one of the existing Web/application servers with a shared mount point.
- 4-way servers do correlate 2:1 to a 2-way server.
- Oracle data files are positioned for a SAN (FC).
  - Blackboard does not recommend the deployment of Oracle on a network attached device at this time.
- For high-availability, RAC may be the most viable solution to manage uptime.

**Large Institution:** Important points to note about a large institution within a high- available model:

- 2-way Web/application servers can be deployed in lieu of 4-way Web/application servers when using the 2:1 formula.
- 8-way Web/application servers do not correlate 4:1 to 2-way servers.
- Similar principles apply as referenced in the moderate institution as it relates to storage.
- If using a scale-out strategy, RAC may be the most viable solution to manage performance during peak usage.
- If using a scale-up strategy, Solaris expands processor counts to 12, 16, 32 and upward.

## Sizing the Blackboard Content System Storage Needs

The *Blackboard Content System* requires additional storage. Use the formula below to calculate storage needs.

Storage Need	Formula	Example
<b>Minimum Storage Space (for Learning System or Learning System and Portal System)</b>	9 Gb	9 Gb
<b>User Storage (My Content)</b>	(users with My Content repository) x (Allocated storage space per user)	(5000 users) x (20 Mb per user)
<b>Course Storage (Course Content)</b>	(storage space per course) x (courses with Course Content repository)	(50 Mb per course) x (200 courses)
<b>Organization Storage (Organization Content)</b>	(storage space per organization) x (organizations with Organization Content repository)	(50 Mb per organization) x (50 organizations)
<b>Institution Storage (Institution Content)</b>	Allocated storage space for institutional repositories (such as Academic Departments).	10 Gb
<b>Library Storage (Library Content)</b>	((storage space per eReserve folder) + (storage space for library repositories)) x (courses using eReserves)	10 Gb
<b>Total Hardware Storage Space Required</b>	Sum of above as available hard disk space in a RAID configuration	~150 Gb of available hard disk space in a RAID configuration

### Notes:

- The *Blackboard Content System* (Release 1) cannot be installed as a stand-alone application. It must be installed on the same server as the *Blackboard Learning System* (Release 6.1) or the *Blackboard Learning System* and the *Blackboard Portal System* (Release 6.1).
- Hard disk space should be on either the Web/Application Server(s) or on a separate file storage device (Network Attached Storage Device, Storage Area Network, and so forth).
- These minimum requirements may be adjusted by Blackboard based on results of additional load testing.

## Updates and Additions

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