

HP BladeSystem architecture for JBoss Application Server



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Executive summary

This technical guide explains best practices for installing and configuring the JBoss Application Server in an architecture based on components of HP BladeSystem and the Linux operating system. Recommendations for high availability and scalability are also presented based on a tested solution stack using the JBoss Application Server, Apache Web Server, and a MySQL database server.

This document is intended for system administrators, system integrators, and other technical personnel with a general working knowledge of Java™ application servers, Linux, and system management techniques. Knowledge of the HP ProLiant Essentials Rapid Deployment Pack Linux Edition (RDP-LE) for provisioning and HP Systems Insight Manager (HP SIM) will be helpful in understanding the examples and best practices described in this document.

Introduction

This technical guide utilizes HP BladeSystem hardware, ProLiant Essentials management software, and the JBoss Application Server as the core components in an HP Adaptive Enterprise implementation. Application servers are the critical middleware component in multi-tiered architectures for connecting database servers, web front-end servers, and end users. BladeSystem servers are compact and efficient servers that save space and power. However, HP BladeSystem offers more than this. BladeSystem is as an integrated, consolidated infrastructure – a complete system – that includes servers, storage, networking, and power that are all virtualized, controlled and automated through a common management framework optimized to scale. Such a modular system design simplifies the construction, maintenance and expansion of scale-out infrastructures. Putting the components together – web server, application server, and database server – on a BladeSystem platform provides the infrastructure components of an Adaptive Enterprise – the HP strategy for building an organization in which business and IT are synchronized to capitalize on change.

JBoss Application Server

The JBoss Application Server is the most popular open source Java™ application server in the market. JBoss provides a fully compliant Java 2 Platform, Enterprise Edition (J2EE) application server for enterprise computing. Enterprise computing is synonymous for distributed computing – computation performed by groups of programs interacting over a network. The J2EE platform is a collection of enterprise APIs and a framework for component-based enterprise computing.¹

J2EE includes APIs for the following functions:

- Java Database Connectivity (JDBC) – provides access to relational databases.
- Remote Method Invocation (RMI) – allows a client to communicate with a server by invoking methods on remote objects that reside on the server.
- Interface Definition Language (Java IDL) – provides an interface to remote CORBA objects.

¹ JAVA ENTERPRISE in a NUTSHELL – by Jim Farley, William Crawford & David Flanagan

- Java API for XML parsing (JAXP) – provides XML parsing and messaging.
- Java Naming and Directory Interface (JNDI) – provides an interface to naming and directory services, such as LDAP, NIS, or Novell's NDS.
- Java Messaging Service (JMS) – provides an interface for networked messaging services and for writing message-oriented middleware.
- JavaMail – provides access to e-mail-based messaging.
- JavaTransaction API (JTA) – provides an interface for managing distributed transactions.
- Java Authentication and Authorization Service (JAAS) – provides an interface for authentication and enforcement of access control.
- J2EE Connector Architecture (JCA) – provides tools for connectivity between JBoss and existing enterprise information systems.

J2EE is also a component framework for the following:

- Enterprise Java Beans (EJB) – a component model for separating units of business logic and data logic. An application server provides a container and server for the EJBs.
- Servlets and Java Server Pages (JSPs) – Tomcat is used for dynamic generation of HTML.

The momentum behind JBoss can be attributed to a number of factors, such as its open source, no-cost product licenses, large developer community, training, and documentation. JBoss is free to download and free to use, regardless of the size of your deployment. Key features include the following:

- Scalability – JBoss offers full clustering of any Java object such as EJB, HTTP, POJO².
- Modular architecture – JBoss offers a unique architecture built on a micro-kernel-based design that leverages Java Management Extensions (JMX) technology. The result is a lightweight component model that delivers advanced class-loading features and full lifecycle management.
- Services-oriented architecture – Services are easily added or removed based on your specific needs within the Adaptive Enterprise. All services are neatly packaged and fully hot-deployable. One can also easily create and add personalized services.

Also included is a full security implementation and Java Authentication and Authorization Service (JAAS) integration. The JBoss Application Server (Version 4.0) is J2EE 1.4 certified.

More information on the JBoss Application Server can be found at <http://www.jboss.org>

HP BladeSystem

HP BladeSystem provides an integrated modular infrastructure with the following benefits:

- Can be racked once to dramatically reduce cabling and allow for shared power and network resources
- Can be easily provisioned and managed utilizing HP ProLiant management software

² POJO – Plain Old Java Object – a normal Java object that is not a JavaBean, Entity Bean, Session Bean, etc.

The ProLiant BL p-Class server blades are recommended for this solution because of the following features:

- Intel® Xeon™ dual processor or AMD Opteron™ dual processor
- Utilizes fault-resilient power
- Redundant NICs
- Integrated RAID
- Hot plug dual SCSI drives
- Networking provided by the redundant GbE2 blade switches

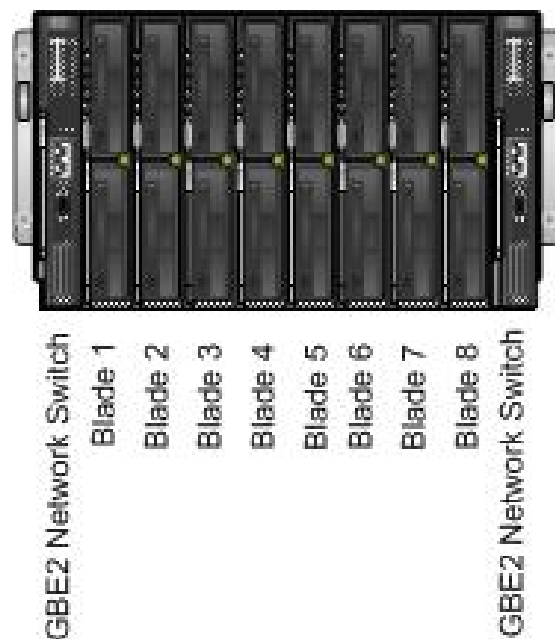
Table 1 provides additional ProLiant BL20p G3 server features.

Table 1. ProLiant BL20p G3 server features

Feature	Description
CPU speed	Up to two 3.6 GHz Intel Xeon
CPU cache	Up to 2MB L2 cache
Memory	Up to 8GB
Memory speed	PC3200 DDR2 SDRAM running at 400MHz
I/O channels	Smart Array 6i controller for internal disks. Optional Fibre Channel Adapter for SAN connectivity
Redundant power	Blade power enclosure provides shared, external, redundant power. Up to 6 hot plug power supplies
Hot swap disks	2 1" Wide Ultra320 SCSI hot plug disks

Figure 1 shows a fully populated blade enclosure and related components.

Figure 1. Fully populated blade enclosure and components



Note: The power is a shared rack-centralized system with optional redundant power supplies.

Management features for the ProLiant BL20p server blade system include HP Integrated Lights-Out (iLO) and HP Systems Insight Manager (HP SIM).

The iLO advanced functionality ships standard on every ProLiant BL p-Class server blade system. In addition to full graphical access to the host server's display, keyboard, and mouse, the advance functionality also includes virtual CD and floppy capability. The pre-boot execution environment (PXE) technology enhances remote access by installing and configuring operating systems to boot remotely. Systems Insight Manager provides system monitoring for the HP BladeSystem environment.

More information on HP BladeSystem can be found at:

<http://h18004.www1.hp.com/products/servers/proliant-bl/p-class/index.html>.

Blade server as building block

The ProLiant BL20p blade server is used as the basic building block for the architecture. The configuration used is listed in Table 2.

Table 2. ProLiant BL20p G2 blade server configuration

Quantity	Description
2	Intel Xeon 2.80 GHz/512KB L2 cache
1	1GB PC2100 DDR SDRAM
2	1" Wide 36GB Ultra 3/Ultra320 SCSI hot plug disks

Figure 2 illustrates the ProLiant BL20p G2 blade server.

Figure 2. ProLiant BL20p G2 blade server



A fully populated enclosure of ProLiant BL20p G2 blade servers was utilized for this solution with the blades numbered from left to right by their enclosure order. At each end of the enclosure are Gigabit Ethernet (GbE2) network switches for a fully redundant network solution.

Figure 1 illustrates the blade components in the blade enclosure while Figure 3 shows the deployment of the functional components in a highly available and easily scalable environment. The blades provide an easy mechanism for a scale-out architecture. The Smart Array 5i Plus controller's onboard RAID is utilized for storage high availability by mirroring the disk drives.

Figure 3. Functional components of the blade architecture



HP provides a detailed solutions guide for High Availability and Scaling of the MySQL database solution located at

<http://h10018.www1.hp.com/wwsolutions/linux/solutions.html>, specifically from [HP ProLiant server configurations for MySQL in a scale-out architecture](http://h71019.www7.hp.com/ActiveAnswers/cache/81881-0-0-225-121.html),

<http://h71019.www7.hp.com/ActiveAnswers/cache/81881-0-0-225-121.html>.

Software solution components

The software components include:

- The JBoss Application Server
- The SUN Java Development Kit (JDK)
- MySQL database server
- Apache Web Server
- HP ProLiant Essentials Rapid Deployment Pack (Linux Edition)
- SuSE Linux Enterprise Server distribution

The Duke's Bank J2EE tutorial java application is used to demonstrate the architecture. It has been modified to utilize a backend MySQL database. [Appendix A](#) provides a list of the specific versions and URLs for this software.

Deployment/management/monitoring

HP provides a suite of tools for Linux systems management that includes deployment, systems management, and systems monitoring.

HP server deployment configuration

HP provides the SmartStart tool to assist with basic hardware and array configuration setup. Installing a Linux distribution on a single rack mount server is a straight forward matter of booting the SmartStart CD and following the instructions for loading the Linux Distribution CDs. When deploying or provisioning a number of servers simultaneously or on blade servers that do not have a CD drive, you need the convenience of advanced deployment tools.

The ProLiant Essential Rapid Deployment Pack (RDP) software automates the process of taking an unconfigured server up to a running Linux operating system using pre-configured installation scripts. Using RDP scripting capability, you can provision application software and perform common management tasks across multiple servers in a simple web-based interface.

For more information see:

<http://h18004.www1.hp.com/products/servers/management/rdp.html>

Management

Being aware of failures and bottlenecks is important to keeping business-critical servers running smoothly. HP provides a number of free system management tools to make this simpler.

- Integrated Lights-Out (iLO) enables remote management of servers by providing multiple access methods to basic system board management functions and diagnostics. The iLO Advanced product can be licensed with the optional ProLiant Essentials Integrated Lights-Out Advanced Pack. The ProLiant p-Class blades ship from the factory with the iLO advanced feature set enabled. Access to iLO functionality is through a web interface, secure shell (SSH), and XML across secure sockets layer (SSL) interfaces. The iLO scripting interface is useful for automating repetitive tasks such as user management, ROM updates, change management, and virtual power control.
- iLO standard provides the following features:
 - Virtual Power for remote access to the server power button
 - Remote text console – operating-system-independent, text-based console for remote host access such as power on self test, startup, and shutdown
 - iLO and server diagnostics – detailed status, logs and alert forwarding

- iLO Advanced Pack extends the product by adding the following features:
 - USB-based virtual media to boot a remote server using a standard 1.44MB diskette, CD on a client machine, network-based floppy, or ISO 9660 CD image from any network location
 - Virtual graphical remote console
 - Directory services integration to Novell eDirectory or Microsoft® Active Directory
 - For more information see:
<http://h18004.www1.hp.com/products/servers/management/ilo>

Monitoring

- HP Insight Management Agents monitor a server's health. These health daemons provide predictive fault alerting for the CPU, disks, network, fans, and memory. The Foundation Pack also includes the HP tested and approved drivers for HP branded NICs, storage devices, and management tools.
 For more information see:
<http://h18004.www1.hp.com/products/servers/proliantessentials>
- HP Systems Insight Manager (HP SIM) is a cross platform management tool that provides systems-level management and monitoring using a common view across hardware platforms. The tool is accessible via a web browser or a command line interface. HP SIM includes these features:
 - Automatic discovery and identification of servers
 - Role-based security
 - Inventory management
 - Distributed tasks
 - Fault management
 - Systems software maintenance

For more information, see:

<http://h18004.www1.hp.com/products/servers/management/hpsim>

Basic installation of software components

Using the ProLiant blade architecture shown in Figure 3, the blades are installed and configured as follows:

1. Use RDP-LE for the initial deployment and provisioning of blades.
2. Install blades 1 – 2 with SuSE Linux Enterprise Server 9 (SLES9) and the Apache Web Server with the mod_jk module.
3. Install blades 3 – 4 with SLES9 and the JBoss Application Server.
4. Install blades 5 – 6 with SLES9 and the MySQL database server (a master/slave architecture is used).
5. Keep blades 7 – 8 as spares should one of the tiers (web, application, or database) need to be scaled.

Detail steps for installing/configuring JBoss

To install the SUN JDK and JBoss Application Server on blades 3 and 4, use the following software and configuration packages:

- jboss-4.0.2.tar.gz
- apache-ant-1.6.5-bin.zip
- j2ee-1_4-doc-tutorial_2.zip³
- mysql-connector-java-3.1.7.tar.gz
- jbossj2ee-src.zip
- jbossj2ee-clustering.zip
- jdk-1_5_0_03-linux-i586-rpm

Note: *Appendix B* lists an example `.bash_profile` file with the appropriate environment variable definitions. These definitions must be set before beginning the installation.

Pull down the Sun Java 2 Standard Edition (J2SE) 5.0 from <http://java.sun.com/j2se/downloads> .

Install the Sun JDK into `/usr/java/jdk1.5.0_03` and soft link from `/opt/jdk`

```
#ln -s /usr/java/jdk1.5.0_03 /opt/jdk
```

1. Install jboss-4.0.2 by unpacking the jboss kit

```
#cd /opt
#tar -zxvf jboss-4.0.2.tar.gz
#mv jboss-4.0.2 jboss
```

```
ls -al jboss*
total 72
drwxr-xr-x  7 root    root          4096 May 16 09:22 .
drwxr-xr-x  7 root    root          4096 May 16 09:58 ..
drwxr-xr-x  2 root    root          4096 Apr 16 08:51 bin
drwxr-xr-x  2 root    root          4096 Apr 16 08:51 client
drwxr-xr-x  5 root    root          4096 Apr 16 08:48 docs
-rw-r--r--  1 root    root        50346 Feb 16 08:52 jar-
versions.xml
drwxr-xr-x  2 root    root          4096 Apr  8 08:51 lib
drwxr-xr-x  5 root    root          4096 Feb 16 08:50 server
```

2. `#cd /opt/jboss/bin/`

3. In the jboss bin directory, edit the JBoss Bootstrap Script configuration file `run.conf` and set `JAVA_HOME` to the installed location of the JBoss JDK, as in the following example:

³ Make sure you are using version 2 and not 4 of the `j2ee-1_4-doc-tutorial` file.

```
JAVA_HOME="/opt/jdk"
```

4. Start the JBoss Application Server using the run.sh script.

```
#./run.sh
```

You now have a running JBoss Application Server.

5. Use a web browser to access JBoss management console. It provides information about the running server, a way to modify the configuration, and to start or stop components. The URL is <http://localhost:8080/jmx-console>.

Example solution

This section provides details to deploy the Duke's Bank demo from the J2EE 1.4 tutorial. The tutorial will be modified to utilize a MySQL backend database and Apache Web Server for software load balancing.⁴

Install Java build tool and tutorial:

- Download the Java build tool Ant from the Apache website (<http://ant.apache.org/>)
apache-ant-1.6.5-bin.zip

6. Unzip in the /opt directory

```
#cd /opt
```

```
#unzip apache-ant-1.6.5-bin.zip
```

Add **/opt/apache-ant-1.6.5** to your path environment variable. See example ".bash_profile" in Appendix B. You can have these environment variable settings take affect immediately by running source on the .bash_profile.

```
#source /root/.bash_profile
```

7. Download the J2EE tutorial (1.4 version 2) from <http://java.sun.com/j2ee/1.4/download.html> and unzip in the opt directory.

```
#cd /opt
```

```
#unzip j2ee-1_4-doc-tutorial-2.zip
```

You should now have this directory created.

```
/opt/j2eetutorial14
```

Note: Make sure you use the 1.4 version 2

⁴ Getting started document - Getting Started with JBoss, J2EE applications and the JBoss 3.2.x Server. Luke Taylor and The JBoss Group

8. Go to the /opt directory and download the supplementary JBoss files, jbossj2ee-src.zip and jbossj2ee-clustering.zip from <http://www.jboss.org/wiki/Wiki.jsp?page=ClusteringDemoUsingDukesBankJ2EE1.4> and place them in the /opt/ directory. This step will overwrite the Duke's Bank tutorial files with bug fixes and JBoss unique configuration files.

```
#cd /opt/j2eetutorial14
#unzip ../jbossj2ee-src.zip
#unzip ../jbossj2ee-clustering14.zip
```

9. Now configure the build properties. Edit **/opt/j2eetutorial14/jboss-build.properties** and set JBoss home, also modify **jboss.server** to be the all instance (deployment target).

```
jboss.home=/opt/jboss
jboss.server=${jboss.home}/server/all
```

Setting clustering complements:

10. Under /opt/j2eetutorial14, you should see a directory named **clustering**.

```
#cd clustering
```

11. Modify the Duke's Bank source code

```
#ant -f jboss-clustering-build.xml update-source
```

12. Enable clustering for Duke's Bank

```
#ant -f jboss-clustering-build.xml update-jboss
```

13. Compile and package the Java source. Go to the Duke's Bank directory (/opt/j2eetutorial14/examples/bank):

```
#cd /opt/j2eetutorial14/examples/bank
#ant -f jboss-build.xml compile
```

Package the ejb jars.

```
#ant -f jboss-build.xml package-ejb
```

Package the war file.

```
#ant -f jboss-build.xml package-web
```

Package the standalone java client.

```
#ant -f jboss-build.xml package-client
```

Prepare database connectivity:

14. Copy the MySQL JDBC connector jar into the deployment library for JBoss.

```
#cp
/opt/j2eetutorial14/clustering/jboss/server/all/lib/mysql-
connector-java-3.1.6-bin.jar
/opt/jboss/server/all/lib/.
```

15. Copy the datasource descriptor.

```
#cp /opt/j2eetutorial14/clustering/jboss/server/all/deploy/mysql-  
ds.xml /opt/jboss/server/all/deploy/.
```

The next step is to install MySQL. Then create the JBoss database to hold the Duke's Bank data. Finally, load the tables for the Duke's Bank demo:

16. On blade 5, install the following packages:

- MySQL-shared-4.1.10a-0
- MySQL-client-4.1.10a-0
- MySQL-server-4.1.10a-0

17. On blade 5, start the MySQL server:

```
#/etc/rc.d/mysql start
```

18. Set the root password to **JBoss**, connect to MySQL, create the database, and set privileges so both JBoss blades can access the database.

```
mysql > CREATE DATABASE jboss;
```

```
mysql > GRANT ALL PRIVILEGES ON jboss.* TO  
jboss@blade5.polyserv.com IDENTIFIED BY 'jboss';  
mysql > GRANT ALL PRIVILEGES ON jboss.* TO  
jboss@blade6.polyserv.com IDENTIFIED BY 'jboss';
```

Note: The password for the MySQL user JBoss should be changed to a more secure password.

19. Now, manually create and load the tables as follows:

Under /opt/j2eetutorial14/clustering/sql, you will find a new "create-table" script modified to accommodate mySQL specifics.

```
mysql> use jboss;  
mysql> source /opt/j2eetutorial14/clustering/sql/mysql-create-  
table.sql  
mysql> source /opt/j2eetutorial14/examples/bank/sql/insert.sql
```

20. On blade 3 (first blade with JBoss Application Server), configure the **JBoss datasource** to be MySQL.

a) In the /opt/jboss/server/all/deploy directory, modify **mysql-ds.xml** (see Appendix C for example). Set the username to jboss and the password to jboss, then modify the IP address for the datasource (MySQL server).

Note: The jboss password should be changed to a more secure password.

Note: The IP address of the MySQL master server will need to be changed for the specific server's IP address. 192.168.10.12 is used in the example file in Appendix C.

b) Remove the configuration file for the built-in HSQL database.

```
#rm hsqldb-ds.xml
```

21. Remove extraneous services and descriptors from the deploy directory.

```
#rm -r -f jms
```

```
#rm -r -f deploy-hasingleton-service.xml
```

```
#rm -r -f snmp-adaptor.sar
```

22. Finally, deploy and then run the Duke's Bank demo.

```
#cd /opt/j2eetutorial14/examples/bank
```

```
#ant -f jboss-build.xml deploy
```

```
#cd /opt/jboss/bin
```

```
#./run.sh -c all
```

Installation summary

Blade 3: running the JBoss Application Server with Duke's Bank EJBs

Blade 5: running the MySQL backend database.

Test the connection to the Duke's Bank demo application by pointing a web browser to <http://blade3:8080/bank/main> (where the IP address is replaced by one of the application server's IP addresses). You can login with customer ID: "200" and password: "j2ee".⁵

⁵ The ATM functions have not been made clusterable and will not function properly in this demo.

Load balancing at the web tier

The Apache Web Server running on blades 1 and 2 are used to serve static web content and also to load balance and fail over the HTTP calls to the servlet containers located on JBoss on blades 3 and 4. Tomcat, which is included in JBoss, provides the HTTP session replication. Details on JBoss clustering and Apache load balancing using mod_jk can be found in the JBoss Clustering documentation at <http://www.jboss.org>.

High availability and scaling

Clustering

JBoss provides a built-in clustering mechanism, known as a partition, for fault tolerance and load balancing through replication. Nodes in a JBoss cluster automatically find each other using automatic discovery. Failover and load balancing is provided for JNDI, RMI, Entity Beans, Stateful Session Beans with in-memory state replication, and Stateless Session Beans. Other features include HTTP session replication and distributed cluster-wide hot-deployment (farming). The farming feature takes care of deploying an application, such as the Duke's Bank demo, onto each node in the cluster. Once the demo is dropped into the /farm (instead of into the deploy directory) subdirectory of a running instance of the JBoss Application Server, it will automatically be hot-deployed across the whole cluster.

The RDP-LE package is used to install Linux and the JBoss software. Adding JBoss Application Server nodes is as simple as starting the JBoss server with the same configuration on an additional node. Applications need only be deployed on one cluster node and will be automatically distributed by JBoss to the other cluster nodes. Once JBoss has been installed on blade 4 in the architecture, start the server using the following commands:

```
#cd /opt/jboss/bin
#run.sh -c all
```

The node will automatically enter the cluster and the Duke's Bank demo will be automatically deployed to this new node.

HP services

HP offers a pre-integrated Open Source Middleware (OSM) environment that is a superset of the software stack described in this document:

- Apache Web Server
- Tomcat Servlet Engine
- JBoss Application Server
- MySQL Database Server
- OpenLDAP Directory Server
- Jabber XML Messaging Server

This environment is tested and validated for a range of Linux distributions (currently Red Hat AS 3.0/4.0 and SLES 8/9) on the HP ProLiant rack and blade platforms. In addition to a full range of support and maintenance services for its OSM environment, HP also offers a variety of Open Source consulting services:

- Open Source workshops
 - Target company business leaders
 - Legal and licensing, market trends, etc.
- Open Source Assessment Services
 - Readiness and needs assessment
 - Available with Adaptive Enterprise, Business Value, IT Consolidation and other assessments
 - Pilot services and proof-of-concepts
 - Applications or business units
 - Complete HP Open Source Middleware or individual components
- Open Source Middleware installation and configuration (custom or express service)
 - HP Open Source Middleware Application Migration and Re-Engineering Services
 - Defined methodology and processes: investigation and assessment through testing, acceptance, and rollout
 - Utilization of CMM level 5 global delivery centers
- HP Open Source Middleware Application Integration Services
 - On average, 33% of IT budgets are spent getting applications to talk to each other.
 - Solutions for: Multiple layers of legacy applications, application silos, heterogeneous application environments, lack of reusable code, web-enablement of applications
- HP Open Source Middleware Application Development Services
- HP Open Source Middleware support
 - Single point of contact for solution support
 - Integration of partner support (JBoss/MySQL)
 - HP customer support for Linux (Red Hat & Novell SuSE)
 - Versions/updates
 - Bi-annual update of HP Open Source Middleware solution stack
 - Testing and validating of new versions/patches
 - Immediate integration of critical/security patches

For more information on these services go to <http://www.hp.com/go/lra>

Appendix A

Links to software components used in this guide:

JDK 5.0 (jdk1.5.0_03) from SUN– JBoss requires a working JDK. HP utilized the Java 2 Standard Edition (J2SE) JDK. <http://java.sun.com/j2se/1.5.0/download.jsp>

Ant 1.6.5 – Java based build tool. <http://ant.apache.org>

JBoss AS 4.0.2 – application server. <http://www.jboss.org>

MySQL 4.0.20-0 – database server. <http://www.mysql.org>

Apache 2.0 – Web Server. <http://www.apache.org>

Mod_jk – load balancing module for accessing Tomcat (provided by JBoss) from Apache. <http://modules.apache.org>

RDP-LE – HP tool for provisioning and deployment of the operating system. <http://h18004.www1.hp.com/products/servers/management/rdple/index.html>

HP SIM – HP Systems Insight Manager. <http://h18004.www1.hp.com/products/servers/management/hpsim/index.html>

HP ProLiant value add software. <http://h18004.www1.hp.com/products/servers/linux/value-add-software.html>

MySQL connector 3.1.7 – JDBC connector for MySQL database. <http://www.mysql.com/products/connector/j/>

Duke's Bank – Sample application from the J2EE tutorial suite with bug fixes and configuration files from JBoss Inc.

- <http://java.sun.com/j2ee/1.4/download.html#tutorial>
- <http://wiki.jboss.org/wiki/Wiki.jsp?page=ClusteringDemoUsingDukesBankJ2EE1.4>

SLES9 – Novell SuSE Linux Operating System. <http://www.suse.com>

Appendix B

Environment variables as defined in root's `.bash_profile`.

```
# Get the aliases and functions
if [ -f ~/.bashrc ]; then
    . ~/.bashrc
fi

# User specific environment and startup programs

PATH=/opt/jdk/bin:$PATH:/opt/apache-ant-1.6.5/bin

export PATH

JAVA_HOME=/opt/jdk
export JAVA_HOME
```

Appendix C

```
<datasources>
  <local-tx-datasource>
    <jndi-name>DefaultDS</jndi-name>

    <connection-url>jdbc:mysql://192.168.10.12:3306/jboss</connection-
url>

    <driver-class>com.mysql.jdbc.Driver</driver-class>

    <user-name>jboss</user-name>

    <password>jboss</password>
  </local-tx-datasource>
</datasources>
```

For more information

HP.com – Linux for ProLiant, <http://h18000.www1.hp.com/products/servers/linux/index.html>

JBoss Application Server, <http://www.jboss.org>

HP.com – ProLiant server management,
<http://h18004.www1.hp.com/products/servers/management/>

HP iLO hardware, <http://h18004.www1.hp.com/products/servers/management/remotemgmt.html>

HP Integrated Lights-Out software and drivers, <http://h18004.www1.hp.com/manage/ilo-downloads.html>

iLO User Guide,
<http://h18004.www1.hp.com/products/servers/management/ilo/documentation.html>

Example Perl scripts for accessing the XML interface,
<http://h18013.www1.hp.com/products/servers/management/ilobest-practice.html>

List of servers supporting the iLO features,
<http://h18004.www1.hp.com/products/servers/management/riloe2/supported-servers.html>

HP BIOS Serial Console, <ftp://ftp.compaq.com/pub/products/servers/management/smartstart/bios-serialconsole.pdf>

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