



# Installing SUSE LINUX Enterprise Server 8 SP3 on an IBM @server BladeCenter JS20

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## I. Introduction

This whitepaper explains how to install SUSE LINUX Enterprise Server 8 (SLES 8) SP3 onto an IBM @server® BladeCenter™ JS20 blade using these installation procedures:

- Manual installation from CD-ROM
- Automatic installation from network
- Installation using Cluster System Management (CSM)

This whitepaper will use SLES 8 SP3aa to be specific.

The remainder of this section describes prerequisites, network information and procedures that are common to all sections of the document

### ***Prerequisites***

This document assumes the Serial Over LAN (SOL) feature is already setup on the BladeCenter. The JS20 blade has no graphics adapter and the serial data is only available over the network using the Serial Over LAN (SOL) function. The *BladeCenter JS20 Type 8842 Installation and User's Guide* describes how to setup the components needed for SOL functionality. There also exists a very good whitepaper describing JS20 SOL setup, *Enabling and Configuring SOL (Serial Over LAN) on an 8842 Blade Server whitepaper, IBM @server BladeCenter, BladeCenter JS20.*

### ***IP address scheme***

This is the IP address scheme used throughout this document. The systems involved consist of a couple JS20 blades and an install server. The two blades in the BladeCenter are connected to an install server on a private network. The IP addresses are as follows:

Install Server:

- eth0 is 192.168.70.50/255.255.255.0

BladeCenter components:

- management module external is static IP at 192.168.70.125/255.255.255.0
- management module to blades is static IP at 192.168.70.126/255.255.255.0
- management module to IO modules is static IP at 192.168.70.127/255.255.255.0
- Ethernet switch module 1 is static IP at 192.168.70.130/255.255.255.0
- Ethernet switch module 2 is static IP at 192.168.70.131/255.255.255.0

Blade1:

- Eth0 is disabled for SOL usage
- Eth1 is dynamic IP at 192.168.70.100/255.255.255.0

Blade2:

- Eth0 is disabled for SOL usage
- Eth1 is dynamic IP at 192.168.70.101/255.255.255.0



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## ***Starting the Management Module's Web interface***

You'll often need to use the BladeCenter Management Module Web interface, since the MM provides the central point of control for the BladeCenter components. To log into the MM Web interface, start a browser and point it to the IP address or name of the MM (eg. <http://192.168.70.125>). Enter the userid/password, the default is USERID/PASSWORD (note: all upper case, with a zero). This is usually done from a Thinkpad, or whatever system happens to be available. Select a reasonable timeout value then click on Continue.

## ***Starting a Serial Over LAN (SOL) session***

To view the serial console output, use the Serial Over LAN feature of the BladeCenter. The *BladeCenter JS20 Type 8842 Installation and User's Guide* describes how to setup the components needed for SOL functionality. There also exists a very good whitepaper describing JS20 SOL setup, *Enabling and Configuring SOL (Serial Over LAN) on an 8842 Blade Server whitepaper, IBM @server BladeCenter, BladeCenter JS20*.

To start a SOL session from an attached system (eg. a Thinkpad®, etc...), telnet to the MM, enter "telnet 192.168.70.125". When prompted, provide the userid/password, the default is USERID/PASSWORD (note: all upper case, with a zero). To bring up a console for a blade, enter this command at the telnet prompt: "console -T system:blade[x]", where x is a number 1-14, indicating which blade in the chassis to select. The SOL session buffers up to 8KB of data, so when the session is started, any buffered data will scroll past.

To set the "environment", so all commands are directed to specific blade, enter: "env -T system:blade[x]", where x is a number 1-14. Then one just needs to enter: "console", to start an SOL session on blade x.

To terminate an SOL session, press ESC, then shift-9 (a left parenthesis).

The Windows telnet client is not good at displaying the YaST install screens. The free telnet client PUTTY seems to work much better. PUTTY can be downloaded from: <http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html>

There are a few recommended changes to the standard PUTTY configuration that will make the YaST install screens more useable. Start PUTTY and make these changes:

- click on Window, change the rows/columns from 24/80 (default) to 40/100
- click on Appearance, change the Font to Courier New, with a Font size of 10

Create all your PUTTY telnet configurations/sessions with those changes.

## **II. Manual installation from CD**

This section describes the process of installation from a CD. This install option is most useful when a small number of systems need to be infrequently installed. These are the steps necessary to perform this type of installation:



Start the MM Web interface (as described in the Introduction). Under “Blade Tasks”, select “Configuration”, then “Boot Sequence”. Select the server to be installed. Insert “Hard drive 0” first in the startup sequence and CD-ROM second into the boot sequence for the server and click on “Save”. This assumes that Hard drive 0 does not have a bootable system installed. If it does, insert CD-ROM first in the boot sequence. In this case, after installing to Hard drive 0, you’ll need to come back and put Hard drive 0 first and CD-ROM second, in the boot sequence. Note the checkbox for changing all the boot sequence on all the blades at once.

Give the target install blade sole access to the CD-ROM drive by pressing the CD button on the top/front of the blade. This can also be done remotely in the MM Web interface, under “Blade Tasks”, select “Remote Control”, then “Start Remote Control” and select the blade from the “Change media tray owner” pulldown. Insert the SLES 8 SP3aa CD #1 into the media tray’s CD-ROM drive.

To reboot the server, and thereby kick off the installation process, under “Blade Tasks” on the left hand side of the MM Web interface, select “Power/Restart”. Check the box for the blade you wish to start installing and power it on by selecting “Power On Blade” or “Restart Blade”.

Next, start an SOL session (as described in the Introduction) in order to perform the manual installation steps. On the SOL console, you should see the bring-up codes scrolling past while the JS20 initializes. This takes a few minutes. When the “boot:” prompt appears, enter “install” or just press the Enter key to begin loading the kernel.

In a few minutes, Linuxrc will present a pop-up window asking you to put “CD number 1 in your drive”. Insert SLES 8 GA CD #1 (not the already inserted SP3aa CD #1) into the media tray’s CD-ROM drive and select “OK”.

When prompted for a terminal emulator, choose:

- Option 1, VT100, if your SOL session is started from a Windows system
- Option 4, xterm, if your SOL session is started from a Unix system

If the install target already has an OS installed, you’ll get prompted for a “New installation”, “Boot installed system” or “Abort installation”. Choose “New installation” to replace an existing installation.

On the next screen you will be shown the installation settings for keyboard, mouse, partitioning, software, boot, timezone and language. Use the Tab key and arrow keys to alter any of the installation settings. Select “Software” if you want to choose a minimum configuration or additional software packages. When finished, use the Tab key to move the cursor to Accept, then press the Enter key.

At this point you’ll be given one last Warning before proceeding with the installation. To proceed, select “Yes, install”.

Now you’ll see a panel containing 3 sub-panels: Current Package, Installation and Installation Log. The Installation sub-panel shows the progress of the overall installation process in the upper right hand corner.

Sometimes you might lose the SOL session, just restart the SOL session to regain the serial console.



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After about 18-20 minutes, you'll be asked to reinsert the SLES 8 SP3aa CD #1 into the media tray's CD-ROM drive. This will get the updated kernel and some necessary updated packages from the SP CD. **Note, this does not install all the updated packages from the CD, we'll do that later.** Now the new installation will boot up.

Prior to presenting the login prompt, you'll be asked to specify the password for the "root" user and add a non-root user.

After SLES 8 SP3aa writes the configuration of your system, you'll be given an option to change some more Installation Settings, specifically for the Network Interfaces. We need to disable eth0 and enable eth1. Tab to the "(Change...)" selection and press Enter, then select Network Interfaces from the pulldown. It should indicate eth0 as an "Already configured device", select "[Change...]" to modify this setting. Then select Delete, and Finish to unconfigure eth0. This should result in both Ethernet Controllers being unconfigured.

Again, Tab to the "(Change...)" selection and press Enter, then select Network Interfaces from the pulldown. Use the Tab and arrow keys to select Ethernet Controller in the list, then select "Configure". In the pulldown, select eth1, then configure the IP settings: DHCP/static, Hostname and name server, and Routing. **Note, before completing this Network Interfaces configuration and pressing "Next", ensure the pulldown at the top still indicates eth1!!!** To verify, it should now indicate "Configured as eth1 with address...". Now press "Finish", then "Next".

The system should continue booting and present a login prompt.

Earlier, when setting the blade's boot sequence, if you put CD-ROM first in the boot sequence because this was a reinstall, you now need to put Hard drive 0 first in the boot sequence. Start the MM Web interface (as described in the Introduction). Under "Blade Tasks", select "Configuration", then "Boot Sequence". Select the server to modify. Insert "Hard drive 0" first in the startup sequence and CD-ROM second into the startup sequence for the server(s) just installed and click on "Save".

To complete the installation of SLES 8 SP3aa, we need to install the remainder of the updated packages from the SLES 8 SP3aa CD(s). To do this, start "yast2", under "Software" select "Patch CD Update". For update mode, choose "Manual Update" then click on Accept. When the installation of the updates has completed, select Finish. The installation procedure will most likely prompt you with reminders to start certain services (eg. sshd), it's cleanest to just restart the server. The installation is complete.

### III. Automatic installation from network

This section describes the automatic installation process (ie. sometimes referred to as the Auto-Installation process in SUSE documents) using an install server over the network. This install option is most useful for installing a large number of systems, where the effort to setup an install server is more efficient than performing a CD-based install on each system. The automatic installation process can also accommodate unique configurations for each system or group of systems.



The primary effort in this option is the setup of the install server. In the rest of this section we'll assume the install server is a separate system (not a blade) with SLES 8 already installed. This is an outline of the steps necessary to perform this type of installation:

- On the install server:
  1. DHCP configuration
  2. TFTP Configuration
  3. NFS Configuration
  4. Building the installation tree
  5. Creating the AutoYaST control file
  6. Modify the kernel command line on the install server
- For the blades to be installed:
  1. Restart the systems to be installed
  2. Post installation tasks

What follows are detailed instructions of the steps in the outline.

## ***DHCP Configuration***

First, the install server needs to be setup as a BOOTP/DHCP server. The DHCP server package that comes with SLES 8 is capable of handling BOOTP and DHCP requests. Create an /etc/dhcpd.conf file, here's an example.

```
# dhcpd.conf

# option definitions common to all supported networks...
allow bootp;
allow booting;
always-reply-rfc1048 true;

default-lease-time 600;
max-lease-time 7200;
ddns-update-style none;
authoritative;
log-facility local7;

subnet 192.168.70.0 netmask 255.255.255.0 {
  group {
    next-server 192.168.70.50;
# filename "/tftpboot/install";
    filename "install";
    host blade1 {
      hardware ethernet 00:0d:60:1e:0e:8d;
      fixed-address blade1;
    }
    host blade2 {
      hardware ethernet 00:0d:60:1e:0e:75;
      fixed-address blade2;
    }
  }
}
```



```
# end of dhcpd.conf
```

To obtain the MAC addresses (ie hardware ethernet entries) to be specified in the dhcpd.conf file, start the MM Web interface (as described in the Introduction). Under "Monitors", select "Hardware VPD", then scroll down to "BladeCenter Server MAC Addresses". Use the "MAC Address 2" column. This corresponds to eth1, which will allow SOL to function on eth0.

Some issues to note about dhcpd.conf:

- Most tftp daemons perform a chroot to a specific directory, usually /tftpboot, based on the usage of the `-s` option. You can verify this in /etc/inetd.conf. If the `-s` option is not specified when starting tftpd, the full path needs to be specified for the "filename" in dhcpd.conf.
- If you want your DHCP server to respond to DHCP requests from a certain interface, this can be handled in /etc/sysconfig/dhcpd. For example, coding:

```
DHCPD_INTERFACE="eth1"
```

..in /etc/sysconfig/dhcpd will force the DHCP server to only listen on eth1.

- The "next-server" and "filename" parameters inform the servers how to continue with the next step in the process, TFTP'ing the kernel from the install server to the server(s).

To start the DHCP daemon (dhcpd), run "rcdhcpd start".

For host name resolution, we'll just setup /etc/hosts, here's an example:

```
# hosts
```

```
192.168.70.50      ms.bclab.com      ms
192.168.70.125   mm.bclab.com      mm
192.168.70.126   mm-int.bclab.com  mm-int
192.168.70.130   esm1.bclab.com    esm1
192.168.70.131   esm2.bclab.com    esm2

192.168.70.100   blade1.bclab.com  blade1
192.168.70.101   blade2.bclab.com  blade2
```

```
# end of hosts
```

## **TFTP Configuration**

Next we need to setup the install server as a TFTP server. To do this, start "yast2", under "Network/Basic" select "Start/stop services (inetd)". Enable inetd and select Next. Select the "tftp" service and click on "Activate or Deactivate". Verify that status column for the tftp service indicates "Active", then click on Finish.

Then we need to copy the `/install` file from the SLES 8 SP3aa CD #1 to the /tftpboot directory. Also, ensure the files in /tftpboot are readable by the UID of "nobody" and the GUID of "nogroup" because the atftpd runs under that UID/GUID combination. To set the owner and group, enter "chown nobody:nogroup install" while in the /tftpboot directory.



## ***NFS Configuration***

Next, we need to setup the install server as an NFS server. To do this, start “yast2”, under “Network/Advanced” select “NFS server”. Select “Start NFS server” and select Next. Under “Directories to export..”, click on “Add directory”, specify “/install-tree” and click OK. Let YaST2 create the directory, if necessary. When prompted for the Hosts wildcard, specify “\*” and for Options, specify “ro,root\_squash,sync”. Note, those are the defaults presented by YaST2 for Hosts wildcard and Options. Then click on Finish and confirm with a “yes”.

Note, you can use the “rcnfs stop|start|status|restart” command to further control the NFS daemon.

## ***Building the installation tree***

Next, we need to setup the installation tree on the install server. When building the installation tree, the variables to consider are:

- Will it be exported using NFS or HTTP or FTP?
- Will it be a flat installation tree or a multiple source installation tree?

In this example, we’ll export using NFS and create a flat installation tree. The installation tree will be built in the /install-tree/SLES 8 directory. These are the steps to build this installation tree.

First, we’ll copy the content of the SLES 8 GA CDs to disk.

1. `mkdir -p /install-tree/SLES 8/GA ; cd /install-tree/SLES 8/GA`
2. `umount /media/cdrom`
3. `insert SLES 8 GA CD #1`
4. `mount /dev/cdrom /media/cdrom ; cp -a /media/cdrom/* . ; umount /media/cdrom`
5. `insert SLES 8 GA CD #2`
6. `mount /dev/cdrom /media/cdrom ; cp -a /media/cdrom/* . ; umount /media/cdrom`
7. `insert SLES 8 GA CD #3`
8. `mount /dev/cdrom /media/cdrom ; cp -a /media/cdrom/* .`

Next, we’ll copy the content of the SLES 8 SP3aa CDs to disk.

9. `mkdir -p /install-tree/SLES 8/SP ; cd /install-tree/SLES 8/SP`
10. `umount /media/cdrom`
11. `insert SLES 8 SP3aa CD #1`
12. `mount /dev/cdrom /media/cdrom ; cp -a /media/cdrom/* . ; umount /media/cdrom`  
Note, when the cp completes, this error message is displayed “cp: will not create hard link...”. The easiest way to solve this is to:
13. `mkdir -p suse/setup/descr`
14. `cp ppc/update/SUSE-SLES/8/rpm/setup/descr/* suse/setup/descr`  
...that solves the limitation of cp not copying the linked directories. Continue by:
15. `insert SLES 8 SP3aa CD #2`
16. `mount /dev/cdrom /media/cdrom ; cp -a /media/cdrom/* . ; umount /media/cdrom`

Link in some files from the CD images.



17. cd /install-tree/SLES 8
18. cp -l -a SP/driverupdate .
19. cp -l -a GA/boot .
20. cp -l -a GA/content .
21. cp -l -a GA/media.1 .
22. mkdir yast
23. mkdir yastcfg

Create the order and instorder files. The order file is a tab-delimited file that pairs a directory with an installation source. The instorder file indicates the order in which to install the installation sources

24. printf "SP\tSP\n" > yast/order
25. printf "GA\tGA\n">> yast/order
26. printf "GA\tGA\n" > yast/instorder
27. printf "SP\tSP\n" >> yast/instorder

That completes the installation tree:

```
/install-tree/  
  SLES 8/  
    GA/  
    SP/  
    driverupdate  
    content  
    boot/  
    media.1/  
    yast/  
      order  
      instorder  
    yastcfg/
```

## ***Creating the AutoYaST control file***

Next, we need to create an AutoYaST control file which will contain the "answers" to the configuration options and be used in lieu of manually stepping through the YaST2 configuration panels. The install server can be used to generate the AutoYaST control file. The autoyast2 RPM needs to be installed on the install server.

To generate an AutoYaST control file, start "yast2", under "Misc" select "Autoinstallation" (or run "yast2 autoyast"). From this point, a number of options are available, such as: creating or modifying a configuration, cloning the install server configuration or importing foreign configurations (eg. Alice or Kickstart configurations). For further details on creating/modifying/customizing a control file or creating a rules file with classes, refer the documentation provided by SUSE at: <http://www.suse.com/~nashif/autoinstall/9.0/html/index.html>

It's simplest to create a control file by cloning the install server but its configuration (ie. hard drive, partitioning, network interfaces, etc...) may not match the desired configuration of the JS20. Cloning an already installed JS20 blade will probably provide the most accurate control file.



Either way, it may be necessary to modify the control file (see <http://www.suse.com/~nashif/autoinstall/9.0/html/index.html> for details). To generate a control file click on the "Clone this machine" button, then Next. Click on the "Save result into repository", use the file name of "default" and click on Next. This will then collect the system data and create a control file of that name. Click on "Save As" and save "default" in /install-tree/SLES 8/yastcfg. When done saving, click on Finish and Close yast2.

One line that is necessary to have in the control file is the line that prevents the /dev/hda1 from being formatted. Make sure the line in bold-face below, is in your partitioning stanza for /dev/hda1.

```
<partitioning config:type="list">
  <drive>
    <device>/dev/hda</device>
    <partitions config:type="list">
      <partition>
        <format config:type="boolean">>false</format>
        <partition_id config:type="integer">65</partition_id>
        <partition_nr config:type="integer">1</partition_nr>
        <region config:type="list">
          <region_entry config:type="integer">0</region_entry>
          <region_entry config:type="integer">7</region_entry>
        </region>
        <size>3096577</size>
      </partition>
      .....
    </partitions>
  <use>all</use>
</drive>
</partitioning>
```

If the configuration of the systems to be installed is different, the coupling of control files to install targets is accomplished by using the hexadecimal value of the node's IP address. For example, blade1's IP is 192.168.70.100, its unique AutoYaST control file would have a file name of "C0A84664". The unique AutoYaST control file for blade2 (192.168.70.101) would have a file name of "C0A84665". In order to avoid replicating the file for each group of similarly configured servers, a common set of hexadecimal values can be specified as a filename. For example, a control file named "C0A846" would be used by all the install targets having an IP address of 192.168.70/24. In general, a control file that matches an install target will be scanned for by truncating one hexadecimal digit at a time. Therefore, the search order for blade1's AutoYaST control file will be:

```
C0A84664
C0A8466
C0A846
C0A84
C0A8
C0A
C0A
C0
C
000D601E0E8D
default
```



The next to last entry in the search order is the install target's MAC address.

Note, in the syslinux RPM package there exists a utility called gethostip, which will generate the hexadecimal value of an IP address.

## ***Modify the kernel command line on the install server***

The final piece of setup on the install server is to insert some commands into a patch area within the kernel. Previously, we copied the `/install` file from the SLES 8 SP3aa CD #1 to the `/tftpboot` directory. Now we need to insert commands into this kernel to inform each install target:

1. where the AutoYaST control file(s) is located
2. where the installation tree is located
3. and to use eth1 for the network install (since SOL is happening on eth0)

This is done using a utility that comes with SP3aa called `mkzimage_cmdline`. This utility is located in the `/ppc/netboot` directory of SP3aa CD #1. Based on the install server setup we've done, the `mkzimage_cmdline` we would invoke would be:

```
mkzimage_cmdline -s "autoyast=nfs://192.168.70.50/install-tree/SLES 8/yastcfg/  
install=nfs://192.168.70.50/install-tree/SLES 8 netdevice=eth1" -a 1 install
```

Where the general syntax for `mkzimage_cmdline` is:

```
mkzimage_cmdline filename  
work with zImage named 'filename'  
[-h] display this help  
[-v] display version  
[-a 0|1] disable/enable built-in cmdline  
          overrides whatever is passed from OpenFirmware  
[-s STRING] store STRING in the boot image  
[-c] clear previous content before update  
no option will show the current settings in 'filename'
```

Again, there are many options that can be set other than `autoyast=`, `install=` and `netdevice=`. For a complete list of options, consult the SUSE documentation at <http://www.suse.com/~nashif/autoinstall/9.0/html/index.html>

## ***Restart the systems to be installed***

The steps necessary to initiate an automatic installation of the servers from the install server are:

1. start the MM Web interface
2. set the boot sequence for the install targets so that NETBOOT is first in sequence
3. restart the install targets
4. view the installation, if necessary, via an SOL connection
5. after installation, remove NETBOOT from the startup sequence



Start the MM Web interface (as described in the Introduction). Under “Blade Tasks”, select “Configuration”, then “Boot Sequence”. Select “Network – BOOTP” from the pulldown for the first device in the boot sequence, and click on Save. Note the checkbox for changing all the blades startup sequence at once.

To view the serial console output of the installation process and to complete the network installation (later), start an SOL session as described in the Introduction section.

To reboot the servers, and thereby kick off the automatic installation process, under “Blade Tasks” on the left hand side of the MM Web interface, select “Power/Restart”. Check the box for the blade you wish to start installing and power it on by selecting “Power On Blade” or “Restart Blade”.

## ***Post installation tasks***

Once the installation is complete, a “login:” prompt will be displayed on the SOL session. Unless you performed customizations of the AutoYaST control file, the network interfaces will not be defined. To define the network interaces, login to the server as root. The password will be the password specified in the AutoYaST control file. If you cloned a system to create the control file, it will be the password of the cloned system.

To define the network interfaces, run “yast2”, under “Network/Basic” select “Network card configuration”. Then select “Configure”. In the pulldown, select eth1, then configure the IP settings: DHCP/static, Hostname and name server, Routing and DHCP client options. **Note, before completing this Network Interfaces configuration and pressing “Next”, ensure the pulldown at the top still indicates eth1!!!** To verify, it should now indicate “Configured as eth1 with address...”. Now press “Finish”, then “Next”.

Now we need to replace NETBOOT with Hard drive 0 in the boot sequence. Start the MM Web interface (as described in the Introduction). Under “Blade Tasks”, select “Configuration”, then “Boot Sequence”. Select the server to modify. Change the first device in the boot sequence to be Hard drive 0 and click on “Save”. Note the checkbox for changing all the blades startup sequence at once.

Finally, we want to reboot the installed server from the hard drive where we just performed the install. On the SOL session, enter “shutdown –r now”. The server should reboot successfully from the harddrive, with network connectivity. The installation is complete.

## **IV. Installation using Cluster System Management (CSM)**

This section describes how to populate the blade servers using Cluster System Management (CSM) for Linux® V1.4. This install option is most useful when you want the blade servers to operate as a cluster of nodes. CSM is an administration tool that will provide an install server capability as well as features that simplify the ongoing administration tasks of the cluster. For detailed descriptions of those administration features, see the *CSM for Linux V1.4 Administration Guide*. This section will address the OS installation capabilities of CSM.



In the rest of this section we'll assume the CSM management server (ie. the install server) is a separate system (not a blade) with SLES 8 already installed. This is an outline of the steps necessary to perform this type of installation:

1. CSM management server (MS) setup
2. Define the nodes to the MS
3. CSM performs SLES 8 installation setup
4. Install the OS to the nodes and verify the installation
5. Monitoring with CSM

## ***CSM management server (MS) setup***

Prior to installing the RPMs, we'll setup /etc/hosts for host name resolution, here's an example:

```
# hosts

192.168.70.50      ms.bclab.com      ms
192.168.70.125   mm.bclab.com      mm
192.168.70.126   mm-int.bclab.com mm-int
192.168.70.130   esm1.bclab.com    esm1
192.168.70.131   esm2.bclab.com    esm2

192.168.70.100   blade1.bclab.com  blade1
192.168.70.101   blade2.bclab.com  blade2

# end of hosts
```

The first RPM to install is the csm.core RPM.

If you've obtained the CSM package **as a tar file from the Website** (<http://techsupport.services.ibm.com/server/cluster/fixes>), download it to the /tmp/csm directory on the install server and uncompress using:

```
cd /tmp/csm
tar -xvzf csm-linux-1.4.0.ppc64.tar.gz
```

You'll also need to obtain the Autoupdate RPM and download it to /tmp/csm. The Autoupdate RPM can be downloaded from: <ftp://ftp.istrata.com/pub/autoupdate/> Install the csm.core RPM by running "rpm -i /tmp/csm/csm.core-\*

If you've obtained the CSM package **as a CD**, you do not need to download Autoupdate from the Web. Install the csm.core RPM by running:

```
mount /dev/cdrom /media/cdrom
rpm -i /media/cdrom/csm.core-*
```

Installing the csm.core RPM will alter the \$PATH and \$MANPATH environment variables. To use them, exit the current shell and start a new shell (logout and log back in).



Now we need to install the other RPMs from the CSM package on the install server using the `installms` command from the `csm.core` RPM:

```
cd /tmp/csm
installms -p /tmp/csm
```

Then mount the SLES 8 GA CD-ROMs when prompted. The installation of CSM on the MS should complete with this message "Installation of CSM has successfully completed!".

Next, we need to either: accept the full CSM license from the CSM CD-ROM or use the 60 day try-and-buy CSM license. To accept the license from the product CD-ROM, insert the CSM CD-ROM into the CD-ROM drive and run these commands:

```
mount /dev/cdrom /media/cdrom
csmsconfig -L /media/cdrom/csmlum.full
```

Verify the full license is in place by running "csmsconfig" (with no parameters). The output should look like this:

```
AddUnrecognizedNodes = 0 (no)
ClusterSNum = 654BN5011
ClusterTM = 9078-160
DeviceStatusFrequency = 12
DeviceStatusSensitivity = 8
ExpDate =
HAMode = 0
HeartbeatFrequency = 12
HeartbeatSensitivity = 8
LicenseProductVersion = 1.4
MaxNumNodesInDomain = -1 (unlimited)
PowerStatusMode = 0 (Mixed)
RegSyncDelay = 1
RemoteCopyCmd = /usr/bin/scp
RemoteShell = /usr/bin/ssh
SetupKRB5 = 0
SetupRemoteShell = 1 (yes)
```

Note the highlighted fields, those fields indicate a "full" license has been accepted and is in place. To accept the 60 day try-and-by license, run "csmsconfig -L". Verify the try-and-buy license is in place by running "csmsconfig" (with no parameters). The output should look like this:

```
AddUnrecognizedNodes = 0(no)
ClusterSNum = 654BN5011
ClusterTM = 9078-160
ExpDate = Tue Oct 19 18:59:59 2004
HeartbeatFrequency = 12
HeartbeatSensitivity = 8
LicenseProductVersion = 1.4
MaxNumNodesInDomain = -1 (unlimited)
PowerstatusMode = 0(Mixed)
RegSyncDelay = 1
RemoteCopyCmd = /usr/bin/scp
```



Installing SUSE LINUX Enterprise  
Server 8 SP3  
on an IBM @server  
BladeCenter JS20

```
RemoteShell = /usr/bin/ssh  
SetupKRB5 = 0  
SetupRemoteShell = 1(yes)
```

Note, prior to accepting one of the licenses, the setting of “MaxNumNodesInDomain = 0” would prohibited defining any nodes to the MS. After accepting one of the licenses, “MaxNumNodesInDomain = -1 (unlimited)” is the new setting.

## ***Define the Nodes to the MS***

In order to install the OS to a blade server, we must define the blade server as a “node” to the CSM MS. This will be accomplished in the following steps:

1. use the lshwinfo command to gather attributes from the HW control point
2. transform the lshwinfo output to a node definition file format
3. make alterations to the node definition file
4. issue the definenode command and provide the node definition file

The BladeCenter’s MM is considered the hardware control point of the cluster. In CSM terminology, that means the MM’s IP address (or hostname) is to be used as the HWControlPoint attribute. We’ll gather as many node attributes, automatically, using the HW control capabilities of the MM. Issue this command: “lshwinfo -p blade -c mm -o /tmp/csm/hwinfo1”. The resulting hwinfo1 file should look like this:

```
# Hostname::PowerMethod::HWControlPoint::HWControlNodeID::LParID::HWType::HWModel::HWSerialNum  
no_hostname::blade::mm.bclab.com::blade1::::8842::41X::ZJ1W6745E17J  
no_hostname::blade::mm.bclab.com::blade2::::8842::41X::ZJ1W6745E17G
```

Note, the first line of the hwinfo1 file provides column headings for the information contained in the subsequent lines. Each column is separated by two colons, “::”.

Next, we’ll edit the hwinfo1 file to supply actual hostnames for blade servers in our environment. Edit the hwinfo1 file and substitute actual hostname for the “no\_hostname” entry in each row. The resulting file should resemble:

```
# Hostname::PowerMethod::HWControlPoint::HWControlNodeID::LParID::HWType::HWModel::HWSerialNum  
blade1::blade::mm.bclab.com::blade1::::8842::41X::ZJ1W6745E17J  
blade1::blade::mm.bclab.com::blade2::::8842::41X::ZJ1W6745E17G
```

Now we’ll use CSM’s definenode command to create a node definition file based on hwinfo1. At the same time, we’ll prime the resulting node definition file with attribute/value pairs that need to be specified for all JS20 nodes. Note, the attribute/value pairs are at the end of the definenode command. Run this definenode command:

```
definenode -M hwinfo1 -C mm.bclab.com::1:2 -s ConsoleMethod=blade \  
InstallAdapterName=eth1 InstallAdapterDuplex=full InstallAdapterSpeed=1000 \  
InstallAdapterType=ent InstallDiskType=ide ConsoleSerialDevice= > nodedef1
```

The resulting nodedef1 file should look like this (with important JS20 attributes in boldface):

```
blade1.bclab.com :  
    ConsoleMethod=blade
```



**ConsolePortNum=1**

ConsoleSerialDevice=  
ConsoleServerName=mm.bclab.com  
HWControlNodeId=blade1  
HWControlPoint=mm.bclab.com  
HWModel=41X  
HWSerialNum=ZJ1W6745E17J  
HWType=8842  
InstallAdapterDuplex=full

**InstallAdapterName=eth1**

InstallAdapterSpeed=1000  
InstallAdapterType=ent  
InstallCSMVersion=1.4.0

**InstallDiskType=ide**

InstallDistributionName=SLES  
InstallDistributionVersion=8.1  
InstallOSName=Linux  
InstallPkgArchitecture=ppc64  
ManagementServer=ms.bclab.com

**PowerMethod=blade**

blade2.bclab.com :

**ConsoleMethod=blade**

**ConsolePortNum=2**

ConsoleSerialDevice=  
ConsoleServerName=mm.bclab.com  
HWControlNodeId=blade2  
HWControlPoint=mm.bclab.com  
HWModel=41X  
HWSerialNum=ZJ1W6745E17G  
HWType=8842  
InstallAdapterDuplex=full

**InstallAdapterName=eth1**

InstallAdapterSpeed=1000  
InstallAdapterType=ent  
InstallCSMVersion=1.4.0

**InstallDiskType=ide**

InstallDistributionName=SLES  
InstallDistributionVersion=8.1  
InstallOSName=Linux  
InstallPkgArchitecture=ppc64  
ManagementServer=ms.bclab.com

**PowerMethod=blade**

Next, we'll feed the nodedef1 file to CSM's definenode command by running "definenode -f nodedef1". Upon completion of the definenode command, we can run the lsnode command to get a list of all the nodes and their attributes. Running "lsnode -l" should result in this output:

```
Hostname = blade1.bclab.com
AllowManageRequest = 0 (no)
CSMVersion =
ChangedAttributes = {}
ConfigChanged = 0 (no)
```



```
ConsoleMethod = blade
ConsolePortNum = 1
ConsoleSerialDevice =
ConsoleSerialSpeed = 9600
ConsoleServerName = mm.bclab.com
ConsoleServerNumber =
HWControlNodeID = blade1
HWControlPoint = mm.bclab.com
HWModel = 41X
HWSerialNum = ZJ1W6745E17J
HWType = 8842
InstallAdapterDuplex = full
InstallAdapterGateway =
InstallAdapterMacaddr =
InstallAdapterName = eth1
InstallAdapterNetmask =
InstallAdapterSpeed = 1000
InstallAdapterType = ent
InstallCSMVersion = 1.4.0
InstallDisk =
InstallDiskType = ide
InstallDistributionName = SLES
InstallDistributionVersion = 8.1
InstallKernelVersion =
InstallMethod =
InstallOSName = Linux
InstallPkgArchitecture = ppc64
InstallServer =
InstallStatus = PreManaged
InstallTemplate =
LParID =
LastCFMUpdateTime =
ManagementServer = ms.bclab.com
Mode = PreManaged
Name = blade1.bclab.com
NodeNameList = {ms}
PowerMethod = blade
PowerStatus = 1 (on)
Status = 127 (unknown)
UpdatenodeFailed = 0 (false)
UserComment =
-----
Hostname = blade2.bclab.com
AllowManageRequest = 0 (no)
CSMVersion =
ChangedAttributes = {}
ConfigChanged = 0 (no)
ConsoleMethod = blade
ConsolePortNum = 2
ConsoleSerialDevice =
ConsoleSerialSpeed = 9600
ConsoleServerName = mm.bclab.com
```



```
ConsoleServerNumber =  
HWControlNodeID = blade2  
HWControlPoint = mm.bclab.com  
HWModel = 41X  
HWSerialNum = ZJ1W6745E17G  
HWType = 8842  
InstallAdapterDuplex = full  
InstallAdapterGateway =  
InstallAdapterMacaddr =  
InstallAdapterName = eth1  
InstallAdapterNetmask =  
InstallAdapterSpeed = 1000  
InstallAdapterType = ent  
InstallCSMVersion = 1.4.0  
InstallDisk =  
InstallDiskType = ide  
InstallDistributionName = SLES  
InstallDistributionVersion = 8.1  
InstallKernelVersion =  
InstallMethod =  
InstallOSName = Linux  
InstallPkgArchitecture = ppc64  
InstallServer =  
InstallStatus = PreManaged  
InstallTemplate =  
LParID =  
LastCFMUpdateTime =  
ManagementServer = ms.bclab.com  
Mode = PreManaged  
Name = blade2.bclab.com  
NodeNameList = {ms}  
PowerMethod = blade  
PowerStatus = 1 (on)  
Status = 127 (unknown)  
UpdatenodeFailed = 0 (false)  
UserComment =
```

Note, if you need to change attributes for a node for any reason, you'll need to use the CSM `chnode` command. For a list of all the possible node attributes, issue the command "man `nodeattributes`". Note that "nodeattributes" is not a CSM command, there is just a man page defined to describe the node attributes.

## ***CSM SLES 8 SP3 installation setup***

Now we need to supply the SLES 8 GA and SP3aa CDs to CSM so it can build the install tree and the AutoYaST control file. First, we'll separately copy the kernel RPM from the SLES 8 SP3aa CD #1 (eg. `/suse/ppc/kernel-ppc64-2.4.21-147.ppc.rpm`) to `/csminstall/Liux/SLES/8.1/ppc64/updates/kernel/`. Note, if the kernel directory does not exist, create it.



A couple other things first though. Unlike other installs, where we've had to control the boot sequence, CSM will manipulate the boot sequence. We need to have Hard drive 0 as the first entry in the boot sequence to start the process. Verify this by starting the MM Web interface (as described in the Introduction). Under "Blade Tasks", select "Configuration", then "Boot Sequence". Select the server to be installed. Verify that "Hard drive 0" is first in the boot sequence. If it isn't, select "Hard drive 0" as the first entry in the sequence and click on "Save".

Note, at this point you can verify remote power control of the nodes. You should be able to enter "rpower -a query" and see results similar to:

```
blade1.bclab.com on  
blade2.bclab.com off
```

If results do not look like that, run "probemgr -p ibm.csm.HWCtrl".

CSM maintains templates for the different automated installs it performs. If you want to alter the AutoYaST control file template for the upcoming install, the template is located in /opt/csm/install/yastcfg.SLES 8.1-ppc64.xml. For further details on creating/modifying/customizing a control file or creating a rules file with classes, refer the documentation provided by SUSE at: <http://www.suse.com/~nashif/autoinstall/9.0/html/index.html>

Next, we need to supply the SLES 8 GA CDs to CSM, run the following command:

```
copycds InstallDistributionName=SLES InstallDistributionVersion=8.1
```

and insert the next SLES 8 GA CD when prompted. As CSM copies the contents of the CD, the % complete should be displayed in the lower left of the window. Note, if the AutoYaST control file template was not modified, CSM will just ask for SLES 8 GA CD #1.

Next, we need to supply the SLES 8 SP3aa CDs to CSM, run the following command:

```
copycds InstallDistributionName=SLES InstallDistributionVersion=8.1 InstallServiceLevel=SP3a
```

Note the value of the last parameter is "SP3a", not "SP3aa". This will still copy the contents of the CDs correctly. Insert the next SLES 8 SP3aa CD when prompted. As CSM copies the contents of the CD, the % complete should be displayed in the lower left of the window. Note, if the AutoYaST control file template was not modified, CSM will just ask for SLES 8 SP3aaGA CD #1.

CSM maintains the content of these CDs in /csminstall/Linux/SLES/8.1/ppc64.

Prior to issuing the CSM commands of csmsetupyast and installnode, run "monitorinstall" to verify the state of each node. The output should look like this:

Node	Mode	Status
blade1.bclab.com	PreManaged	Not Installed
blade2.bclab.com	PreManaged	Not Installed

Next, we need to run: "csmsetupyast -x -P" to create an AutoYaST control file for each of the nodes in the cluster. The "-P" option indicates to create the control file for each node with Mode=PreManaged. The output of the csmsetupyast command can be found in



/var/log/csm/csmsetupyast.log. Most of the CSM commands provide the following options to identify the target(s) of the command:

- -P: for all nodes where Mode=Premanaged
- -a: all nodes
- -n: followed by a node or comma separated list of nodes (eg. -n blade1)  
Also, see the noderange man page for a shorthand way to specify many nodes.
- -N: followed by a nodegroup or comma separate list of nodegroups (eg. -N BladeNodes)

## ***Install the OS to the nodes and verify the installation***

The next step is to install SLES and the CSM client code on the nodes, to do this run “installnode -P”. This is an asynchronous command. To monitor the installation status, run “monitorinstall”, typical output might be:

Node	Mode	Status
blade1.bclab.com	Installing	Rebooting and Installing Node.
blade2.bclab.com	Managed	makenode complete

To continuously monitor the installation, run “watch monitorinstall”. When finished installing the nodes, the monitorinstall results will be:

Node	Mode	Status
blade1.bclab.com	Managed	Installed
blade2.bclab.com	Managed	Installed

When the installation is complete, you can login to the nodes using CSM’s default password of “cluster”.

To verify that Resource Monitoring and Control (RMC) are working on the nodes, run “lsnode -H -l”. The output should look similar to:

```
Name = blade1
ActiveMgtScopes = 1
Architecture = ppc64
DistributionName = SLES
DistributionVersion = 8.1
KernelVersion = 2.4.21-147-pseries64
LoadAverage = {0,0,0.01}
NodeNameList = {blade1.bclab.com}
NumOnlineProcessors = 2
NumProcessors = 2
NumUsers = 1
OSName = Linux
PctRealMemFree = 29
PctTotalPgSpFree = 100
PctTotalPgSpUsed = 0
PctTotalTimeIdle = 96.2245
```



```
PctTotalTimeKernel = 1.06353
PctTotalTimeUser = 2.67518
PctTotalTimeWait = 0.0367596
RealMemSize = 477413376
TotalPgSpFree = 155734
TotalPgSpSize = 155734
UpTime = 2137
VMPgInRate = 0
VMPgOutRate = 8
VMPgSpInRate = 0
VMPgSpOutRate = 0
```

```
-----
Name = blade2
ActiveMgtScopes = 1
Architecture = ppc64
DistributionName = SLES
DistributionVersion = 8.1
KernelVersion = 2.4.21-147-pseries64
LoadAverage = {0,0,0}
NodeNameList = {blade2.bclab.com.com}
NumOnlineProcessors = 2
NumProcessors = 2
NumUsers = 1
OSName = Linux
PctRealMemFree = 29
PctTotalPgSpFree = 100
PctTotalPgSpUsed = 0
PctTotalTimeIdle = 96.4853
PctTotalTimeKernel = 1.03231
PctTotalTimeUser = 2.44684
PctTotalTimeWait = 0.0355847
RealMemSize = 477409280
TotalPgSpFree = 155734
TotalPgSpSize = 155734
UpTime = 2341
VMPgInRate = 0
VMPgOutRate = 51
VMPgSpInRate = 0
VMPgSpOutRate = 0
```

You can also verify the Distributed Shell (dsh) command is working, run “dsh –as date”. The output should look similar to:

```
blade1.bclab.com: Wed Aug 18 22:06:02 CDT 2004
blade2.bclab.com: Wed Aug 18 22:08:17 CDT 2004
```

## ***Monitoring with CSM***

CSM contains some easy-to-use monitoring commands. In CSM, monitoring of an event begins when a “condition” and “response” pair are activated. On the MS, there are some predefined



conditions immediately available, view them by running the command "lscondition". Similarly, the predefined responses can be listed by running the command "lsresponse". The currently activated condition and response pairs can be listed by running the "lscondresp" command. The listing below shows the automatically activated condition and response pairs:

Displaying condition with response information:

Condition	Response	Node	State
"NodeFullInstallComplete"	"RunCFMToNode"	"ms"	"Active"
"NodeFullInstallComplete"	"GatherKRB5keytabs"	"ms"	"Active"
"pSeriesNodeFullInstallComplete"	"removeArpEntries"	"ms"	"Active"
"NodeFullInstallComplete"	"GatherSSHHostKeys"	"ms"	"Active"
"UpdatenodeFailedStatusChange"	"UpdatenodeFailedStatusResponse"	"ms"	"Active"
"NodeChanged"	"rconsoleUpdateResponse"	"ms"	"Active"

We'll monitor the event of a blade server changing its power state (to either on or off) and log the event. To this we'll use the predefined condition NodePowerStatus and the predefined condition LogCSMEventsAnyTime. To activate this condition and response pair, run this command:

```
startcondresp NodePowerStatus LogCSMEventsAnyTime
```

The output of "lscondresp" should contain this additional event pairing:

Condition	Response	Node	State
"NodePowerStatus"	"LogCSMEventsAnyTime"	"ms"	"Active"

The most important attribute of a response is its action script. To see the attributes that define the LogCSMEventsAnyTime response, run "lsresponse LogCSMEventsAnyTime". This is the output:

Displaying response information:

```
ResponseName = "LogCSMEventsAnyTime"  
Node         = "ms"  
Action       = "logEvent"  
DaysOfWeek   = 1-7  
TimeOfDay    = 0000-2400  
ActionScript = "/usr/sbin/rsct/bin/logevent /var/log/csm/systemEvents"  
ReturnCode   = 0  
CheckReturnCode = "n"  
EventType    = "b"  
StandardOut  = "n"  
EnvironmentVars = ""  
UndefRes     = "n"
```

The LogCSMEventsAnyTime response will add a log entry to the file /var/log/csm/systemEvents whenever one of the blades is powered off and on.

Users can make their own conditions and responses as well. For details of the CSM monitoring capabilities, see the CSM for Linux V1.4 Administration Guide.



## V. Troubleshooting

### *Serial Over LAN*

If Serial Over LAN sessions aren't showing you the expected output. You might need to disable and re-enable SOL on the JS20. To do this, under "Blade Tasks", select "Serial Over LAN". Check the box(es) next to the appropriate JS20. Click on the "Disable Serial Over LAN" link at the bottom. After the page reloads, the SOL column of the table should indicate "Disabled". Then check the JS20's box again and click on the "Enable Serial Over LAN" link at the bottom. After the page reloads, the SOL column of the table should indicate "Enabled".

### **CSM**

If the installation of CSM on the management server does not complete successfully, run:

```
probemgr -p ibm.csm.ms -l 0
```

There are a number of probes available in CSM. For details, see the CSM for Linux V1.4 Administration Guide.

CSM maintains its log files in `/var/log/csm`. These files can provide per-command-instance information (eg. `installms.log.1`, `installms.log.2`, etc...).

To monitor discussion of CSM topics, subscribe to one of the CSM mailing lists.

- the external list: <http://www-124.ibm.com/developerworks/oss/mailman/listinfo/csm>
- the internal list: <http://lxsvr4.ppd.pok.ibm.com/cgi-bin/lwgate/CSMDEV/>



## VI. References

1. BladeCenter JS20 Type 8842 Installation and User's Guide,  
<http://www-307.ibm.com/pc/support/site.wss/document.do?Indocid=MIGR-54526>
2. IBM eServer BladeCenter - Management Module User's Guide,  
<http://www-307.ibm.com/pc/support/site.wss/document.do?Indocid=MIGR-45153>
3. IBM eServer BladeCenter – Planning and Installation Guide,  
<http://www-307.ibm.com/pc/support/site.wss/document.do?Indocid=MIGR-53670>
4. Enabling and Configuring SOL (Serial Over LAN) on an 8842 Blade Server whitepaper, IBM eServer BladeCenter, BladeCenter JS20, by Mike Noterieke.  
<http://www-307.ibm.com/pc/support/site.wss/document.do?Indocid=MIGR-55018>
5. "AutoYaST Automatic Linux Installation and Configuration with YaST2", Anas Nashif  
<http://www.suse.com/~nashif/autoinstall/9.0/html/index.html>
6. "A net install environment for JS20 Blades using SLES 8 and AutoYaST", Joachim Jordan.
7. PureNetworkInstall.HOWTO on SUSE SLES 8 SP3A CD 1, in /ppc/netboot.
8. CSM for Linux 1.4 Administration Guide,  
<http://publib.boulder.ibm.com/clresctr/docs/csm/linux/200408/am7al103/am7al10302.html>
9. CSM for Linux 1.4 Planning and Installation Guide,  
<http://publib.boulder.ibm.com/clresctr/docs/csm/linux/200408/am7il103/am7il10302.html>
10. CSM for Linux 1.4 Command and Technical Reference,  
<http://publib.boulder.ibm.com/clresctr/docs/csm/linux/200408/am7cl102/am7cl10202.html>



Installing SUSE LINUX Enterprise  
Server 8 SP3  
on an IBM @server  
BladeCenter JS20

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