



White Paper

Serial Over LAN (SOL) for EPSD Server Hardware

1. Introduction

Serial over LAN (SOL) is a mechanism that enables redirection of serial character stream from UART (Universal Asynchronous Receiver Transmitter aka Serial Port) to a LAN using IPMI RMCP+ session on a managed server. It provides a means to manage a server remotely by using a command-line interface (CLI) over a Telnet or Secure Shell (SSH) connection. SOL provides console redirection for both BIOS as well as the server operating system [text based]. The advantages of SOL include the following:

- Remote administration without keyboard, video, or mouse (for example, headless servers)
- Reduced cabling by removing the need for a serial connector
- Standard Telnet interface that eliminates the need for special client software

With SOL console redirection system administrators can remotely view the text-based console on their remote managed servers from anywhere and perform any task that doesn't require a GUI. Some applications of SOL include:

- Install or reconfigure the OS and run utilities by accessing the Linux* serial console.
- Remote access to Emergency Management Services (EMS) or Special Administration Console (SAC) for Windows* to remotely view the boot, operating system loader or emergency management consoles
- Configure BIOS setup options remotely
- Remotely view the EFI console and hence run EFI commands on a remote system.

Thus, SOL out-of-band remote console can be used from any location to diagnose and repair problems - eliminating the need to physically go to a system. Such access can work within a domain or across firewalls assuming that UDP (Universal Datagram Protocol) packets are permitted.

2. Overview of SOL

SOL is based on RMCP (Remote Management and Control Protocol) request-response protocol delivered using UDP to port 623. SOL needs firmware running on the Baseboard Management Controller (BMC), and client software running on a management workstation and/or central network proxy to work.

The BMC firmware is responsible for controlling the serial hardware MUX, the transformation of serial data to and from network packets, and the transmission and reception of SOL network packets through the NIC port.

A remote SOL client is responsible for initiating the SOL session with the BMC and transformation of console input and output through network packets as shown in Figure 1.

To allow access to Telnet style programs, primary SOL services are implemented as a background network task. Throughout this document, this task will be referred to as the Network Proxy. The network proxy can run on individual management workstations, or may be a centralized service that can be used by any management workstation.

Intel offers this network proxy or "SOL Proxy" through a utility called "DPCCLI" and "DPCProxy". This can run on individual management workstations or may be a centralized service that can be used by any management workstation. "Telnet" is used as a client program to connect to the proxy where the SOL data is displayed.

The other commonly used tool is the IPMITool (<http://ipmitool.sourceforge.net/>) from Open source community which runs as a standalone utility that can connect to the firmware running on BMC and perform SOL.

3. Architectural Components

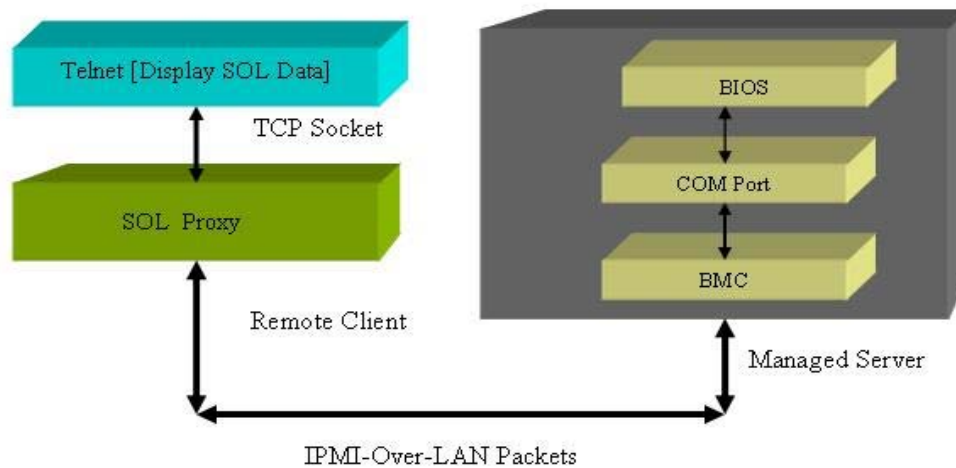


Figure 1. SOL Communication Stack

4. System Configuration to Enable SOL Redirection

The following section provides step by step instructions to configure BIOS and BMC firmware, and enable SOL using [Intel® Deployment Assistant](#) or the [Intel® System Configuration Utility](#).

In addition, the BMC can be accessed by any standard, off-the-shelf terminal or terminal emulator utilities such as open source IPMItool or IPMI Utility that allows access to sensor status information, and power controls.

In the latter option, end users have the risk of using any unvalidated open source utilities.

4.1 BIOS Configuration

- Restart the server and press **F2** when prompted to start the BIOS Setup
- Select Devices and I/O Ports; then, make sure that the Serial Ports value is set to Enabled
- Go to the Server Management tab and select Remote Console Redirection; then, make sure that the values are set as follows:
 - BIOS Redirection Port: Serial
 - Baud Rate: 19.2K (or other baud rates which is supported)
 - Flow Control: CTS/RTS
 - Terminal Type: VT100/VT100+
- Press **Esc** to exit the Remote Console Redirection and Devices and I/O Ports
- Press **F10**
- Make sure that **OK** is selected; then, press **Enter**, as shown in Figure 2.

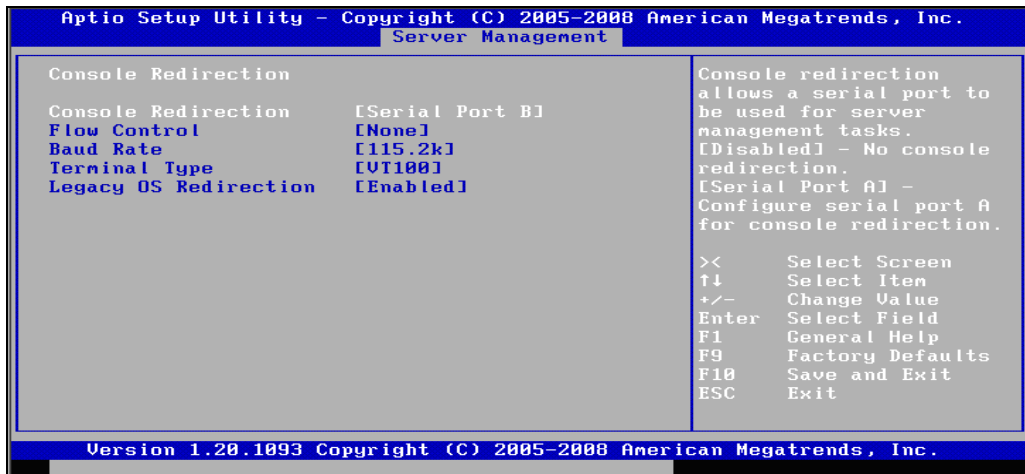


Figure 2. BIOS Console Screen

4.2 BMC Firmware Configuration

Along with the BIOS configuration, the firmware in the BMC has to be configured for Out-of-band [OOB] communication over LAN Setting Users and Enabling SOL. Following are the BMC settings that can be done using either the [Intel® Deployment Assistant](#) or the [Intel® System Configuration Utility](#).

- IP source (static or DHCP)
- IP Address
- Subnet mask
- Default gateway (only required if you will be connecting from client outside of subnet)
- Enable one user
- Enable user's privilege level
- Set Users and passwords
- Enable text based console redirection (serial Over LAN - SOL)

4.2.1 Enabling and Configuring LAN Channel using Intel® System Configuration Utility

Following steps use the Intel® System Configuration Utility to set the LAN channel, User, and SOL settings on the BMC:

1. Configure LAN channel IP info on BMC channel 1 using the Intel® System Configuration Utility.
 - Type: syscfg /le 1 static 192.168.1.12x 255.255.255.0
2. Configure BMC users authorization
 - Set password for BMC user 1 (Anonymous):
Type: syscfg /u 1 "" "password" ----- password is "password" in this tab
 - Enable the BMC user 1 on BMC channel 1:
Type: syscfg /ue 1 enable 1
 - Enable "admin" privilege and payload type to "SOL" for the BMC user 1 on BMC channel 1:
Type: syscfg /up 1 1 admin sol
3. Configure BMC for SOL Parameters.
 - Enable Serial Over LAN (SOL) on the BMC channel 1:
Type: syscfg /sole 1 enable admin 115200 5 60

NOTE: Make sure that the baud rate for SOL configured in BIOS Setup and in the BMC firmware, *both on a managed server*, are the same.

4.2.2 Enabling and Configuring LAN Channel using Intel® Deployment Assistant

Following steps use the Intel® Deployment Assistant (IDA) to set the LAN channel, User, and SOL settings on the BMC, *and are an alternative to the previous section.*

1. **To use Intel® Deployment Assistant to configure OOB LAN:**

- Select “Configure a Server” after boot from the IDA CD
- Select “Server Management Settings” and click **Next**
- Click **LAN Channel 1 (onboard NICS1)** if you want to configure BMC LAN channel 1, and then click **Next**.

NOTE: You can also select “LAN Channel 2” depending on your configuration.

- Select “IP Address From a DHCP Server” or “Static IP Address” for BMC LAN Channel IP and key in your IP address/Subnet Mask/Gateway depending on your network configuration.

2. **To use Intel® Deployment Assistant to configure users:**

1. Select “Anonymous User” line and click **Edit** to configure BMC anonymous user.

NOTE: you can configure other BMC users depending on your choice.

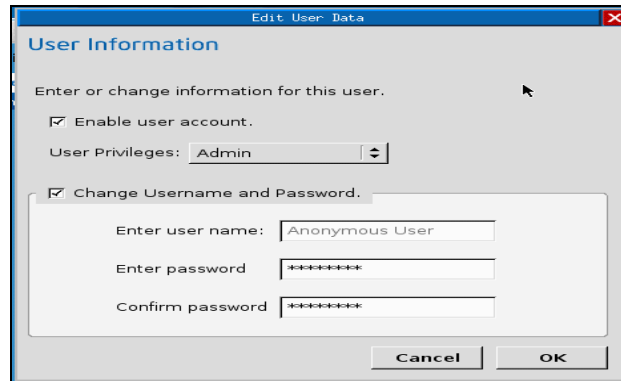
Set Up Users

Set up user accounts for this server.

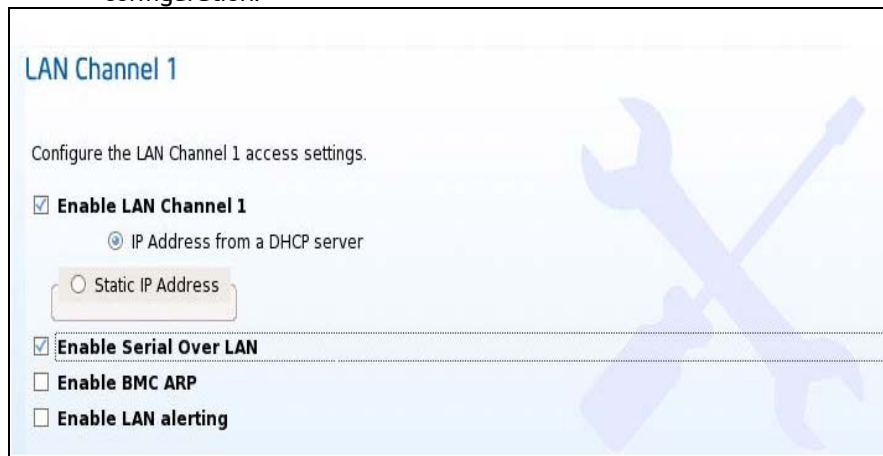
User Name	Status	Password	User Privileges
Anonymous User	Mixed	*****	Admin
	Disabled	*****	None
	Disabled	*****	None
	Disabled	*****	None

Edit

2. In the "Edit User Data" pop-up window, you can enable the selected user account and assign user privileges to this user. Make sure to select "Change Username and Password" and enter password/confirm password, then click **OK**.



3. **Using Intel® Deployment Assistant to configure SOL:**
 - Select the "Enable Serial over LAN" option along with the LAN configuration option in the LAN Channel configuration page. This enables the SOL configuration.



NOTE: Make sure that the baud rate for SOL configured in BIOS Setup and in the BMC firmware are the same *on the same managed server*.

5. Using Intel® Management Module Command Line Interface (DPCCLI) and DPCProxy utility for SOL

DPCProxy utility runs a background service in Windows* or as a daemon for Linux*. It can either be installed on the management console or in a centralized server. Serial over LAN mode requires a telnet session from the managing console to the Network Proxy [DPCProxy], regardless of which operating system (Windows® or Linux*) you are running on either system. Start the telnet session to the remote server as described below.

- At the operating system command prompt, type "telnet xxx.xxx.xxx.xxx 623 <Enter>". The xxx represent the IP address of the system running the Network Proxy. This may be a central network server with the Proxy installed. If you are connecting to the local system, use "localhost" instead of the system's IP Address. The 623 represents the default Port address required for Intel Command Line Interface connections. For example: telnet 10.7.162.58 623 or telnet localhost 623.
- At the "Server:" prompt provide the IP Address or DNS Name of the server to which you want to connect.
- Provide the BMC username and password for the target system. After authentication is performed, you will see a login successful message and the "dpccli>" prompt (even over telnet).
- At the command prompt type "console". It will immediately be redirected to the SOL mode.
- Typing "reset -console" command will do a system reset along with console redirection.
- To disconnect SOL you need to give "~." The SOL will be terminated.

6. Functionality using SOL

6.1 Using SOL to access BIOS Menu

After having established the Telnet session with dpcproxy perform the following steps to get BIOS console screen redirection.

- To remote power-off the managed system
type: dpccli> power -off
- To power on the managed system and start an SOL session
type: dpccli> power -on -console

- Monitor the managed system BIOS boot up screen via Serial Over Lan (SOL):
Press "F2" go to BIOS menu and select "Discard Changes and Exit" as shown in Figure 3.

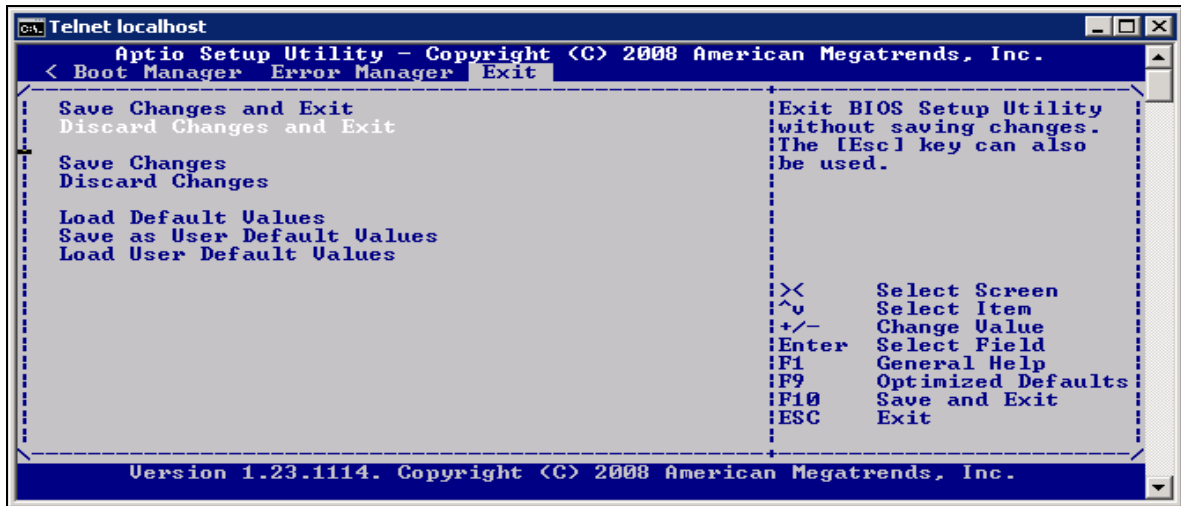


Figure 3: BIOS menu screen under SOL

7. Configuring Windows Server 2003* to support SOL

When you connect to the BMC using the DPCCLI, you can remotely control the text console. With SOL this also includes operating systems such as Windows Server 2003* and Linux*.

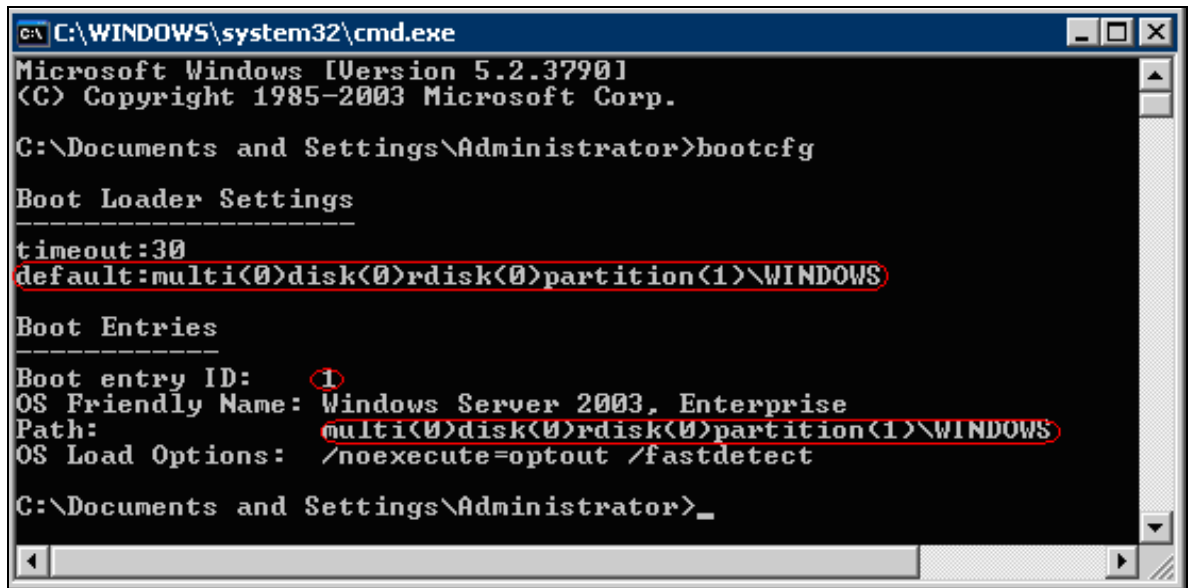
Windows Server 2003* has two components that work with DPCCLI and the BMC to provide out-of-band access to the operating system:

- Microsoft* Emergency Messaging Service (EMS)
- Microsoft* Special Administration Console (SAC)

To exit SOL and return to the SMBridge prompt, press the tilde key and the period key (that is, ~.). For more information, see: http://www.microsoft.com/resources/documentation/WindowsServ/2003/standard/proddocs/en-us/EMS_SAC_commands.asp

To enable EMS on a Windows Server 2003*, do the following:

1. Log in to Windows* as an administrator.
2. Launch a command prompt and enter the command bootcfg, as shown in Figure 4.



```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 5.2.3790]
(C) Copyright 1985-2003 Microsoft Corp.

C:\Documents and Settings\Administrator>bootcfg

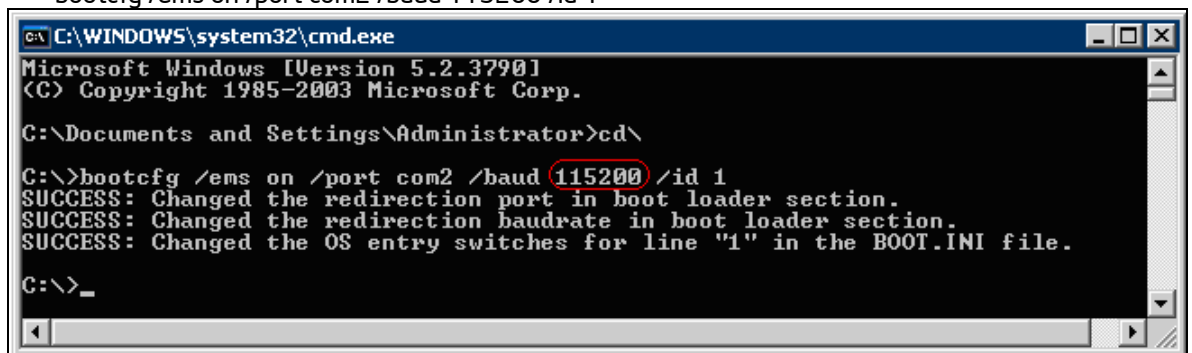
Boot Loader Settings
-----
timeout:30
default:multi(0)disk(0)rdisk(0)partition(1)\WINDOWS

Boot Entries
-----
Boot entry ID: 1
OS Friendly Name: Windows Server 2003, Enterprise
Path: multi(0)disk(0)rdisk(0)partition(1)\WINDOWS
OS Load Options: /noexecute=optout /fastdetect

C:\Documents and Settings\Administrator>_
```

Figure 4: Windows* EMS screen

- Examine the output. If there is more than one boot entry then you will need to determine the default entry by looking at the default line under Boot Loader Settings and determining whether Boot Entry has a matching Path value. In this case, there is only one boot entry, 1.
- Issue the following command, substituting your boot entry number in the /id parameter if it is not 1 as in example.
bootcfg /ems on /port com2 /baud 115200 /id 1



```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 5.2.3790]
(C) Copyright 1985-2003 Microsoft Corp.

C:\Documents and Settings\Administrator>cd\

C:\>bootcfg /ems on /port com2 /baud 115200 /id 1
SUCCESS: Changed the redirection port in boot loader section.
SUCCESS: Changed the redirection baudrate in boot loader section.
SUCCESS: Changed the OS entry switches for line "1" in the BOOT.INI file.

C:\>_
```

NOTE: In order to enable perform this step, you need enable console redirection on COM2 (SOL session) with baud rate 115200 in advance for this setting.

- Reissue the bootcfg command to see the result. The changes in the example are highlighted.

```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 5.2.3790]
(C) Copyright 1985-2003 Microsoft Corp.

C:\Documents and Settings\Administrator>cd\

C:\>bootcfg

Boot Loader Settings
-----
timeout:          30
default:          multi(0)disk(0)rdisk(0)partition(1)\WINDOWS
redirect:         COM2
redirectbaudrate:115200

Boot Entries
-----
Boot entry ID:    1
OS Friendly Name: Windows Server 2003, Enterprise
Path:             multi(0)disk(0)rdisk(0)partition(1)\WINDOWS
OS Load Options: /noexecute=optout /fastdetect /redirect

C:\>_
```

Figure 5. EMS Setting Results

- Reboot the server to have the changes take affect.
Note: To turn EMS off again, issue the following command:
bootcfg /ems off /id 1
where 1 is the boot entry you have modified in the above steps.

Reboot to bring the changes online.

- Once you have rebooted and engaged the DPCCLI console, you will see the EMS console. You can now issue the various SAC commands described in above Table. For example, to start a command prompt, the commands are as follows.
Tip: After you start the DPCCLI console, if you only get a blank screen, press Enter a few times to get the SAC> prompt.

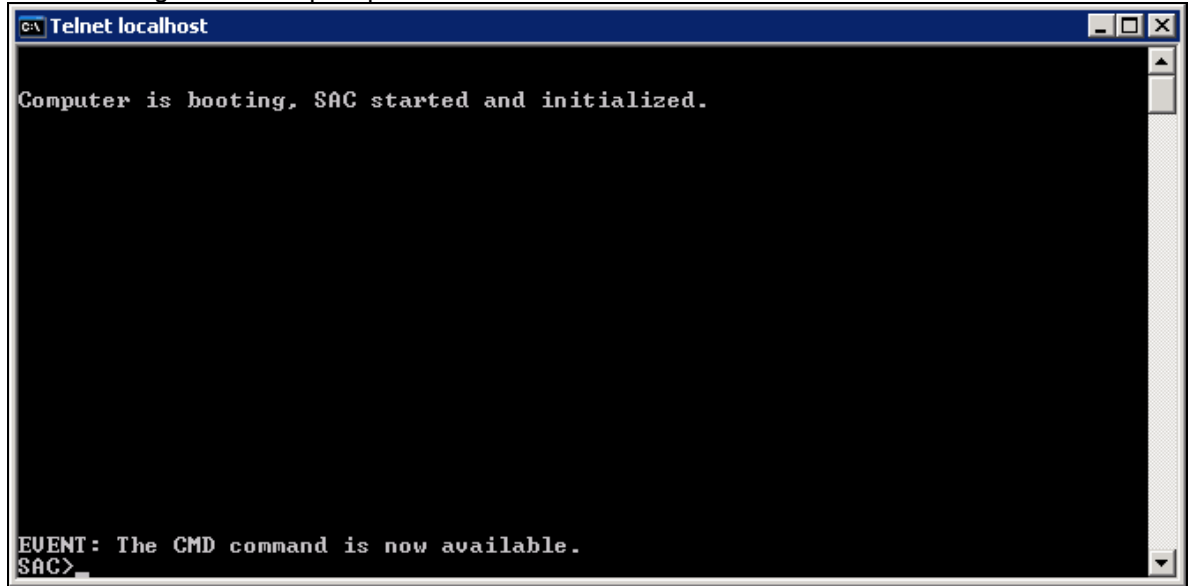


Figure 6. EMS Console

- Key in "ch -si" command to login into Windows OS command line environment
NOTE: In Login screen, key in username/domain name/password for authorization.
 Now, you are under Windows Command Line Prompt:

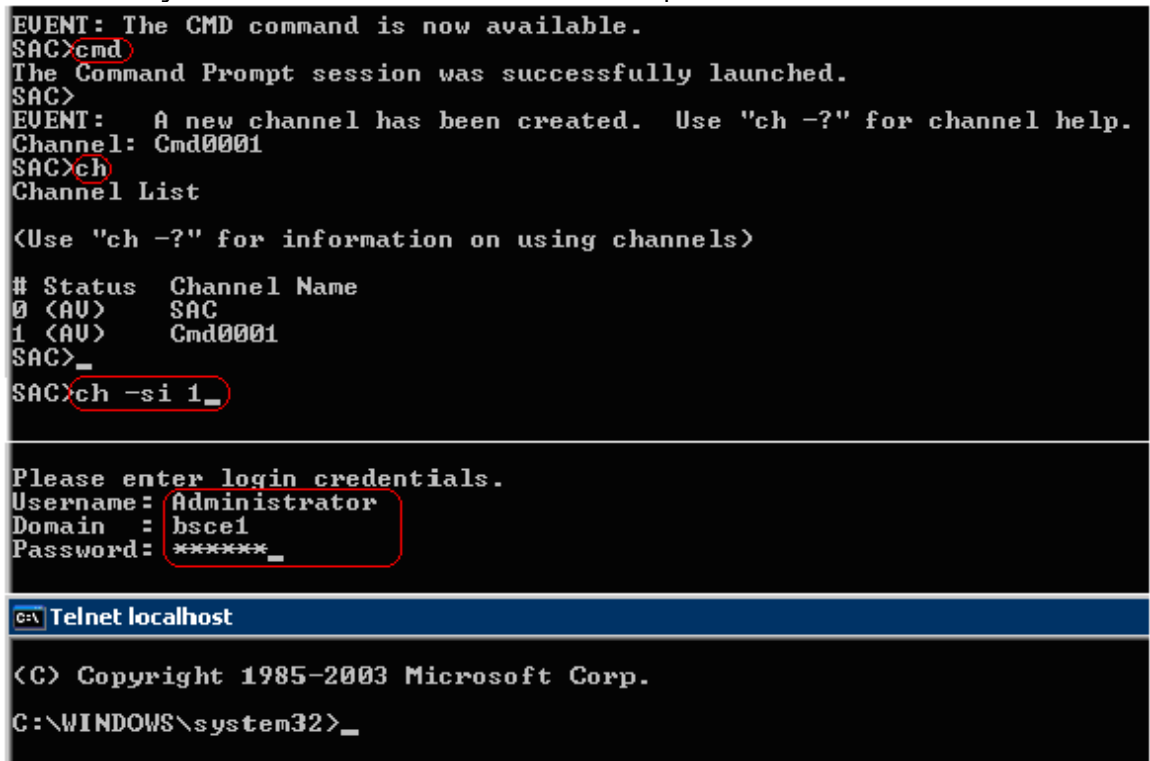


Figure 7. Login into Windows* command line prompt

- To close the command prompt channel, enter exit.
- To leave the channel open and return to the SAC prompt, press Esc+Tab+0 (the number zero key), three keys in sequence.
- To leave the remote console and return to DPCCLI press tilde+period (that is, ~.)

8. Configuring Linux* to support SOL

You must configure Linux* to expose the Linux initialization (booting) process via SOL. This enables users to log in to the Linux console through an SOL session and directs output to the serial console.

In this document, we provide SuSE Linux* as an example. The solution for Red Hat Linux* is similar.

Make sure that the settings mentioned here is similar to what has been set in the BIOS console.

```
linux-ml6q:/usr/local/syscfg #
linux-ml6q:/usr/local/syscfg # ./syscfg /d sol 1
SOL Configuration Settings:
-----
Channel Number Selected: 1
SOL Enable: Enabled
Privilege Level Limit: Admin
Baud Rate (bits/second): 115200
Retry Count: 5
Retry Interval (ms): 60
linux-ml6q:/usr/local/syscfg #
```

Figure 7. Baud Rate setting for SOL

The steps for configuring SuSE Linux* to support SOL as an example:

- Log in as root.
- Modify the /boot/grub/menu.lst file as follows:
Change GRUB GUI setting to TXT to allow GRUB menu to be displayed in SOL console.
Comment out the gfxmenu line.
gfxmenu (hd0,1)/boot/message
TO
display (hd0,1)/boot/message

```
# Modified by YaST2. Last modification on Sat Feb 14 02:19:16
default 0
timeout 8
# gfxmenu (hd0,5)/boot/message
display (hd0,5)/boot/message
```

Figure 8. Change GRUB GUI to be displayed via SOL

- The following action is to enable Linux boot procedure to be displayed also in SOL console by adding "console=ttyS1,115200n"
- Add the following comment line before the first title line:
title SUSE Linux* Enterprise Server 10 SP2 SOL Session
- Append SOL Monitor to the first title line.
title linux SOL Monitor
- Append the following text to the kernel line of the first title section:
console=ttyS1,19200 console=tty1
- Add the following lines between the first two title sections:
This will allow you to interact with the OS boot via SOL
title linux SOL Interactive
kernel (hd0,1)/boot/vmlinuz root=/dev/hda2 acpi=oldboot vga=791
console=tty1 console=ttyS1,19200
initrd (hd0,1)/boot/initrd

The result is as shown in following figure.

```
###Add SOL boot option###
title SUSE Linux Enterprise Server 10 SP2 SOL Session
    root (hd0,5)
    kernel /boot/vmlinuz-2.6.16.60-0.21-bigsmpt root=/dev/disk/by-id/
scsi-SATA_ST3160811AS_6PT03YN8-part6 vga=0x314 acpi=off resume=/d
ev/sda5 splash=silent showopts console=ttyS1,115200n console=tty1
    initrd /boot/initrd-2.6.16.60-0.21-bigsmpt

###Don't change this comment - YaST2 identifier: Original name: linu
x###
title SUSE Linux Enterprise Server 10 SP2
    root (hd0,5)
    kernel /boot/vmlinuz-2.6.16.60-0.21-bigsmpt root=/dev/disk/by-id/
scsi-SATA_ST3160811AS_6PT03YN8-part6 vga=0x314 acpi=off resume=/d
ev/sda5 splash=silent showopts
    initrd /boot/initrd-2.6.16.60-0.21-bigsmpt
```

Allow users to login as root from SOL console:

- Modify the /etc/security file by adding the following line to enable users to log in as root at the SOL console:
ttyS1

```
# without leading /dev/) on which root is allowed to login.
#
tty1
ttyS1
tty2
tty3
tty4
tty5
tty6
```

- Restart Linux

```

c:\ Telnet localhost
GNU GRUB  version 0.97  (639K lower / 2591680K upper memory)

SUSE Linux Enterprise Server 10 SP2 SOL Session
SUSE Linux Enterprise Server 10 SP2
SUSE Linux Enterprise Server 10 SP2 (</dev/sda2>)
SUSE Linux Enterprise Server 10 (</dev/sdc3>)
Windows
Failsafe -- SUSE Linux Enterprise Server 10 SP2

Use the  and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the
commands before booting, or 'c' for a command-line.

```

```

c:\ Telnet localhost
Type: CD-ROM ANSI SCSI revision: 03
4:0:0:0: Attached scsi generic sg5 type 5
Intel<del: RMM2 UDrive 4 Rev: 0.01
Type: CD-ROM ANSI SCSI revisiosr0: scsi-1 drive
sr1: scsi-1 drive
sr2: scsi-1 drive
sr3: scsi-1 drive
IA-32 Microcode Update Driver: v1.14 <tigran@veritas.com>
IA-32 Microcode Update Driver v1.14 unregistered
NET: Registered protocol family 10
lo: Disabled Privacy Extensions
IPv6 over IPv4 tunneling driver
powernow: This module only works with AMD K7 CPUs

Welcome to SUSE Linux Enterprise Server 10 SP2 <i586> - Kernel 2.6.16.60-0.21-bi
gsmg <ttyS1>.

linux-ml6q login: root
Password:
Last login: Sun Feb 15 19:50:42 EST 2009 on ttyS1
You have new mail.
linux-ml6q:~ #
linux-ml6q:~ #

```

9. Role of BIOS in SOL

During POST, BIOS queries the BMC for the SOL status. If SOL is found active then BIOS forces the console on SOL serial port. BIOS also auto enables redirection of DOS, Linux* shell, Windows* SAC on to the serial port. BMC acts as a bridge between serial data coming from SOL port and the network proxy. BMC picks up the data on serial port and converts them into RMCP+ LAN packets so that the SOL proxy can decode the packets and display the serial data on remote telnet console.

Often the BIOS Console redirection and SOL are considered as same features of BIOS. But the truth is, they are two independent features of BIOS. SOL uses the services of Console redirection subsystem to redirect the console over SOL serial port. Depending upon current configuration of BIOS console redirection setting, there are three cases,

9.1 Case 1: Console Redirection disabled and SOL Active

BIOS queries SOL status during POST. If SOL active then BIOS will force the Console on SOL serial port, even though console redirection is disabled in BIOS setup. During this process, BIOS Setup will not reflect console redirection settings because, on next boot of SOL is not active then we will be enabling console on SOL serial port forever.

9.2 Case 2: Console Redirection enabled on SOL serial port and SOL Active

BIOS queries SOL status during POST. If SOL active, then BIOS will override console redirection Baud rate settings with that of SOL Baud settings. For examples, assume SOL is configured at 57600 baud where as console redirection has 115200 Baud. Then BIOS will enable console on SOL port with 57600 Baud, however BIOS will not change this in BIOS Setup due to reason mentioned in Case 1.

9.3 Case 3: Console Redirection enabled on system Serial (non SOL) port and SOL active

BIOS queries SOL status during POST. If SOL active, then BIOS will enable Console on SOL serial port. BIOS will also enable console on non SOL serial port. Hence you will see console on both SOL console and non SOL serial port.

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