

System Recovery

Using Windows Server 2003 on Dell PowerEdge Servers

By understanding different ways to recover a failed server, administrators can minimize interruptions to critical business processes. This article explores several powerful mechanisms for the recovery of Dell™ PowerEdge™ servers running the Microsoft® Windows Server™ 2003 operating system.

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Business interruptions and loss of productivity caused by system failure can be damaging and expensive. To help avoid unplanned outages, Microsoft has improved the robustness of the Windows Server™ 2003 operating system (OS), introducing enhanced system recovery features. At the same time, Windows Server 2003 continues to support the recovery options that were provided in the Microsoft® Windows® 2000 Server OS.

Dell also provides support for system recovery with both software- and hardware-based server management products. Dell™ remote access controllers (RACs) are one such category of hardware devices. RACs are supported in most Dell PowerEdge™ servers. Together, Microsoft and Dell recovery features can help provide smoother operation of Dell PowerEdge servers running Windows Server 2003.

Most recovery methods require advanced knowledge of the OS. Therefore, attempting to recover the system using basic recovery options such as Windows Safe-Mode Boot, Last Known Good Configuration, and Device Driver

Rollback—a feature new to Windows Server 2003—is recommended before proceeding to more advanced features. This article covers two advanced Microsoft Windows recovery options:

- **Emergency Management Services:** An advanced recovery option introduced in Windows Server 2003, Emergency Management Services (EMS)¹ provides powerful out-of-band management capabilities.
- **Automated System Recovery:** As a last resort when EMS functionality does not solve the problem, Automated System Recovery (ASR)² may be used to format the hard disks and recover the system from backed-up files.

Understanding in-band and out-of-band management

In-band management refers to the many mechanisms available to manage a system that has a fully functional OS and server hardware. For example, the Dell OpenManage™ systems management product suite offers in-band server

¹ Microsoft EMS should not be confused with the Dell OpenManage IT Assistant event management system (EMS), which monitors servers for specific events. For more information on event monitoring by IT Assistant, see "Understanding and Selecting Events to Monitor in IT Assistant" by Manoj Gujarathi in *Dell Power Solutions*, May 2002.

² Microsoft ASR should not be confused with automated server recovery (ASR), which is a hardware-based fault-tolerance feature. All ASR mentions in this article refer to Microsoft ASR.

management that enables administrators in an enterprise environment to manage hundreds of servers over the network from a single management console.

An in-band connection can be used only when the server is fully operational and accessible over the network. When these conditions cannot be met, out-of-band management methods must be used to manage the server remotely. Administrators can use out-of-band management when attempting to recover a system that has had a critical failure such as an unresponsive, or *hung*, OS.

An out-of-band connection uses a serial port, a modem, or a dedicated network interface card (NIC) together with specialized administration software—such as the EMS suite of applications—to communicate with the remote server. The out-of-band systems management approach does not replace in-band systems management; it simply enables administrators to quickly return a server to its fully functional state so they can once again control the server using in-band methods.

In a typical out-of-band management network, administrators control devices over a route separate from the main communication network. When in-band communication over a standard network path fails, administrators use the out-of-band network to connect to the servers, diagnose the problem, and effect repairs. Figure 1 shows a network that has both in-band and out-of-band connections, the latter implemented through serial connections.

An out-of-band connection through a serial console port relies on the most primitive OS services. As long as the kernel is functioning, the system can be accessed through the serial console port—even if the network stack or graphical user interface (GUI) is not operational. Because the console port delivers only text data, it offers good performance over low-bandwidth connections such as dial-up lines.

Using Windows EMS for out-of-band management

EMS is a powerful new out-of-band system recovery suite introduced in Windows Server 2003. EMS features, which involve multiple elements of the Windows Server 2003 OS, allow for system recovery through the server's serial console port even when the server is unavailable through the network because the operating system's network stack and user interface are not functional.

EMS support on Dell PowerEdge servers has two primary requirements:

- **BIOS support for console redirection:** To control and recover a server using out-of-band management, the server firmware must support console redirection; additional requirements may depend on an organization's specific

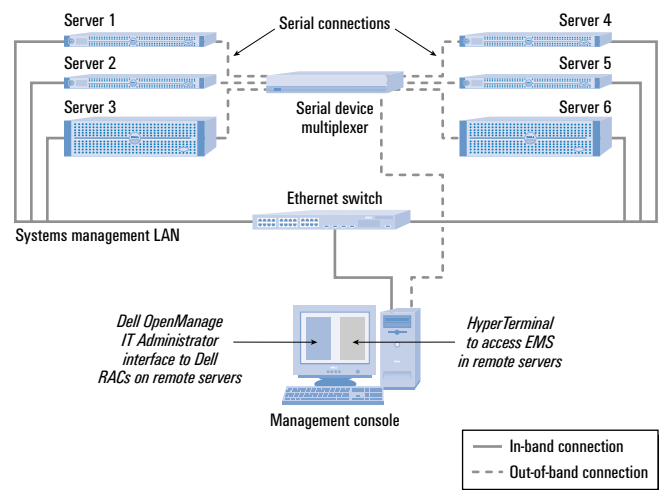


Figure 1. A server infrastructure that supports both in-band and out-of-band management

server management implementation. Fifth-generation PowerEdge servers (such as the PowerEdge 2500 and 2550) and newer PowerEdge servers (such as the PowerEdge 2650 and 6600) support console redirection by allowing the local display to be diverted to a remote console through serial ports. To enable or verify this feature, administrators can access the BIOS configuration page of a Dell PowerEdge server by pressing F2 immediately after the server starts booting, and then setting Console Redirection to “Enabled.”

- **BIOS support for SPCR table:** With the exception of the PowerEdge 1550, all fifth-generation and newer PowerEdge servers support the Serial Port Console Redirection (SPCR) table. The SPCR table provides EMS with information about the out-of-band management port as well as related configuration details. If the Dell PowerEdge server does not support the SPCR table, administrators must provide the EMS configuration parameters and information about the out-of-band management port to the Windows Server 2003 OS by using the `bootcfg` command.³ The same command may be used to change the default configuration of EMS even if the server supports the SPCR table.

The main components of EMS are the two remote management consoles that are available only within EMS: the Special Administration Console (SAC) and the !Special Administration Console (!SAC). EMS also includes components that are standard features of the Windows Server 2003 OS, to which EMS has added console redirection capability.

³ For more information about using `bootcfg` to enable EMS, visit http://msdn.microsoft.com/library/default.asp?url=/library/en-us/ddtools/hh/ddtools/bootini_58xf.asp.

```

SAC>
EVENT: The CMD command is now available.
SAC>?
ch          Channel management commands. Use ch -? for more help.
cmd        Create a Command Prompt channel.
d          Dump the current kernel log.
f          Toggle detailed or abbreviated tlist info.
? or help  Display this list.
i          List all IP network numbers and their IP addresses.
i <#> <ip> <subnet> <gateway> Set IP addr., subnet and gateway.
id         Display the computer identification information.
k <pid>    Kill the given process.
l <pid>    Lower the priority of a process to the lowest possible.
lock       Lock access to Command Prompt channels.
m <pid> <MB-allow> Limit the memory usage of a process to <MB-allow>.
p          Toggle paging the display.
r <pid>    Raise the priority of a process by one.
s mm/dd/yyyy hh:mm Display the current time and date (24 hour clock used).
t          Set the current time and date (24 hour clock used).
restart    Restart the system immediately.
shutdown  Shutdown the system immediately.
crashdump Crash the system. You must have crash dump enabled.
SAC_

```

Figure 2. List of commands available in the EMS SAC

EMS supplies text-mode console redirection

EMS console redirection has been integrated into multiple aspects of the OS, including the setup loader, the text-based setup process, Remote Installation Services (RIS), the loader, and the Stop error handler. Support for console redirection in the setup loader, the text-based setup process, and RIS allows for remote installation of the OS using EMS. Meanwhile, console redirection support by the loader and the Stop error handler are crucial in aiding system recovery.

The console redirection feature allows administrators to view and manage a remote server. The Dell PowerEdge server BIOS supports text-mode console redirection during the server's power-on self-test (POST) until the OS begins to load. EMS supports text-mode console redirection as soon as Windows Server 2003 begins to load, and the feature remains available until the Windows GUI begins to load. This provides administrators with uninterrupted text-mode console redirection through an out-of-band management port beginning from server POST until the EMS SAC or !SAC session is available.

SAC enables OS management

SAC is the primary EMS command-line environment⁴ that allows administrators to access and control several Windows Server 2003 components. As a kernel-level function, SAC remains accessible even after high-level applications cease to respond. If a server is not responding because of a misbehaving process, administrators can use SAC to stop the errant process and even restart the server. By providing a limited set of very powerful commands, SAC can return the system to an in-band state. While in a SAC session, administrators can do the following:

- Set or view the IP address of the server
- Restart or shut down the server

- List all used and available resources (such as physical memory and kernel memory)
- List processes, kill processes, limit a process's memory usage, or change process priority
- Create command-prompt channels to access the file system, enabling administrators to run text-based applications such as the bootcfg command-line utility, replace system files, and copy files from CDs or floppy disks
- Invoke a crash dump that can be used for debugging
- Generate a Stop error that will create a memory dump file
- Dump the kernel log

For a complete list of SAC commands, use the help or ? command from within the SAC session. This will display the command list as shown in Figure 2.

One of the most robust features of SAC is the provision for administrators to access the local file system. This capability is made possible by the Special Administration Console Helper service (sacsvr), which allows administrators to create up to eight simultaneous command-prompt channels. Access to each channel is secured and requires valid login credentials to a local or domain account. With access to the file system and even floppy disks, CDs, and network shares, the SAC command-prompt channels can be used to replace corrupted or missing system files. Although SAC will not remember the mapped network connections on the host server, SAC command-prompt channels can be used to access network shares as long as the TCP/IP stack on the host server is functional (see Figure 3).

If critical system files such as pci.sys or files that identify hardware necessary for the boot process are corrupted or missing,

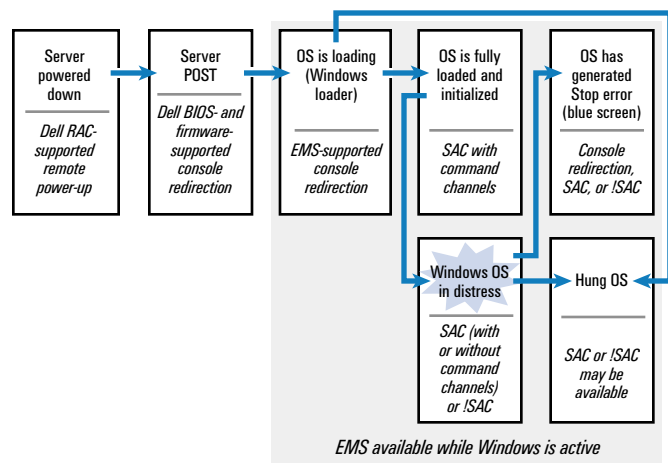


Figure 3. Availability of system recovery components on a Dell PowerEdge server when the Windows Server 2003 OS is in different states (arrows represent the transitions in OS state)

⁴ The SAC command-line environment is different from the standard command-line environment available in Windows operating systems and it offers different functionality.

some of the basic OS components including SAC may fail to load. When SAC fails to load, Windows Server 2003 attempts to make !SAC available.

!SAC provides auxiliary OS control

!SAC is an auxiliary EMS command-line environment hosted by Windows Server 2003 that also communicates through the out-of-band management port. The !SAC command-line environment is different from both the SAC and Windows Server 2003 command-line environments. When SAC fails to load or is not functioning, !SAC becomes available automatically.

The primary functions of !SAC are to redirect text from Stop error messages and allow administrators to restart the computer if SAC becomes unavailable. To this end, !SAC offers a subset of SAC commands, which can do the following:

- Restart the server
- Display computer identification information and all log entries
- Display Stop error message explanatory text

If missing or corrupted critical system files prevent even !SAC from loading, administrators should use alternative methods to replace key system files.⁵

Terminal emulation software establishes SAC and !SAC sessions on remote servers

The serial port is the most common out-of-band management port used by EMS, and PowerEdge servers continue to provide a legacy serial port that is supported by Windows Server 2003. Industry-standard conventions for terminal emulation such as VT-UTF8 and VT-100 enable remote EMS consoles to send commands to the server through a serial connection. With its support for enhanced escape sequences and language localization, VT-UTF8 is the preferred terminal type for viewing EMS output. However, if VT-UTF8 emulation is not available or supported by the terminal emulation software, VT-100+ or VT-100 emulation can be used.⁶ Dell PowerEdge servers currently support only VT-100 emulation for console redirection.

A terminal emulator such as the Hilgraeve HyperTerminal® utility, which supports VT-UTF8 and other terminal control standards, can be used for viewing EMS output sent through the server's serial port. The Hilgraeve HyperTerminal utility ships with most Windows client and server operating systems, including Windows

Microsoft EMS	Dell RAC	Microsoft ASR
<ul style="list-style-type: none"> • Support out-of-band management only • Allow remote power-down • Allow remote reboot • List and kill processes • List used and available resources • Access file system, local external storage media, and network shares • Configure IP address • Redirect Stop error messages • Dump kernel log and invoke crash dump 	<ul style="list-style-type: none"> • Support out-of-band and in-band management • Allow remote power-up • Allow remote power-down • Support graphic and text-mode console redirection if OS is functional • Access hardware log, POST log, and boot log • Monitor system health and alert administrators to potential hardware problems • Perform remote floppy boot function 	<ul style="list-style-type: none"> • Offer alternative recovery option when all other recovery operations fail • Require backup and restore of system volumes • Require administrators to proactively make periodic backups using the ASR utility • Support backup and restore of system state only (not a full data backup utility)

This listing includes only features that may be useful for system recovery, and is not representative of the full feature set for each component.

Figure 4. Components useful for system recovery of Dell PowerEdge servers running Windows Server 2003

Server 2003. The connection from the host client system that runs the terminal emulation software to the target server should be through a null modem cable. For information on configuring a HyperTerminal session to connect to the EMS console and on accessing EMS SAC and !SAC using HyperTerminal, see “Using HyperTerminal to send EMS commands to the server.”

Exploring alternative system recovery options

The EMS implementation in Windows Server 2003 allows administrators to attempt out-of-band system recovery when the OS or the software stack on the server might have caused a system failure. With the Dell OpenManage systems management suite, Dell extends the capabilities of administrators to troubleshoot hardware issues by supporting in-band and out-of-band management. Dell OpenManage Server Administrator—which can monitor a server's health including voltage, temperature, and cooling fan status—can be configured to alert administrators of any potential problems.⁷

Figure 4 summarizes the features of each system recovery option discussed in this article and how those features may contribute to the recovery of PowerEdge servers running Windows Server 2003.

Windows EMS enhances the functionality of a Dell RAC

On many PowerEdge servers Dell provides a RAC, which is a hardware-based remote console that is completely independent of

⁵ The Windows loader (NTLDR) makes available a concise version of !SAC that allows administrators to restart the server. This version of !SAC is automatically made available to either the remote or local console by the loader when it cannot load the kernel.

⁶ For more information about selecting client terminal software for EMS and supported conventions and escape sequences, visit http://www.microsoft.com/technet/treeview/default.asp?url=/technet/prodtechnol/windowsserver2003/proddocs/standard/EMS_VT100_conventions.asp.

⁷ For more information on the Dell OpenManage suite, visit <http://support.dell.com/systemdocumentation/index.aspx?category=6,111>.

USING HYPERTERMINAL TO SEND EMS COMMANDS TO THE SERVER

The following two procedures indicate how to connect to Microsoft EMS and access EMS SAC and ISAC using the Hilgraeve HyperTerminal utility.

Configuring HyperTerminal to connect to EMS using a serial port

Prerequisites:

- Enable console redirection on the target server system BIOS by pressing F2 immediately after the server starts booting, and then setting Console Redirection to "Enabled."
- Connect a null modem cable between the client system's serial COM port and the target server's serial COM port.

1. On a client computer, open a new HyperTerminal session from the Start menu by selecting Start > Programs > Accessories > HyperTerminal. If HyperTerminal is not available in the Accessories list, locate it by selecting Start > Programs > Accessories > Communications > HyperTerminal.

Note: Although the HyperTerminal utility is available in Microsoft Windows Server 2003, it is not installed by default. It can be installed manually by enabling it in the Add/Remove Windows Component applet. To do so, go to Start > Settings > Control Panel > Add/Remove Programs > Add/Remove Windows Components > Accessories and Utilities > Communication > HyperTerminal.

2. In the Connection Description dialog box, enter a name for the connection.
3. In the Connect Using field on the Connect To dialog box, select the COM port on the client that has been connected to the server.
4. Choose the following in the COM Port Properties dialog box:
 - Bits per second: 9,600
 - Data bits: 8

- Parity: None
- Stop bits: 1
- Flow control: Hardware

The HyperTerminal serial communications program is now ready to use.

Accessing EMS SAC and ISAC using HyperTerminal

1. Complete the previous procedure to configure a HyperTerminal session between the client and target systems.

2. Power on the target server.

The Dell server firmware will redirect the power-on self-test (POST) information for the server to the HyperTerminal session. After the POST, when the OS begins to load, Dell firmware console redirection will end and EMS console redirection will begin. The following message will appear on the HyperTerminal session window: "Computer is booting, SAC started and initialized."

At this time, most SAC commands are accessible, but the command-prompt channels are not yet available because the SAC services have not yet completely registered. SAC is fully operational when it displays the following message: "EVENT: The CMD command is now available."

3. If the Redirection After Boot option has been selected in the server system BIOS, the SAC messages will be blinking. Press Esc + Tab to stop the blinking.
4. Use the help or ? command at the SAC prompt to display a list of supported SAC commands.
5. Use the Esc and Tab keys to toggle between the command channels and the SAC console.

the server firmware and OS.⁸ The RAC's dedicated network port offers an Ethernet-based out-of-band management option. Typically, when a server hangs, administrators must physically press the power button to power cycle the server. The capability of the RAC to remotely cold boot, restart, and shut down servers that do not have a functional OS can greatly enhance the power cycling capabilities of Windows recovery systems. When used in conjunction with the EMS available in Windows Server 2003, a RAC can help provide a powerful and robust recovery system.

All the latest Dell servers ship with the Dell Embedded Remote Access (ERA) controller or support the Embedded Remote Access

Option (ERA/O). Older systems support variations of the ERA controller such as the Dell Remote Access Card III (DRAC III) and DRAC III/XT, which provide a subset of the functionality that the ERA controller offers.⁹

ASR recovers a failed system and restores system state

ASR is an advanced option of the Windows Server 2003 Backup Tool that allows administrators to recover a failed system and restore it to the configuration that was most recently backed up. In Windows Server 2003, ASR takes the place of the Emergency Repair Disk feature found in earlier Microsoft server operating

⁸ In this article, Dell Remote Access Card III (DRAC III), DRAC III/XT, Embedded Remote Access (ERA), and Embedded Remote Access Option (ERA/O) are collectively referred to as RACs. When information applies only to a specific RAC, it is identified explicitly.

⁹ For more information on Dell RACs, visit <http://support.dell.com/docs/software/smdrac3/RAC/en/is/racug1.htm#28099>. To access the user guides for the different RACs, visit <http://support.dell.com/docs/software/smdrac3/index.htm>.

systems. *Note:* It is highly recommended that ASR be used only after all other system recovery methods have been attempted and the only remaining option is to reformat the disk and reinstall the OS.

The advanced recovery options discussed thus far are tools that can be used to attempt to recover a failed system without requiring any prerequisites such as a system backup. With the ASR Backup utility, administrators can initiate periodic backups of server system state and then, with the ASR Restore utility, use these backup files to attempt to restore system state when a server encounters a critical failure.

Without a backup, ASR Restore will not be able to restore a failed system. In such cases, the only option to recover the system is for administrators to reinstall the OS and reconfigure all physical storage manually.

ASR allows for the restoration of system state, critical files on the system, and boot partitions. System state includes the following:

- Boot files and system files
- Files protected by Windows File Protection (WFP)
- The registry
- Performance counter configuration information
- The Component Object Model+ (COM+) class registration database
- The certificate services database (if the server is a Microsoft Certificate Server)
- Microsoft Active Directory® directory service database
- The sysvol directory (if the server is a domain controller)
- Cluster database information (if the server is a node in a cluster)
- Internet Information Services (IIS) metabase (if the server has IIS installed)


Backing up user data is critical and should be implemented as a separate process from ASR, which is not a data backup utility. Although ASR can restore data files that are in the system or boot volumes, it does not restore data files that reside in other logical or physical partitions or volumes. However, if the disks that host the data volume are not corrupted, they may be accessible once ASR restoration is complete.

An ASR restoration typically follows these steps:

- Rebuild the critical volumes (volumes that host the OS) using the information stored in a floppy disk that was created during ASR backup.
- Perform a simple installation of Windows Server 2003 using the Windows Server 2003 installation CD.
- Begin the restoration automatically from the media on which the ASR backup was created.

For step-by-step instructions on how to use ASR for backup and restore operations, visit *Dell Power Solutions* online at http://www.dell.com/magazines_extras.

Developing more robust recovery mechanisms

With the introduction of EMS and enhanced ASR features, Windows Server 2003 offers IT organizations robust system recovery options. Dell PowerEdge servers provide the required hardware and software stack that further expedites system recovery. In the future, the Dell OpenManage systems management suite will introduce enhanced support for EMS and other recovery options that will allow administrators to use more robust and standardized Ethernet-based out-of-band mechanisms to handle system recovery. 

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FOR MORE INFORMATION

Disaster recovery:

http://www.microsoft.com/technet/treeview/default.asp?url=/technet/prodtechnol/windowsserver2003/proddocs/entserver/concepts_recovery.asp

Microsoft Emergency Management Services:

http://www.microsoft.com/technet/treeview/default.asp?url=/technet/prodtechnol/windowsserver2003/proddocs/entserver/ems_topnode.asp

<http://www.microsoft.com/whdc/hwdev/platform/server/headless/default.msp>

Microsoft Automated System Recovery:

http://www.microsoft.com/technet/treeview/default.asp?url=/technet/prodtechnol/windowsserver2003/proddocs/entserver/asr_overview.asp

Dell remote access controllers:

<http://support.dell.com/docs/software/smdrac3/RAC/en/is/racugc1.htm#28099>

<http://support.dell.com/docs/software/smdrac3/index.htm>

http://www1.us.dell.com/content/topics/global.aspx/power/en/ps2q02_bell?c=us&cs=555&l=en&s=biz