



Data Center Availability Features for High-End Servers

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Data Center Availability Features for High-End Servers

This article describes the System Management Services (SMS) 1.4.1 software features that enhance high-end server availability. This document is useful for support personnel who have a basic knowledge of high-end server systems. This article applies to Sun Fire™ E20K/E25K servers and Sun Fire 15K/12K servers.

In a mission critical environment, high availability is achieved by system resiliency, appropriate configuration, serviceability, and efficient and automated restoration processes. The SMS 1.4.1 software enhancements address all of these elements and increase availability, serviceability, and diagnosability of high-end server systems.

The SMS software, which runs on the System Controllers (SCs) of high-end servers, can detect domain hangs and stops, then recover from such situations by resetting and rebooting the domain. The power-on self-test (POST) runs at increasing diagnostic levels when the domain panics repeatedly. POST allows the system to identify and isolate persistent hardware faults.

Standardized messages, component health status, and automatic diagnosis are powerful features for users and service providers. When combined with dynamic reconfiguration (DR), automatic diagnosis on high-end server systems greatly increases availability and decreases the scheduled downtime for maintenance.

This article contains the following topics:

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Requirements

To take advantage of the high-end server system's availability enhancements in the SMS 1.4.1 software, the domains must have Solaris Operating Environment (Solaris OE) version 8 (02/04) or version 9 (04/04) with required patches. (See "Solaris OE Enhancements" on page 12 for details).

The SCs can be run with Solaris OE version 8 (02/02) or Solaris OE Version 9 (04/04).

Note – For Ultra IV system boards, you need Solaris OE version 8 (02/04) and required patches.

Additionally, you must install the following patch updates:

- If using Solaris 8 OE, with patch 108528-29 and patch 117000-03 or newer.
- If using Solaris 9 OE, with patch 112233-12.

New Features

New SMS 1.4.1 features improve the availability, serviceability, diagnosability, and recovery characteristics of high-end server systems.

The features included in SMS 1.4.1 are the following:

- Automatically diagnose causes of domain faults
- Provide actionable repair information through Component Health System (CHS)
- Enhance automatic system restoration capability by removing faulty resources from the system configuration
- Enable more efficient remote support capabilities through event error logging and event reporting

The following paragraphs describe the features in the SMS 1.4.1 software and how they relate to improving availability for these systems.

Automatic Diagnosis

When certain hardware errors occur in a domain, the SC performs the diagnosis and domain recovery steps. The automatic diagnosis (AD) software consists of three different diagnostic engines (DE).

- The SMS DE diagnoses hardware errors associated with the domain stop (DStop).
- The Solaris DE identifies nonfatal domain hardware errors, and reports them to the system controller.
- The POST DE identifies any hardware test failures that occur when the power-on self-test (POST) is run to bring up the domain.

By default, the AD process is enabled. The following sections describe the diagnosis and recovery steps that occur for the hardware errors identified by each diagnostic engines.

SMS Diagnostic Engine

FIGURE 1 describes the flow of the automatic diagnosis and automatic recovery process.

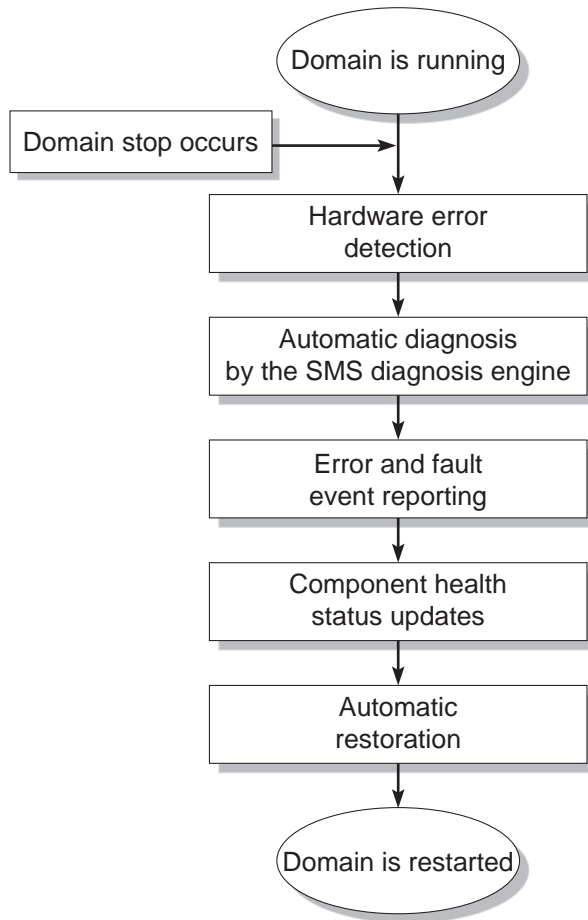


FIGURE 1 Automatic Diagnosis and Recovery Process for Hardware Errors With Domain DStop

The SC performs a `Dstop` when hardware errors involving CPU boards, processors, I/O controllers, and memory banks are detected. A dump file is generated when `Dstop` occurs.

Then SMS DE determines the failure, based on the errors captured in the `Dstop` dump file. The SMS DE identifies one or more components responsible for the errors.

Autodiagnosis lists the error events reported by the error reporting daemon (ERD), in the configured reporting channels, such as the message log and email.

Additionally, the event log access daemon (ELAD) records the information in the event log.

The SMS DE records the diagnosed fault of each component by updating the CHS on that component.

As a part of domain restoration, the POST reviews the updated CHS information to determine which component to remove from the domain configuration. The appropriate components are then deconfigured, and the domain is restarted.

Solaris Diagnostic Engine

FIGURE 2 shows the automatic diagnosis process for nonfatal domain hardware errors.

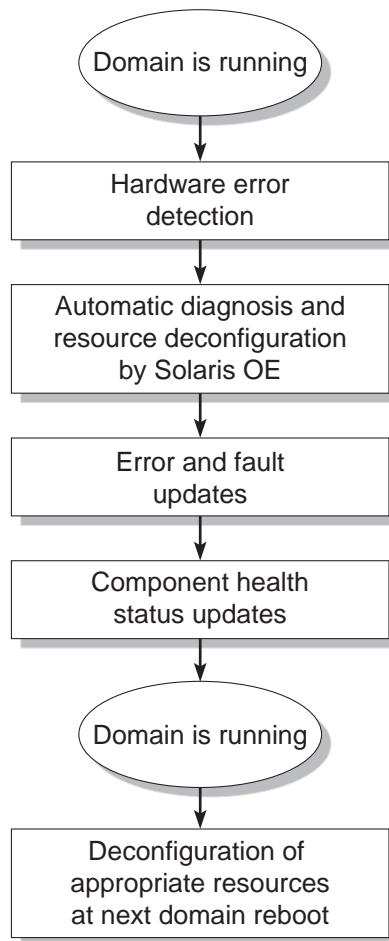


FIGURE 2 Automatic Diagnosis for Nonfatal Domain Hardware Errors

The Solaris OE determines when a nonfatal hardware error has occurred and reports it to the SC. In this case, the domain is not stopped. The Solaris OE identifies the failure and the components that caused the failure. If appropriate, the Solaris OE might also deconfigure the component. For example, a CPU might be taken offline because of nonfatal errors that occur within the module, or a virtual memory page might be retired due to errors contained in the page.

The diagnostic information is then handled through the same channel as the SMS DE, and event messages are generated. These list events are then reported by ERD and recorded by ELAD. Then the SMS DE records the diagnosis error in each of the components by updating the CHS on that component.

As stated earlier, the domain is not stopped, and resources are removed by POST from the domain configuration at the next domain reboot.

POST Diagnostic Engine

FIGURE 3 shows the POST diagnosis process.

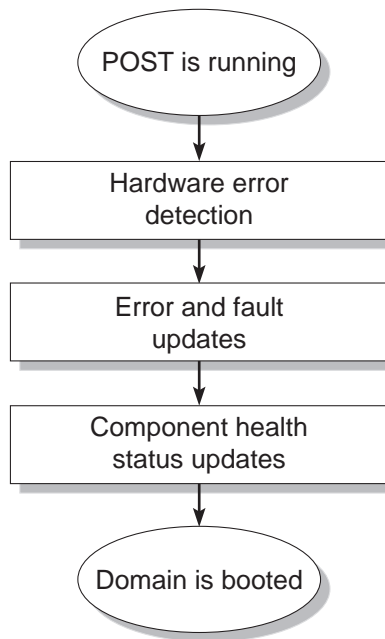


FIGURE 3 POST Diagnosis Process

Whenever POST is run to test and configure the domain, any components that fail during the self-test are reported to SMS.

SMS records the diagnosed fault in each of the components by updating the CHS on that component. The appropriate components are then removed from the domain configuration and the domain is booted.

If AD determines that a single component is at fault, the CHS for that component is marked as faulty. If it indicates that more than one component could be at fault, all possible components are marked as suspect.

Note – It is possible that not all the components listed are faulty. The hardware error could be caused by a smaller subset of the identified components. Further analysis might be required to determine which field-replaceable units (FRUs) are faulty.

Component Health System (CHS)

This feature records the CHS of each component in the system.

The SMS `disablecomponent` command blacklists the component. The blacklisted component is location based; that is, if a system board in expander 1 is moved to expander 2, the system board slot of expander 1 is still blacklisted, and the system board now in expander 2 can be integrated into a domain.

The new functionality uses CHS to mark the component as faulty. In the previous example, the status of system board 1 is stored with the component, and it is not integrated into a domain by POST, even though the board is moved to expander 2.

CHS is stored in the FRU's SEEPROM. The FRUs with a faulty CHS can be removed from the resource pool without the use of blacklisting.

Automatic Restoration

Automatic restoration occurs on the domain after the fault is isolated.

The SMS software has automatic system recovery (ASR) features. If the `reboot_on_error` flag is set, the domain is restarted with a minimum level of POST and might not reconfigure the faulty component.

During the domain initialization, the new functionality allows POST to query whether a resource should be excluded from a domain configuration due to CHS. If the component is faulty, POST does not configure it in the domain configuration.

Also, if POST can determine that a single component is at fault, the CHS for that component is marked as faulty.

Error Event Logging

Enhancements were made to the Solaris OE to improve the availability of the domain. The SMS 1.4.1 software error event feature reports events in compliance with the changes to Solaris OE. For more information about Solaris OE availability features, refer to the Sun BluePrints™ OnLine article “Solaris Operating System Availability Features.”

The SMS error handling is processed by the error and fault handling daemon (EFHD). This daemon collects all relevant error information and creates the fault and list events in addition to the error events. A fault event represents a diagnosed fault that caused one or more error events. All fault events are encapsulated into one list event.

If a single fault event is present, the diagnosis is unambiguous. However, if more than one fault event exists, any of the faults could be the cause of the errors.

The SMS error reporting daemon (ERD) is responsible for sending the events to the message log and other possible reporting channels, such as emails, Sun Management Center software, and System Resources Services.

The SMS event log access daemon (ELAD) records the events and provides an interface that is used by the SMS `showlogs` command to view the event log.

Event Reporting

Event reporting uses four different channels to report events:

- Text messages
- Sun Management Center software
- Email
- Remote services using Sun Remote Services Net Connect

Text Messages

The error events are logged into the platform messages log and appropriate domain message log. These text messages are in a single-line standard format, with enough information to help service personnel troubleshoot the problem.

The following example shows the text message template.

```
<initiator> Event: <> CSN: <> DomainID: <> ADInfo: <> Time: <>  
Recommended Action: Service action required
```

The following shows a text message example for DStop.

```
[AD] Event: SF15000-8001-0W CSN: 053A2003 DomainID: A ADInfo:  
1.SMS-DE.1.4.1 Time: Fri Jul 11 14:26:36 PDT 2003 Recommended-  
Action: Service action required
```

The following shows a text message example for POST test failure.

```
[AD] Event: SF15000-8001-DE CSN: 053A2003 DomainID: A ADInfo:  
1.POST-DE.1.4.1 Time: Fri Jul 11 14:30:36 PDT 2003 Recommended-  
Action: Service action required
```

The following shows a text message example for domain Solaris.

```
[DOM] Event: SF15000-8000-FF CSN: 053A2003 DomainID: B ADInfo:  
1.SF-SOLARIS-DE.1 Time: Thu Jul 31 08:37:54 PDT 2003 Recommended-  
Action: Service action required
```

Sun Management Center Software

The event reporting daemon in the SMS software generates SMS events. These SMS events are handled by Sun Management Center software Event Front-End (EFE) daemon.

These SMS events contain event class, event code, and the Sun Fire chassis serial number (CSN). The Sun Management Center platform agent then issues a Sun Management Center text message for display on the Sun Management Center console.

Email

By default, SMS does not generate email messages. You need to configure the email list by fault classes, domains, and recipients. The sample template of the email message form is included with SMS software in `$SMSETC/config/templates/sample_email`.

The sample template needs to be customized by substituting tags with fault information. A standard shell script is included for sending email. This script can be replaced with a customized shell script.

The script needs to be customized for the correct recipients, desired faults, and domains. The email control file, `event_email.cf`, contains the email notification parameters. These parameters identify the email recipient based on the event class and domain in which the event occurred and whether the event message structure is sent as an attachment with the event email.

Use the `testemail` command to verify that the email event notification works properly. This command is at `/opt/SUNWSMS/SMS/lib/smsadmin/testemail`.

The following is an example of email received.

```
Date: Tue, 19 Aug 2003 10:45:28 -0600 (MDT)
Subject: FAULT: SF15000, serial# 352A0007, code SF15000-8000-GK
From: FMA@xyz.com
To: undisclosed-recipients:;

FAULT: SF15000, serial# 352A0007, code SF15000-8000-GK
Fault event in domain(s) A at Tue Aug 19 10:45:18 MDT 2003.
Fault severity = SMIEVENT_SEV_FATAL <7>
Indictment Count: 2
Indictment list:
sb11
ex11
```

For complete details about event tags described in the email template file, refer to the *System Management Services (SMS) 1.4.1 Administrator Guide*.

Support Utilities

Two new commands, `showlogs` and `testemail`, support the new availability functions.

`showlogs` Command

The SMS `showlogs` command is updated to view the error event reports.

The parameter `-E` in the `showlogs` command formats and condenses the event log information displayed.

The option `-p e` displays the event log according to the arguments passed to the option.

The `showlogs` event output supplements the diagnosis information presented in the platform and domain message logs or event emails. The `showlogs` event output can be used for additional troubleshooting purposes.

testemail Command

Use the `testemail` command to test the email setup and verify email-generated reports. This command ensures that the reports contain the proper domain information, faults, and recipients.

Solaris OE Enhancements

The Solaris OE includes features aimed at enhancing availability by helping the system react better to normally occurring error conditions. These features were improved in recent kernel updates.

Kernel and patch updates for Solaris 8 OE and Solaris 9 OE on UltraSPARC™ III systems enhance the correctable error (CE) L2_SRAM module handling. Multiple CEs on accessing an L2_SRAM module indicate a higher probability of experiencing an uncorrectable error (UE). To prevent a fatal UE, the Solaris OE attempts to take CPUs offline. The availability of domains increases because the Solaris OE does not access L2_SRAM modules that have an increased failure probability.

Solaris 8 OE with patch update 108528-20 and Solaris 9 OE with patch update 112233-06 introduce an enhanced L2 cache error-handling technique called processor offlining.

Solaris 8 OE with patch update 108528-24 and Solaris 9 OE with patch update 112233-11 introduced an enhanced memory DIMM error-handling technique called page retirement. Subsequent kernel update patches modify the behavior of the initial implementations. The aggressive page retirement feature was implemented in the release of Solaris 8 OE with patch update 117000-03 and Solaris 9 OE with patch update 112233-12.

The Solaris 8 OE kernel update underwent a patch rejuvenation process, which changed its base patch number from 108528 to 117000. Refer to Sun Alert Notification 57489 for further details.

If the system is using the appropriate kernel update, a message is sent to the SC when the Solaris OE identifies and isolates a faulty L2_SRAM module. The failed L2_SRAM module is not reconfigured into a domain on future domain reboots or `setkeyswitch off` and `setkeyswitch on` operations, because the SC has recorded the component as faulty in its CHS.

As with the memory page retirement, the Solaris OE keeps track of the number of ECC errors over time on an L2_SRAM module (see FIGURE 4). Two types of ECC errors are considered here—nonfatal multibit errors (UCU, CPU, WDU, EDU) and nonfatal single-bit correctable errors (UCC, CPC, WDC, EDC). If an L2_SRAM module experiences one nonfatal multibit error or three single-bit correctable errors

in a 24-hour window, the L2_SRAM module is diagnosed with an increased probability of suffering a fatal failure in the future. In this scenario, the Solaris OE has been enhanced to automatically attempt to take the affected CPU module offline. It is possible that the CPU offline might not succeed, because there might be processes bound to the CPU.

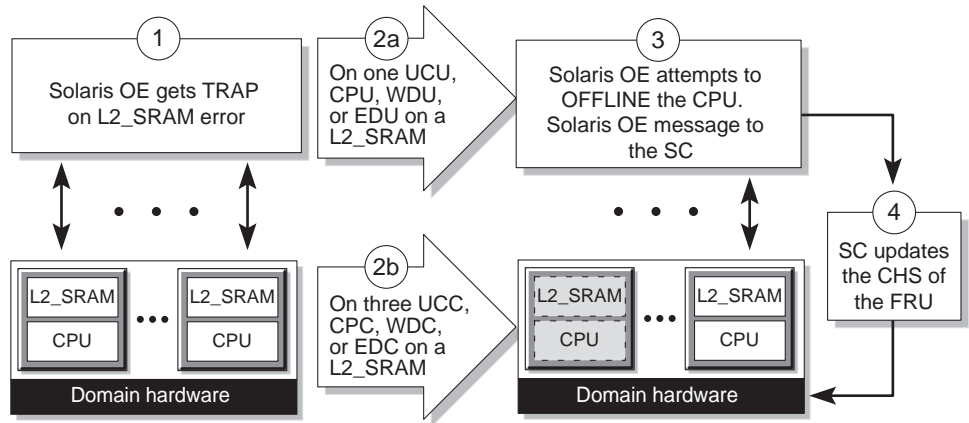


FIGURE 4 Solaris OE L2_SRAM Error Handling

The following code example shows the messages that are displayed after successfully taking a CPU offline that experienced more than three CE events in a 24-hour period.

```
Feb  3 06:38:40 doma SUNW,UltraSPARC-III: NOTICE: [AFT1] CPU6
offline due to more than 3 xxC Events in 24:00:00 (hh:mm:ss)
```

Once a CPU is taken offline, the Solaris OE sends a message to the SC. The SC updates the CHS of the affected FRU so that the faulty CPU is not configured into a domain on future reboots or `setkeyswitch off` and `setkeyswitch on` events.

Taking offline the CPU associated with L2_SRAM modules with a higher probability of experiencing fatal errors increases the availability of the Solaris OE. Communication between the Solaris OE and the SC to persistently store the CHS increases availability and provides easier diagnosis and serviceability of the system. Dynamically reconfigured CPU/memory boards can be replaced with minimal impact to the Solaris OE and user applications.

The aggressive page retirement feature in Solaris 8 OE with patch update 117000-03 and Solaris 9 OE with patch update 112233-12 improves the effectiveness of the existing page retire functionality in Solaris OE, by removing the physical page from use by Solaris OE. This page will not be allocated by either the Solaris OE or a user application for the lifetime of this instance of Solaris.

The software disables the failing portion of the memory dual in-line memory module (DIMM) by eliminating the need to replace the DIMM. The DIMM is marked as faulty, and it is removed after a reboot or using DR at later time.

For more information about the aggressive page retirement in Solaris OE, refer to the Sun BluePrints OnLine article titled “Solaris Operating System Availability Features.”

About the Author

Vasant Butala joined the PTS Americas High-End Server Group (HSG) in May 2002 and provides support for the Sun Fire 15K and Sun Enterprise™ 10000 platforms. Vasant has worked with High Performance Computing (HPC) areas for almost three decades. While working for Control Data Corporation, ETA, Cray Research, and Sun, he supported customers worldwide on large complex systems. He has administered large systems such as CDC 205, ETA-10, and Cray Supercomputers at Florida State University, Princeton University, German Weather Service, NASA, and other organizations. He worked on the CS6400, which was a part of Cray Superserver. As a technical consultant for HPC in Sun's Education Market, he helped customers with technical requirements, configuration issues, and optimizing and tuning HPC applications. He has presented papers at conferences and received the Gigaflop Performance award at a Super-Computing (SC) Conference. Vasant holds a Master of Science degree from the University of Minnesota.

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Related Resources

Publications

- Chalfont, Thomas. "Solaris Operating System Availability Features," Sun BluePrints OnLine, May 2004.
<http://www.sun.com/blueprints/0504/817-7039.pdf>.
- Gonscherowski, Peter and Wittsack, Tricia. "Sun Fire™ 6800/4810/3800 Auto Diagnosis and Recovery Enhancements: Updated for Firmware Release 5.17.0," Sun BluePrints OnLine, April 2004. <http://www.sun.com/blueprints/0404/817-6212.pdf>.
- Sun Microsystems, Inc. *Sun Fire 15K/12K Software Overview Guide*, Part No 817-3075-10, http://www.sun.com/products-n-solutions/hardware/docs/Servers/High-End_Servers/Sun_Fire_15K/SW_FW_Documentation/SMS/index.html.
- Sun Microsystems, Inc. *System Management Services (SMS) 1.4.1 Installation Guide*, Part No 817-3055-10, http://www.sun.com/products-n-solutions/hardware/docs/Servers/High-End_Servers/Sun_Fire_15K/SW_FW_Documentation/SMS/index.html.
- Sun Microsystems, Inc. *System Management Services (SMS) 1.4.1 Release Notes*, 817-3058-10, http://www.sun.com/products-n-solutions/hardware/docs/Servers/High-End_Servers/Sun_Fire_15K/SW_FW_Documentation/SMS/index.html.
- Sun Microsystems, Inc. *System Management Services (SMS) 1.4.1 Administrator Guide*, Part No 817-3056-10, http://www.sun.com/products-n-solutions/hardware/docs/Servers/High-End_Servers/Sun_Fire_15K/SW_FW_Documentation/SMS/index.html.
- Sun Microsystems, Inc. *System Management Services (SMS) 1.4.1 Reference Manual*, Part No 817-3057-10, http://www.sun.com/products-n-solutions/hardware/docs/Servers/High-End_Servers/Sun_Fire_15K/SW_FW_Documentation/SMS/index.html.

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- System Management Services Software: <http://www.sun.com/servers/highend/sms.html>.
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