Sun Fire™ Hardware Midrange Servers Auto Diagnosis and Recovery Enhancements

Updated for Firmware Release 5.17.0

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Sun BluePrints™ OnLine—April 2004

http://www.sun.com/blueprints

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Part No. 817-6212-10
Revision A, April 2004

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Sun Fire™ Hardware Midrange Servers Auto Diagnosis and Recovery Enhancements

This article describes the Sun Fire™ hardware midrange servers availability enhancements provided in system controller (SC) firmware versions 5.15.0 through 5.17.0 and the required minimum Solaris OE kernel updates. This document is useful for support personnel who have a basic technical knowledge of the Sun Fire midrange servers.

This article covers the following topics:

- System Controller Firmware Enhancements
- Solaris OE Enhancements

Enhancements have been added to both the Solaris™ Operating Environment (Solaris OE) and the Sun Fire firmware release versions 5.15.0 through 5.17.0. Improved auto diagnosis of hardware failures and system recovery are now available. These enhancements achieve increased availability and better serviceability of the Sun Fire midrange servers. Firmware versions 5.15.0 through 5.17.0 and either the Solaris 8 OE kernel update 24 or Solaris 9 OE kernel update 9 are required to benefit from these enhancements.

TABLE 1 lists the patches needed to benefit from the Sun Fire midrange servers auto diagnosis and recovery enhancements.

TABLE 1 Minimum Required Patches for Auto Diagnosis and Recovery Features

	Sun Fire Firmware Release	Solaris 8 OE	Solaris 9 OE
Sun Fire™ 3800-6800 servers	5.15.0	Solaris 8 kernel update 108528-24	Solaris 9 kernel update 112233-09 with patch 116009-01
Sun Fire™ 4900-6900 servers	5.16.0	Solaris 8 kernel update 108528-28	Solaris 9 OE update 6
Sun Fire™ V1280, Netra 1280, and Netra 2900 servers	5.17.0	Solaris 8 kernel update 108528-24	Solaris 9 kernel update 112233-09 with patch 116009-01

Sun Fire firmware release 5.17.0 introduces support for the Sun Fire V1280, Netra 1280, and Netra 2900 servers and the ability of persistent logging of certain types of error messages and message logs if the platform is using system controller (SC) V2 components (enhanced-memory system controllers). Sun Fire firmware release 5.16.0 introduces support for the Sun Fire 4900-6900 servers and incorporates all the auto diagnosis and recovery features of firmware release 5.15.3. Sun Fire firmware release 5.15.3 when used with the appropriate Solaris OE (Solaris 8 KU-108528-24 and Solaris 9 KU-112233-09 with patch 116009-01) introduces the ability for the SC to receive hardware failure messages from the Solaris OE. The 5.15.3 functionality ensures that hardware failures identified by the Solaris OE are not configured in future reboots or `setkeyswitch on` and `off` events. In Sun Fire firmware release 5.15.0, several enhancements were made to improve the availability, serviceability, diagnosability, and repair characteristics of Sun Fire midrange servers. This document discusses both the existing firmware release 5.15.0 enhancements, the additional firmware release 5.15.3 enhancements, and the recent firmware release 5.16.0 and 5.17.0 enhancements:

- Sun Fire firmware release 5.15.0 enhancements:
  - Auto diagnosis—Automated diagnosis of runtime hardware faults
  - Component health status—Persistent record of the information stored in the component
  - Auto restoration—Automatic restoration of a domain
  - Domain hang recovery—Detects and recovers from a domain hang
  - Repeated domain panic recovery—Runs power on-self test (POST) at increasing diagnosis levels to identify and isolate the faulty hardware (if any)

- Sun Fire firmware release 5.15.3 enhancement:
  - Persistent record of hardware failures identified by the Solaris OE—Receives hardware failure messages from the Solaris OE and stores the component health status in the affected FRU
- Sun Fire firmware release 5.16.0 enhancement:
  - Support for Sun Fire 4900 and 6900 servers.
- Sun Fire firmware release 5.17.0 enhancements:
  - Persistent logging of certain SC error messages and message logs—SC platform and domain logs and the error buffer now survive an SC reboot to ensure events are available for analysis in the event the SC is rebooted if the platform is using SC V2 components (enhanced-memory system controllers).
  - Support for Sun Fire V1280/Netra 1280 and Netra 2900 servers.

Additionally, some enhancements have been made in the Solaris OE to improve the availability of the domain:

- CPU off-lining—Off-line a CPU when an L2_SRAM module has an increased probability of experiencing fatal errors
- Communicate hardware failures to the system controller—Sends a message to the system controller when the Solaris OE identifies and isolates a faulty component (off-lined CPU modules only at this time)
- Memory Page Retirement—Retires memory pages that have an increased probability of experiencing fatal errors

System Controller Firmware Enhancements

When the system encounters a fatal hardware error that causes a domain to be *error paused*, the hardware fault is automatically diagnosed. The auto diagnosis (AD) enhancement updates the component health status (CHS) on the affected FRU if the hardware failure can be isolated to a specific FRU or a set of specific FRUs. During the automatic restoration phase, POST consults the CHS and restores the domain with the fault isolated.

In addition to the preceding enhancements, if POST encounters a test failure, the CHS is stored in the appropriate FRU.

The SC firmware is enhanced to detect domain hangs and recover from such situations by resetting and rebooting the domain. Another SC firmware enhancement runs POST at increasing diagnostic levels when the domain panics repeatedly, so that the system can identify and isolate any persistent hardware faults.

Auto Diagnosis

The SC monitors the domains for hardware faults. AD is automatically invoked on hardware faults that cause a *domain pause* or *data parity errors.* On Sun Fire midrange servers the data path is protected by parity and ECC. Domain operation is not impacted if data parity errors occur. Domain pauses are fatal errors and stop domain operation. AD analyzes the following errors:

- Interconnect errors
- Data parity errors
- Internal ASIC errors

FIGURE 1 shows the AD phase, Steps 1 through 5. Depending on the fault, three types of diagnosis results are possible:

- Fault diagnosed to a single component
- Fault diagnosed to a set of components
- Unresolved fault diagnosis

Note that when a fault is diagnosed to a set of components, it does not mean that all the components are faulty, just that the fault is located in a subset of these components (usually one).

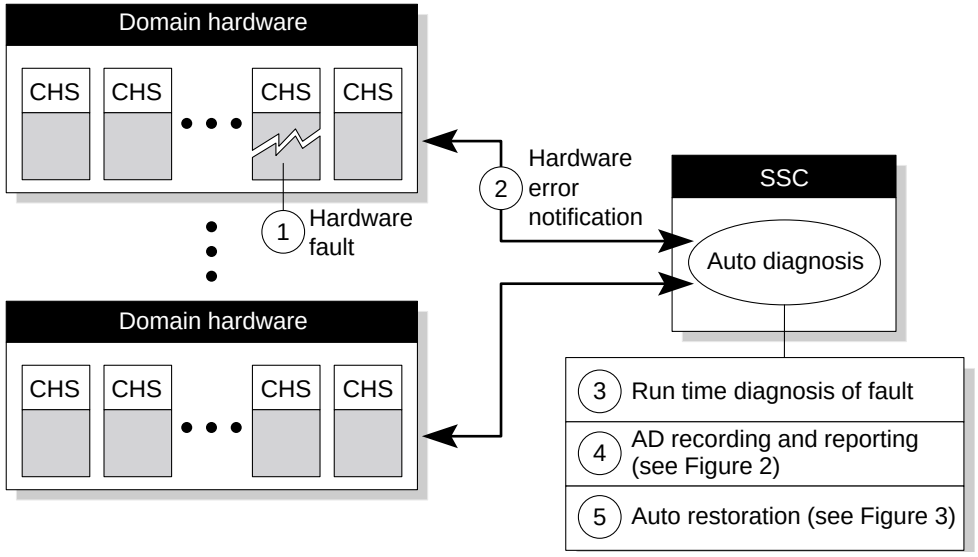

FIGURE 1 Auto Diagnosis Process

Auto Diagnosis Recording and Reporting

After the fault has been diagnosed, AD records its diagnosis persistently in the CHS and reports it to the domain console and loghost as shown in FIGURE 2.

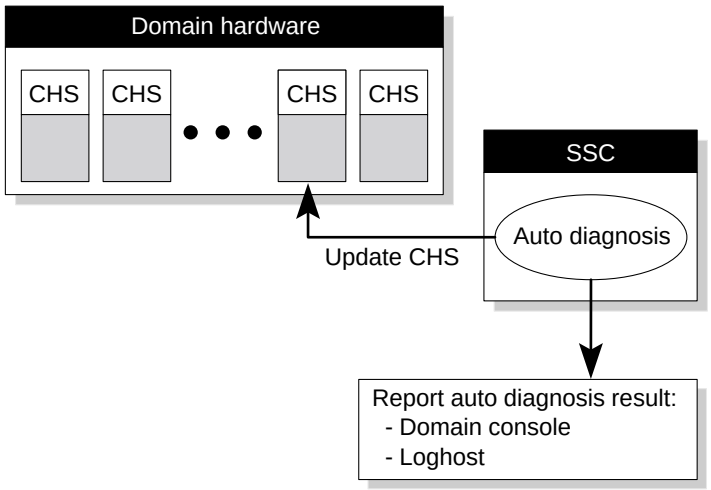

FIGURE 2 Auto Diagnosis Recording and Reporting

TABLE 2, "Example 1," shows the AD result that is output to the domain console for a single FRU diagnosis.

TABLE 2 Example 1

```
[AD] Event: SF3800.ASIC.SDC.PAR_SGL_ERR.60111010
     CSN: 124H58EE  DomainID: A ADInfo: 1.SCAPP.15.0
     Time: Thu Jan 23 20:47:11 PST 2003
    FRU-List-Count: 1;FRU-PN:5014362;FRU-SN: 011600; FRU-LOC:/N0/SB0
     Recommended-Action: Service action required
```

AD reports a unique event code for the failure type and the diagnostic time. A full description of the AD output format is in the S*un Fire 6800/4810/4800/ 3800 Systems Platform Administration* manual. In this example AD determined that the error is within CPU/Memory board at FRU-LOC:N0/SB0.

The reported information enables your service provider to make a quick determination of the problem and initiate corrective service action.

CHS on Sun Fire midrange servers is implemented for the following FRUs and components:

- CPU/Memory boards
- CPUs

- L2_SRAM modules
- DIMMs
- I/O assemblies
- Fireplane switches

Since the CHS and diagnostic information is persistently stored on a component, it moves with the component, which prevents the recurrence of a fault even if the component is moved to a different location. Preventing the recurrence of a fault improves the availability characteristic of Sun Fire midrange servers. The diagnosis information is contained inside the component. This makes service and repair of these systems easier.

Auto Restoration

POST performs the domain auto restoration function. POST runs automatically after AD or it is manually started by issuing the `setkey` command on the SC. POST consults the CHS of the domain hardware and reconfigures the domain to isolate the fault (FIGURE 3).

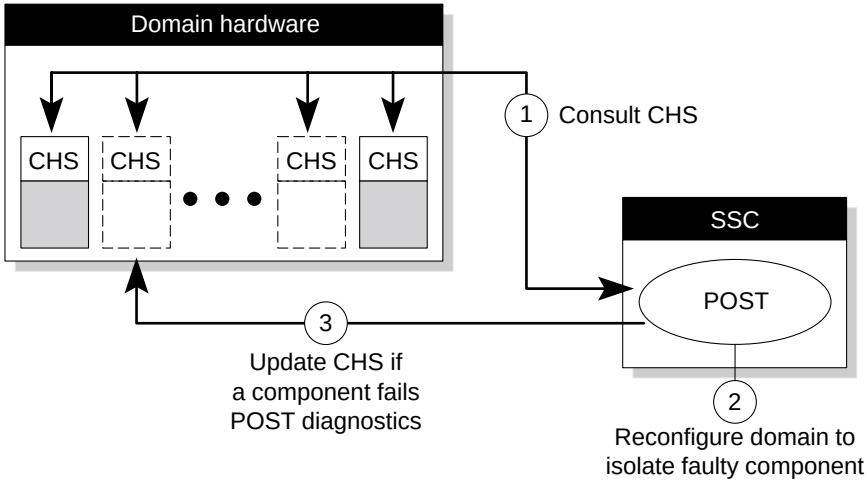

FIGURE 3 Auto Restoration

After the domain has been restored, you can run the `showcomponent` command to check which components have been disabled due to CHS.

If a FRU or component is disabled because of its CHS, immediate replacement is not necessary because the domain is restored with the fault isolated. Utilizing dynamic reconfiguration (DR), the FRU can be replaced at any time with minimal impact to the Solaris OE and user applications. For more information about DR, see [1] *Sun BluePrints OnLine* article “Sun Fire™ 3800-6800 Servers Dynamic Reconfiguration.”

Domain Hang Recovery

A situation in which a domain is not updating its heartbeats or is unreachable by using the console is categorized as a *domain hang.* A domain's heartbeat is a communication mechanism that informs the SC that it is alive. If a domain is not updating its heartbeat, this indicates a domain hang. A domain hang can occur due to hardware or software issues.

When using firmware version 5.15.0 or above on a Sun Fire midrange servers, the SC acts as an external monitor for each domain. The SC monitors for a domain hang condition and initiates an XIR domain reset if the domain heartbeat register is not updated within the maximum time out limit. The domain heartbeat monitoring is configurable for each domain using the `watchdog_timeout_seconds` parameter in the `/etc/systems` file of each domain.

The default time out value for a domain is three minutes. For additional details, refer to the `system`(4) man page. If `watchdog_timeout_seconds` is set to a value less than three minutes, the SC defaults to three minutes.

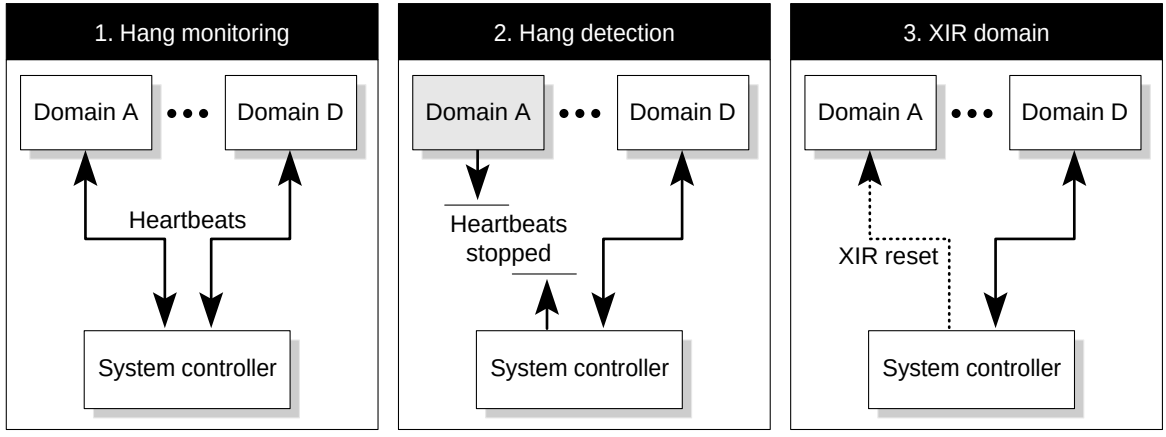

FIGURE 4 Domain Hang Restoration

TABLE 3, “Example 2,” shows the console output of a domain that was declared hung and was reset by the SC.

TABLE 3 Example 2

```
Jan 22 17:02:06 sc0 Domain-A.SC: Domain watchdog timer expired.
Jan 22 17:02:06 sc0 Domain-A.SC: Using default hang-policy (RESET).
```

In addition to the heartbeat monitoring, the SC also checks if the domain is picking up the interrupts sent to it by the SC. The SC sends interrupts to the domain when, for example, characters are entered on the domain console. If on a second interrupt, the previous one has not been picked up by the domain, the SC waits for one minute before declaring the domain hung. TABLE 4, “Example 3,” shows the console output of a domain that is hung because it has not been picking up its interrupts.

TABLE 4 Example 3

```
Jan 22 18:09:02 sc0 Domain-A.SC: Domain is not responding to interrupts.
Jan 22 18:09:02 sc0 Domain-A.SC: hang-policy is NOTIFY.  Not resetting domain.
```

The *hang policy* is set by the `setupdomain` command to `notify` or `reset`. If set to `notify`, the SC reports the hang condition on the domain console and does not reset the domains (TABLE 4, “Example 3”). If set to `reset`, the SC reports the hang condition on the domain console and initiates a domain reset (TABLE 3, “example 2”). By default the hang policy is set to reset. By default, the domain is also set up to dump core when it is reset through the error-reset-recovery variable of the `domainsetup` command. To identify the cause of the domain hang, consult your service provider while referring to the core file.

A system's hang-policy can be verified using the `showdomain` command in the domain shell.For more information about domain setup, refer to the *Sun Fire™ 6800/4810/4800/3800 Systems Platform Administration* manual.

Recovery From Repeated Domain Panics

Domain panics can be caused by software or hardware. To prevent hardware faults from causing panic-reboot loops, the SC firmware runs POST at increasing diagnostic levels on recurring panics.

On the first panic, the domain reboots and writes a core file, which can be used to analyze the problem. However, if further panics occur within a short time period, it is desirable to run POST automatically at a higher level as part of domain restoration. POST diagnostics verify the status of the hardware and could identify and isolate faulty components (if any). After identifying faulty components, POST updates the appropriate CHSs. With firmware release 5.14.0 and higher, the SC.

keeps track of the number of domain panics over time. A panic reboot of a domain has a unique register signature that differs from the normal reboot of a domain. If the domain is manually rebooted in the meantime, the panic-reboot counter is reset.

On recurring panics, the domain POST diagnostic level is increased to the next higher level from diag-level `quick`. In increasing order, POST levels are `init`, `quick`, `default`, `mem1`, and `mem2`. The domain is put into standby position if it continues to panic undetected by the user after the highest level of POST is run (FIGURE 5). For further analysis, consult your service provider while referring to the core file.

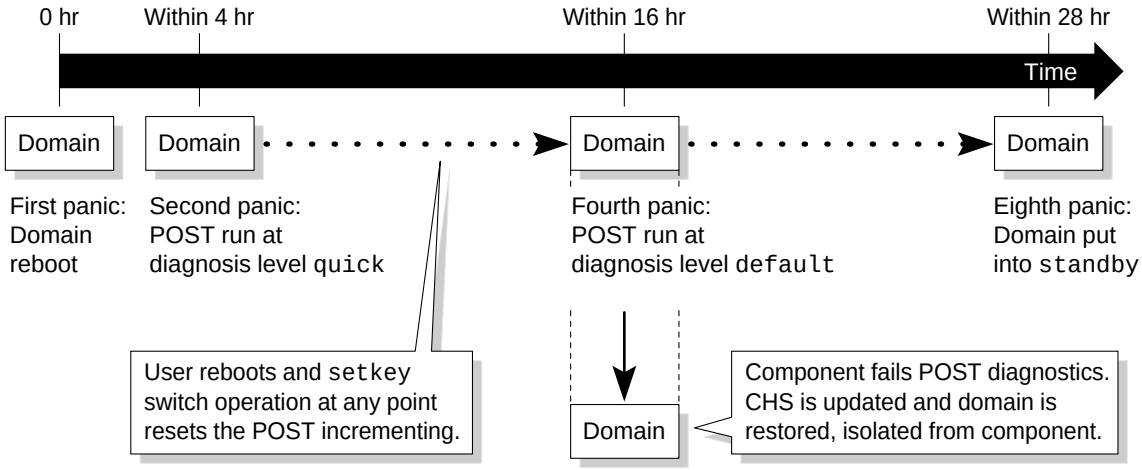

FIGURE 5 Domain Panic Restoration

This feature prevents a panic-reboot loop of domains. If recurring panics are caused by a software bug, the increased POST level minimizes hardware as a possible cause. Downtime for running further POST diagnostics is not required because the system automatically takes the necessary measures.

Persistent Record of Hardware Failures From the Solaris OE

As of Sun Fire firmware release 5.15.3, certain hardware failures diagnosed by the Solaris OE are persistent. The SC receives and stores hardware failure messages from the Solaris OE via internal platform communication structures if the system is using the appropriate Solaris kernel update that applies to Solaris 8 (KU-108528-24) or Solaris 9 (KU-112233-09). Solaris 9 kernel update -09 also requires patch 116009-01. Domain reboots and `setkeyswitch off` and `on` events no longer configure components that the Solaris OE has previously diagnosed as failed.

When the system controller receives a hardware event message from the Solaris OE, the SC updates the CHS of the affected FRU. Any future POST consults the CHS and does not configure any listed faulty components. System availability is improved as future domain configurations deconfigure the failed L2_SRAM modules. The Solaris OE can currently identify and isolate the following types of faults:

- L2_SRAM ECC SERD
- L2_SRAM ECC UC

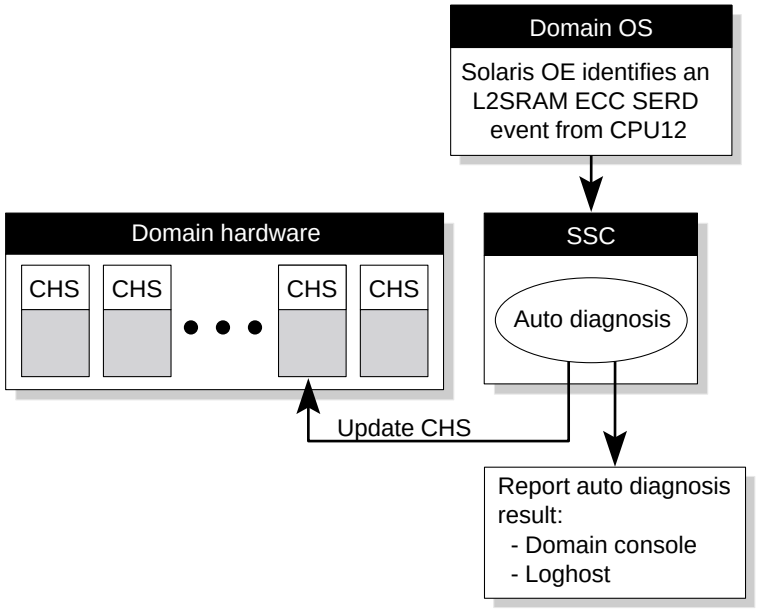

FIGURE 6 Persistent Failure Record

The soft error rate discrimination (SERD) algorithm detects when a specified number of distinct CPU events have occurred on the same processor in a 24-hour period. After the specified CPU SERD events, the CPU becomes a candidate for Solaris OE off-lining. The AD failure message (TABLE 5, “Example 4,”) specifies the phrase SF-SOLARIS-DE in the ADInfo Domain Log message to identify which hardware failures were received from the Solaris OE.

TABLE 5 Example 4

```
[DOM] Event: SF6800.L2SRAM.SERD.f.1b.10040000000091.f4470000
      CSN: 044M347B DomainID: A ADInfo: 1.SF-SOLARIS DE.5_9_GENERIC_112233-09
      Time: Mon Jun 02 23:34:59 PDT 2003
     FRU-List-Count: 1; FRU-PN: 3704125; FRU-SN: 090K01; FRU-LOC: /N0/SB3/P3/E0
      Recommended-Action: Service action required
```

The SC's persistent failure record of hardware faults identified by the Solaris OE improves availability. System service, diagnosis, and repair are also easier and quicker.

Persistent Logging of Certain SC Error Messages and Message Logs in SC V2 (Enhanced-Memory System Controllers)

In midrange systems configured with SC V2s (enhanced-memory system controllers), system error messages and six levels of messages (alert, critical, emergency, error, fault, warning) in the message logs are retained in persistent storage as of Sun Fire firmware version 5.17.0. This enhances service, diagnosis and repair as vital error messages and message logs are retained if the SC is rebooted or powered off.

- The persistent system error messages can be viewed by using the `showerrorbuffer` command
- The persistent logs can be viewed by using the `showlogs` command

The information displayed can be used by your service provider for troubleshooting purposes. For details on message logs and system error messages, refer to the Sun Fire Midrange Systems Platform Administration Manual and the `showlogs` and `showerrorbuffer` command descriptions in the *Sun Fire Midrange System Controller Command Reference Manual.*

Solaris OE Enhancements

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

The enhanced Solaris OE kernels have the ability to communicate hardware failures to the SC. If the system is using the appropriate kernel update for the Solaris 8 OE (KU-108528-24) or the Solaris 9 OE (KU-112233-09) with patch 116009-01, 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 `on` operations because the system controller has recorded the component as faulty in its CHS. Messaging from the Solaris OE to the SC for retired memory pages is not currently available as of Sun Fire firmware release 5.17.0.

CPU Off-lining

As of Solaris 8 KU 108528-20 and Solaris 9 KU 112233-09, the Solaris OE keeps track of the number of ECCs over time on an L2_SRAM module (FIGURE 7). Two types of ECCs 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 future. In this scenario, the Solaris OE has been enhanced to automatically attempt to off-line the affected CPU module. It is possible that the CPU off-line may not succeed because there might be processes bound to that CPU.

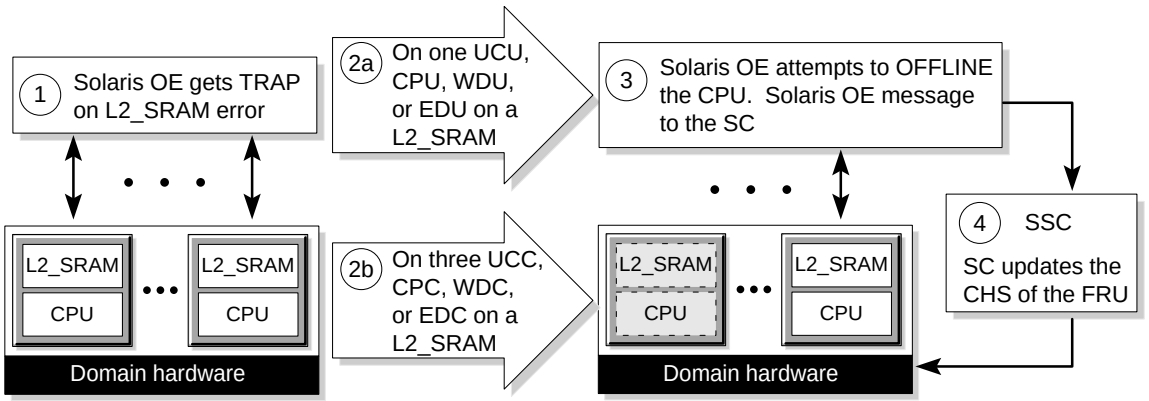

FIGURE 7 Solaris OE L2_SRAM Error Handling

TABLE 6, "Example 6," shows the messages on successfully off-lining a CPU that experienced more than two CE events in a 24-hour window.

TABLE 6 Example 6

```
Feb  3 06:38:40 doma SUNW,UltraSPARC-III: NOTICE: [AFT1] CPU6
offlined due to more than 2 xxC Events in 24:00:00 (hh:mm:ss)
```

Once a CPU is off-lined the Solaris OE sends a message to the system controller. The system controller 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 `on` events.

Off-lining the CPU associated with L2_SRAM modules with a higher probability of experiencing a fatal error increases the availability of the Solaris OE. Communication between the Solaris OE and the SC to persistently store the CHS increases Memory Page Retirement

The Solaris OE keeps track of the number of CEs over time on a DIMM. If more than three errors occur on the same DIMM within a 24-hour period, the domain automatically schedules retirement of the memory page if using the appropriate Solaris OE (Solaris 8 KU 108528-29 and patch 117002-03 or Solaris 9 OE Solaris 9 OE KU 112233-12)(FIGURE 8). Memory pages can be retired when all processes have released the page. Retired pages are not used by the domain. On a reboot, retired pages are used again by the domain.

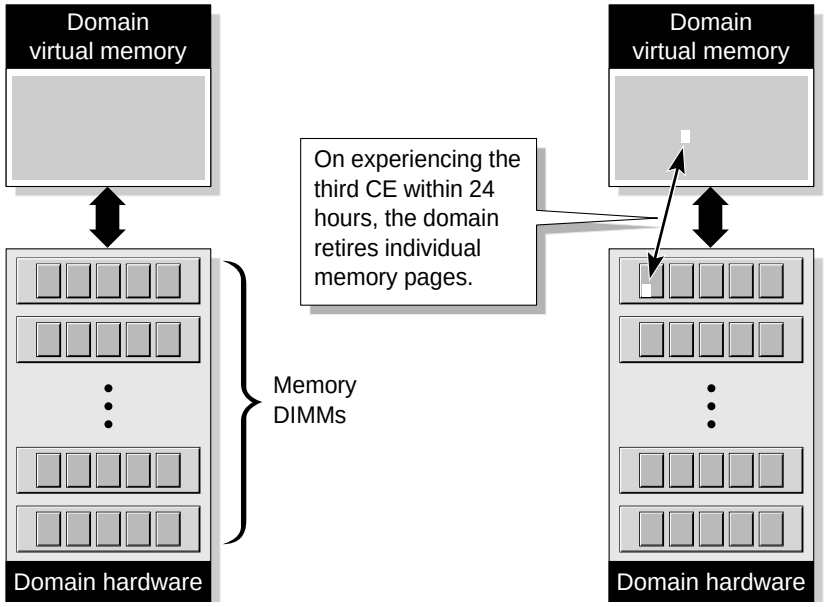

FIGURE 8 Solaris OE Memory ECC Handling

TABLE 4, "Example 4," shows the messages output when a memory page is retired. On a reboot, retired pages are accessible again for the domain.

TABLE 4 Example 4

```
Jan  7 04:14:07 doma unix: [ID 596940 kern.warning] WARNING: [AFT0]
3 soft errors in less than 24:00 (hh:mm) detected from Memory
Module Board 4 J3801

Jan  7 04:14:07 doma unix: [ID 618185 kern.notice] NOTICE:
Scheduling removal of page 0x00000001.2bf6c000

Jan  7 04:14:12 doma unix: [ID 693633 kern.notice] NOTICE: Page
0x00000001.2bf6c000 removed from service
```

Conclusion

To benefit from the auto diagnosis and recovery enhancements, upgrading to firmware version 5.15.3 and KU 108528-24 for Solaris 8 OE and KU 112233-09 for Solaris 9 OE plus patch 116009-01 is required. The additional memory page retirement enhancement requires Solaris 8 KU108528-29 and patch 117002-03 or Solaris 9 OE KU 112233-12. Sun Fire Firmware 5.17.0 and an enhanced system controller, SC V2, are required to benefit from the additional persistent logging enhancement. In a mission critical environment, high availability is achieved by system resiliency, the appropriate configuration, serviceability, and efficient and automated restoration processes. The enhancements made in version 5.15.3 address all of those elements and increase availability, serviceability, and diagnosability of Sun Fire midrange servers.

TABLE 5 lists the requirements for the various Auto Diagnosis and Recovery Features that are available for the Sun Fire 6800/4800/4810/3800 Systems. Note that SC firmware release 5.15.3 requires the domains use Solaris 8 KU24 or Solaris 9 KU6 with patch 116009-01. For additional patch IDs, refer to TABLE 1.

TABLE 5 Auto Diagnosis and Recovery Feature Firmware Requirements

SC firmware version	5.15.0 - 5.15.2	5.15.3	5.16.0	5.17.0
Auto diagnosis	√	√	√	√
Component health status	√	√	√	√
Domain hang recovery	√	√	√	√

TABLE 5 Auto Diagnosis and Recovery Feature Firmware Requirements *(Continued)*

Repeated domain panic recovery	√	√	√	√
Persistent updating of CHS by the Solaris OE for CPU off-line for L2_SRAM conditions		√ With either Solaris 8 KU 24 (108528-24) or Solaris 9 KU 09 (112233-09) and patch 116009-01	√ With either Solaris 8 KU 24 (108528-24) or Solaris 9 KU 09 (112233-09) and patch 116009-01	√ With either Solaris 8 KU 24 (108528-24) or Solaris 9 KU 09 (112233-09) and patch 116009-01
Persistent Logging in the SC Platform Log and Domain Logs				√

TABLE 6 lists the enhancements that are within the Solaris OE only.

TABLE 6 Enhancements Within the Solaris OE Only

CPU off-Lining for L2_SRAM conditions within Solaris OE	Solaris 8 OE KU20 (108528-20) or Solaris 9 KU09 (112233-09)
Memory Page Retirement for DIMM conditions within Solaris OE	Solaris 8 OE KU29 (108528-29) and patch 117000-03 or Solaris 9 OE KU-12 (112233-12)

Standardized messaging, CHS, and AD are powerful tools for users and service providers. AD in combination with DR on Sun Fire midrange servers greatly increases the availability and decreases scheduled downtime for maintenance.

The proactive actions of the Solaris OE on L2_SRAM and DIMM events makes the Solaris OE more resilient and increases its availability.

References

[1} Gonscherowski, Peter, “Sun Fire™ 3800-6800 Servers Dynamic Reconfiguration,” *Sun BluePrints Online,* April 2002

Related Resource

Sun Fire™ Midrange Systems Firmware 5.16.0 Release Notes, Sun Microsystems, 817-2973

Sun Fire™ Midrange Systems Platform Administration Manual (5.16.0), Sun Microsystems, 817-2971

Sun Fire™ Midrange System Controller Command Reference Manual (5.16.0), Sun Microsystems, 817-2972

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Sun Fire™ 6800/4810/4800/3800 Systems Firmware 5.15.X Release Notes, Sun Microsystems, 817-1001

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Acknowledgments

Thanks to Kris Bayuk who encouraged us to write this Sun Blueprint article and Domingo Goyena, James Hsieh, David Re, Sundeep Panicker, Frederic Vecoven, Jim Quigley, Mark A. Matthews, and the Serviceability Team under the lead of Marc Young for their constructive feedback and time reviewing the document.

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