

Understanding the Dynamic Cooling Mechanism of Infortrend Storage

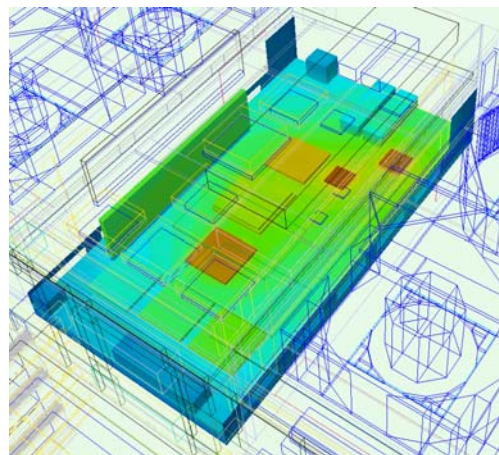
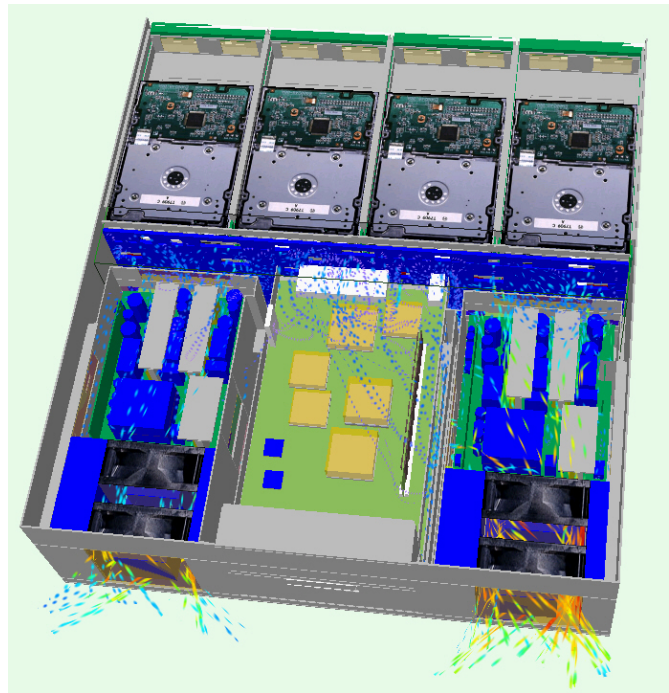
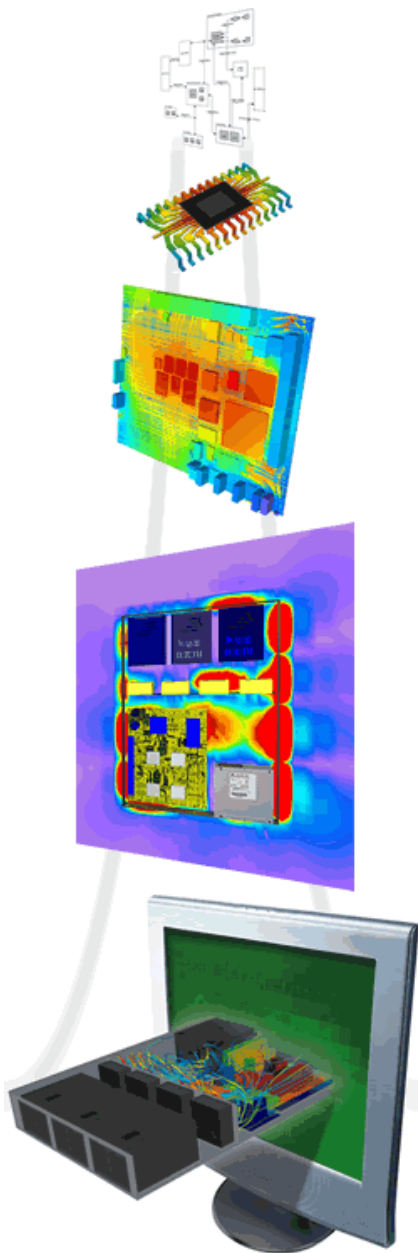
Technical Brief

Abstract

This application note explains how the dynamic cooling mechanism is implanted on Infortrend storage to increase system energy efficiency.

Hardware Design

First of all, we utilize CFD (Computational Fluid Dynamics) techniques to simulate and predict airflow, temperature, and heat transfer through components, boards, modules, and the entire system. We then acquainted ourselves with the airflow requirements during normal operations or in the event of a single module failure, making our enclosures ideal for high-availability purposes.



Adaptive Fan Speeds

Cooling fans operate at several pre-defined rotation speeds, e.g., 3200rpm, 4500rpm, and 5300rpm. Rotation speeds are dynamically adjusted to reduce power consumption, lower noise level, and to ensure system stability. Depending on the thermal readings or operating conditions detected by firmware, cooling fans raise or lower their rotation speed. For example, in the event of a single cooling fan failure, the other fans in system raise their rotation speed to extract more heat. Once the fault is corrected, cooling fans return to the default of low-speed operation.

The internal thresholds for board or component temperatures are tested and adjusted for different Infortrend models.

Firmware Implementations

We also provide the management function to help users have real-time monitoring of the operating statuses. The function can be accessed through the terminal or the SANWatch GUI.

```

Thu May 10 14:56:30 2007 Cache Status: Clean WT
                                BAT: BAD

< Main Menu >
Quick installation
view and edit Logical drives
view and edit Logical Volumes
view and edit Host luns
view and edit Drives
view and edit channels
view and edit Power Supply
view and edit Cooling Fan
view and edit Temperature Sensor
view and edit Drive Failure Output Definition
view and edit Device Set Descriptor
view and edit I2C Peripheral Device
view and edit I2C Peripheral Device

Power Supply
Cooling Fan
Temperature Sensor
Drive Failure Output Definition
Device Set Descriptor
LOCATION

R D
Devi JBOD S16S-J1000 Failback Complete Primary

I2C Peripheral Device Operational

Arrow Keys:Move Cursor Enter:Select Esc:Exit Ctrl+L:Refresh Screen

```

The screenshot displays the 'Enclosure View' interface, which includes a RAID status bar at the top, an 'Information Summary' section, and a 'System Information' table.

Information Summary

Device	Description
Controller	CPU:PPC750FX(PL, Cache:1024MB (ECC DDR), Firmware:3.490.12, Bootrecord:1.22D, SN:27768a
Channel	Channel 0 (Host, iSCSI, Speed:Negotiated to 100Mb/sec, Full Duplex)
Channel	Channel 1 (Host, iSCSI, Speed:Link not detected)
Logical Drive	ID:4AC4C8F3, RAID 5, 7151440MB
Lun	CH ID:0, SCSI ID:0, LUN:0
Lun	CH ID:0, SCSI ID:0, LUN:1
Lun	CH ID:0, SCSI ID:0, LUN:2

System Information

Device Name	Value	Status
CPU Type	PPC750FX(PL	
Total Cache Size	1024MB (ECC DDR)	
Firmware Version	3.490.12	
Bootrecord Version	1.22D	
Serial Number	27768a	
PSU0 status		PSU0 status functioning normally
PSU1 status		PSU1 status functioning normally
Cooling Fan0		Cooling fan0 is in low speed
Cooling Fan1		Cooling fan1 is in low speed
Cooling Fan2		Cooling fan2 is in low speed
MC Middle Backplane Inner Temp 0	26.0 C	Temp. within safe range
MC CPU Temp Sensor	42.0 C	Temp. within safe range
MC Board1 Temp Sensor	40.5 C	Temp. within safe range
MC Board2 Temp Sensor	40.0 C	Temp. within safe range
+3.3V Value	3.336 V	Voltage within acceptable range
+5V Value	5.099 V	Voltage within acceptable range
+12V Value	12.26 V	Voltage within acceptable range
Battery-Backup Battery		Battery-Backup Battery is disabled

Event-triggered Operations

Several conditions can be used as triggers for system firmware to enter a conservative and self-protective state. They include:

- * Controller failure,
- * BBU low or failed
- * Power supply failure
- * Fan failure
- * Temperature exceeds threshold

When these triggering conditions are enabled and one of them does occur, firmware will

- 1). Change caching mode from “write-back” to the conservative “write-through.”
- 2). Flush all cached data to reduce the chance of data loss.
- 3). Raise the rotation speed of cooling fans.



```

Fri Jan 16 10:51:39 2004                                     Cache Status: Clean

      < Main Menu >
Quick installation
view and edit Logical drives
view and edit logical Volumes
view and edit Host luns
view and edit scsi Drives
view an      Event Trigger Operations
view an      Controller Failure - Disabled
view an      BBU Low or Failed - Disabled
S           UPS AC Power Loss - Enabled
V           Power Supply Failed - Disabled
View        FAN Failure - Disabled
Set         Temperature exceeds threshold - Shutdown Period: 2 min
A           Event Trigger Operations
C           R
R
Arrow Keys:Move Cursor | Enter:Select | Esc:Exit | Ctrl+L:Refresh Screen
  
```

The last condition, "Temperature exceeds threshold," can result from an inadequate ambient temperature at the installation site. If the condition of an elevated temperature persists for a configurable period of time, say, 5 minutes, the system can automatically enter a shut down state. Firmware will automatically issue warning messages, flush cached data, and stop receiving I/Os until the working condition is corrected. This can prevent a system breakdown that might occur before a system administrator can improve the condition of an installation site.

```

      < Main Menu >
Quick inst
view and e  Disable
view and e  Enable
view and e  Shutdown Period: 2 min
view and e  Shutdown Period: 5 min
view an     Shutdown Period: 10 min      Operations
view an     Shutdown Period: 20 min      d
view an     Shutdown Period: 30 min      ed
S           Shutdown Period: 45 min
V           Shutdown Period: 1 hour
View        Temperature exceeds threshold - Shutdown Period: 2 min
Set         Event Trigger Operations
A           R
C           R
R
  
```