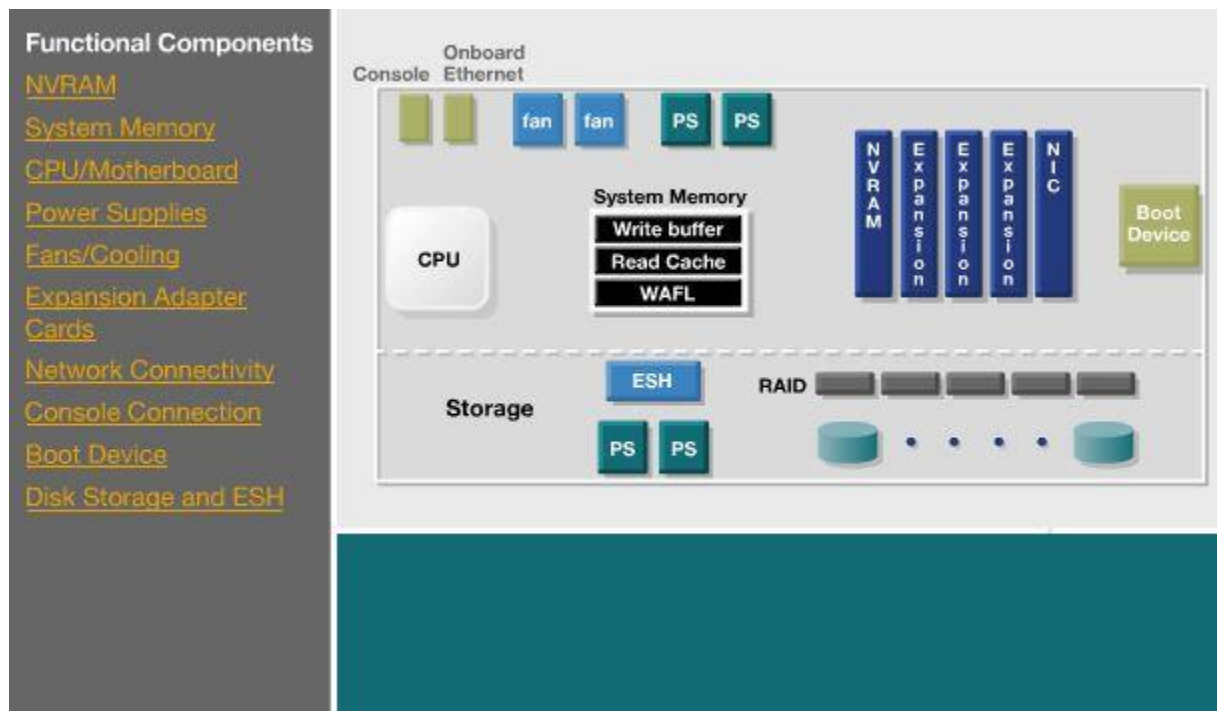## NetApp Hardware Overview

NetApp Core Products:

- Filer
- NearStore
- NetCache
- AltaVault

NetApp System Hardware Components:

Types of NetApp Storage Systems:

1. Modular System: A Modular system is filer attached to head to one or more diskshelves.
2. Integrated System: An integrated system is one in which the head functionality built in to disk shelf.

System Hardware Components:

All System Hardware Components residing on Mother Board.

- CPU: CPU main function is to execute instruction. Many systems have dual processors for performance enhancements. System uses the fans to prevent over-heating in the CPU.
- System Memory: Main System Memory holds current programs and data that are in use.

- NVRAM: NVRAM is type of computer memory that retains data in the event of power loss. The NVRAM is used for logging incoming write data requests. The NVRAM battery maintains data in the event of a system power loss.
- Expansion Adapter Cards: These cards extend the system's control over peripheral devices. For example, network connectivity is controlled by the Network interface Card (NIC)
- NIC: Network connectivity provides access to many types of networks and network protocols. NetApp system use both onboard connections and expansion cards to provide the physical network connection.
- Boot Device: The boot device is used by the appliance to boot the system
- Console Connection: A console connection is a physical or virtual terminal that is used to monitor and control a NetApp system. This connection can be used to run diagnostics and gather system information.

Disk Shelf Hardware Components:

- ESH: Embedded Switched Hub and Loop Resiliency Circuit (LRC) modules connect the storage appliance to the disk shelves and communicate environmental data about the shelf.
- Disk Drive: A disk drive is the device used to store and retrieve data bits from a magnetic disk.

Data Process Flow:

- **DataOntap:**
  - NetApp systems run on a unique operating system called Data ONTAP. This system is the bridge between client requests for data and the disks where the data is stored.
- **WAFL:**
  - At the core of Data ONTAP is WAFL ("Write Anywhere File Layout"), a file system whose function is to write and read data on disks. A patented system designed exclusively for NetApp, WAFL provides extremely fast access to data. Most file systems must write data in a specific location on the disk. WAFL can write data anywhere on the disk, greatly increasing system performance.
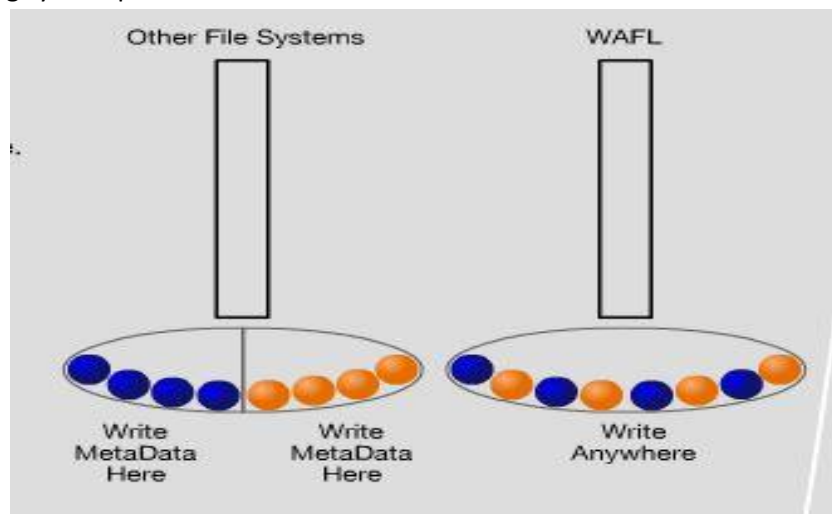
   o   WAFL uses NVRAM memory to store data as it comes into the appliance.
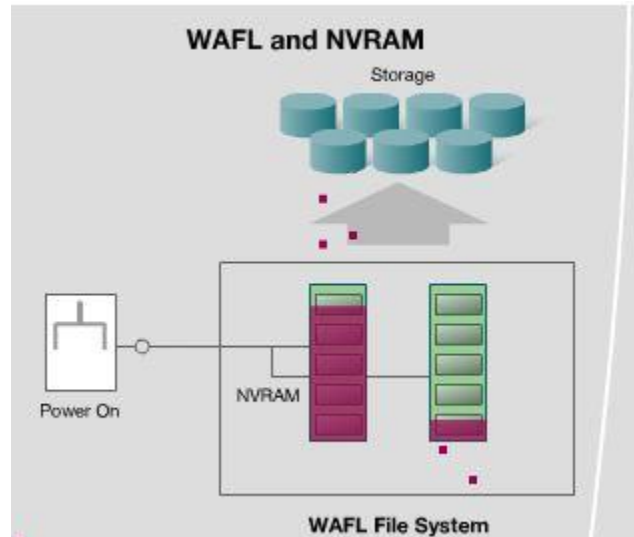
- **RAID:**
    - o WAFL uses a third piece of software, Redundant Array of Independent Disks (RAID), to protect data in the event of disk failure. NetApp uses "parity RAID," which protects data without requiring additional disks.

Write Data Process Flow:

- Client writes data, and data request is sent to Network Interface Card (NIC).
- CPU sends write request to System Memory.
- CPU triggers Direct Memory Access (DMA) of data to NVRAM).
- The CPU allows the NIC to acknowledge receipt.
- A CP event is triggered.
- As part of CP, WAFL does write allocation and hands off data to RAID.
- RAID passes data to disk drive and commits to disk.
- RAID sends completion message to CPU to flush out contents of NVRAM log.
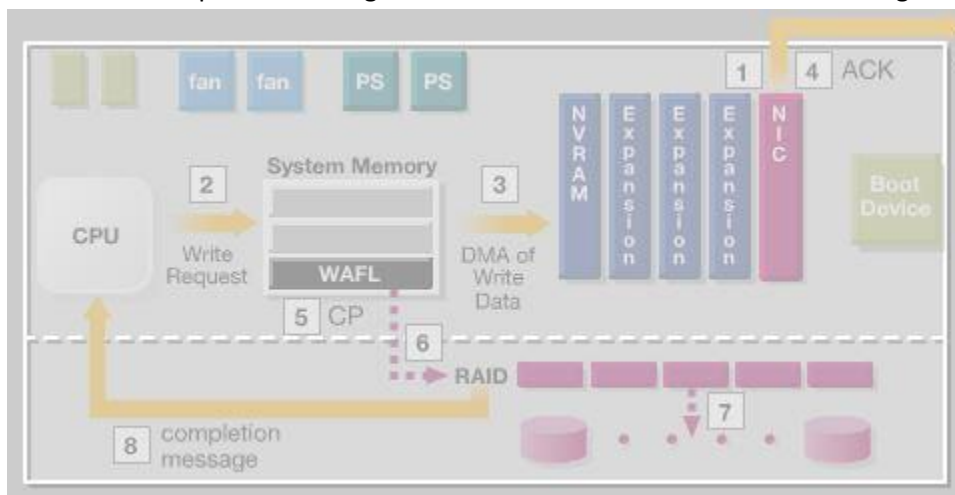
Read Data Process Flow:

Normal read process or how a client accesses data stored in the system during normal operations.

- Client sends read request and data is sent to the Network Interface Card (NIC).
- The CPU sends read request to System Memory. (Read request are not logged to NVRAM)
- If requested data is located in Cache, it is returned immediately to requesting client.
- If requested data is not located in Cache, then WAFL initiates a read request from disk.
- The requested blocks, plus intelligently chosen selections of read-ahead data, are sent to Cache.
- The CPU sends the data to the NIC and then to requesting client
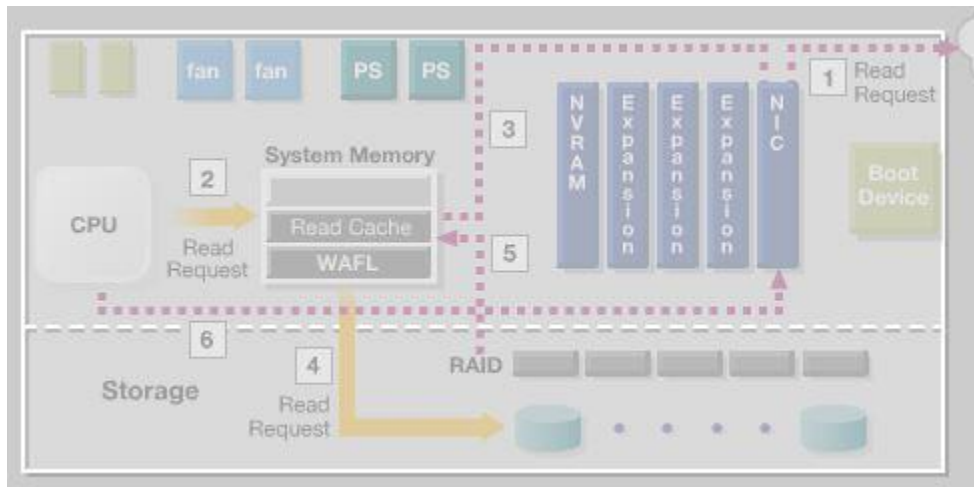
Dirty Shutdown:

- A dirty shutdown occurs when the system shuts down unexpectedly, such a during a power outage.

Power UP After a dirty Shutdown:

- When powered UP, the system checks to determine whether a dirty shutdown has occurred.
- Data is flushed from NVRAM to System Memory
- A consistency point (CP) is triggered.
- As part of the CP, WAFL does write allocation and hands off data to RAID.
- RAID passes data on the disk drive and commits to disk. No data is lost.
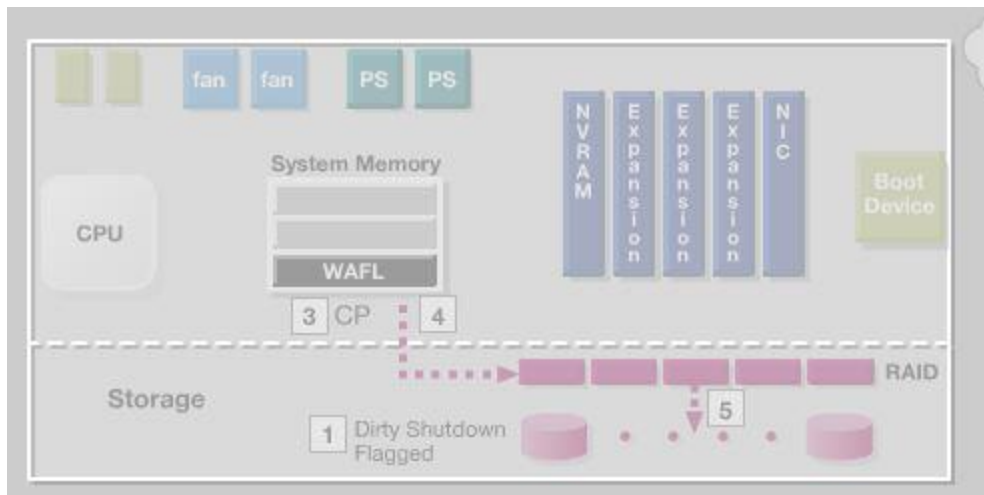
Clean Shutdown:

- Issue "halt" command to perform a clean shutdown. When the halt command is issued, all contents of system memory are committed to disk, and NVRAM is flushed.
- Power down system
- After planned activity has been completed, the system is powered up and an entry is logged to disk on the disk label indicating the system experienced a clean shutdown. The system knows that the data held in NVRAM has been flushed and written to disk. No data is lost.