REDUNDANT ARRAYS OF INEXPENSIVE DISKS

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OVERVIEW

• What is RAID?
• Standard levels
• Nested RAIDS
• RAID parity
• Problems with RAID
• Software Vs Hardware RAID
What is RAID?

• Raid provides increased storage reliability through redundancy.

• Combines multiple low cost, less reliable disk drivers into a logical unit.

• Drives are interdependent
• David A. Patterson, Garth A. Gibson, Randy Katz - University of California, Berkeley in 1987.

• Raid – computer data storage scheme

• Divide and replicate data among multiple disk drives.

• Goals of various designs of raid – increase reliability, input/output performance.
Standard Levels

There were five RAID levels originally conceived.

- **RAID (0):**
  - Block level striping without parity or mirroring
  - Improved performance, additional storage
  - No redundancy or fault tolerance
  - Any disk failure destroys the array
  - Likelihood of failure increases with increase in number of disks.
• RAID 1:
  ➢ Mirroring without parity or striping.
  ➢ Data written identically to a multiple disk.
  ➢ Fault tolerance
  ➢ RAID 1 with separate controller for each disk- duplexing.
• RAID 2:
  ➢ Bit level striping with dedicated hamming code parity
  ➢ Disk spindle rotation synchronized
  ➢ Each sequential bit is on different disk.
  ➢ Hamming code parity calculated, high data transfer rates
• **RAID 3:**
  Byte level striping with dedicated parity.
  
  All disk spindle rotation synchronized.
  
  Data striped – sequential byte is on different disk.

• **RAID 4:**
  Block level striping with dedicated parity
- Confines all parity to a single disk.
- Files distributed between disks.
- Each disk operates independently – i/o request performed in a parallel way.
- Low data transfer speed due to parity
- Error detection - dedicated parity
• RAID 5
  ➢ Block level striping with distributed parity
  ➢ Drive failure requires replacement
  ➢ Array not destroyed due to single drive failure
  ➢ Subsequent reads calculated from distributed parity upon drive failure, data loss- second drive failure
• RAID 6:
  - Block striping with double distributed parity
  - Array operates – up to 2 failed devices
  - Large devices - time taken to rebuild more
  - Double parity gives more time to rebuild the array without loss of data.
NESTED RAID

- They describe by attaching the numbers which indicates raid levels with ‘+’ sign in between.
- Order of digits is the order in which the nested array is built.

Examples
- Raid 1+0
- Raid 0+1
RAID PARITY

Raid parity is used to check for errors.

Xor operations are performed.

The value of each drive is taken, Xor operation is performed and the value is checked.
PROBLEMS WITH RAID

- Write cache reliability
- Equipment compatibility
- Data recovery in the event of a failed array
- Drive error recovery algorithms
- Increasing recovery time
- Operator skill / correct operation
SOFTWARE RAID VS HARDWARE RAID

• With a software implementation, the operating system manages the disks of the array through the normal drive controller (ATA, SATA, SCSI, Fibre Channel.)

• With present CPU speeds, software RAID can be faster than hardware RAID.
• A hardware implementation of RAID requires a special-purpose RAID controller.

• On a desktop system, this may be a PCI expansion card, or might be a capability built in to the motherboard.

• The controller handles the management of the disks, and performs parity calculations.
REFERENCES

• RAID Wikipedia: http://en.wikipedia.org/wiki/RAID#Standard_levels

• David A. Patterson, Garth Gibson, and Randy H. Katz: A Case for Redundant Arrays of Inexpensive Disks (RAID).