Sleeping Disks

• From last time:
  • MSR filesystem traces are available
  • Soon at http://iotta.snia.org/
  • For now: DVDs with Greg Ganger
  • Ping me if you want me to put them online

Digital Preservation

• This is a bigger topic than just power (but power is important!)
• What threats?
• How long?
• How much data?

Traces

• Large-scale disaster (flood, fire, famine, earthquake, war, hurricane, locusts)
• Human error (major cause in most systems)
  Accidental deletion; intentional but wrong deletion; turning off A/C; replacing wrong disk; yoinking wrong plug; typoing configuration
• Component faults (hw -- ALL hw), software (transient; heisenbugs; permanent - y2k); software licenses? domain name registration? IP addresses?
- Media Faults - bit flips, sector errors, media failures, device failures
- Obsolescent media (thriving business in reading old tapes...)
- Obsolescent format (thriving business in reading WordPerfect 1.0 docs... -- EBCDIC?) (proprietary, undocumented, ...)
- Loss of context - encryption keys, linked or embedded objects
- Malice (always malice) - and censorship
- Cash. Does it require ongoing cost or just sit quietly in a basement?

Correlated failures
- Large-scale disaster (9/11 destroyed a datacenter whose only replica was also in NYC; staff couldn’t get to the other version in time to keep it running)
- Correlated human error
- RAID correlated failures
- Going out of business

Defining Faults
- Error detection - discovering that there is an error
- Error containment - limiting how far the effects of an error can propagate (see “module”)
- Error masking - assuring correct operation despite the error (redundancy, etc) -- error correction is one form
- Fault - an underlying defect that has the potential to cause problems
  Latent fault - a fault that has not yet manifested in a failure
- Failure - not producing the intended result at the interface of a module

Measuring Reliability
- TTF: Time to Failure
- TTR: Time to Repair
- Availability: time system running / time it should have been running
- MTTF = mean time to failure
  MTTR = mean time to repair
  MTBF = mean time between failure = MTTF + MTTR
- Availability: MTTF / MTBF = (MTBF - MTTR)/MTBF
- Can improve availability by reducing MTTF or MTTR
**Some #s**

- **Shang dynasty (1200BC):** Carved bone. Still going strong today.
- **Paper:** >> 100 years acid-free, no handling
- **Mag tape & optics:** 10-20 years +
- **Magnetic disk:** ? *device failures are a few % per year, but media may be recoverable much longer; depends on app*