Operating System
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**OS 2021 Problem Sheet #12**

**Problem 12.1:** redundant arrays of independent disks

$$Failure\ probability\ =\ p$$
$$Identical\ storage\ disks\ =\ n$$

a) Failure probability $F_0$ of a RAID 0 (striping) configuration of all $n$ disks is:

$$Probability\ of\ not\ failure\ for\ each\ disk\ =\ 1\ -\ p$$
$Probability\ of\ any\ one\ of\ the\ disk\ fails\ =\ 1\ -\ (Probability\ of\ none\ of\ the\ disks\ failing)$

$$General\ expression\ for\ n\ number\ of\ disks:\quad f_0(p,\ n)\ =\ 1\ -\ (1\ -\ p)^n$$

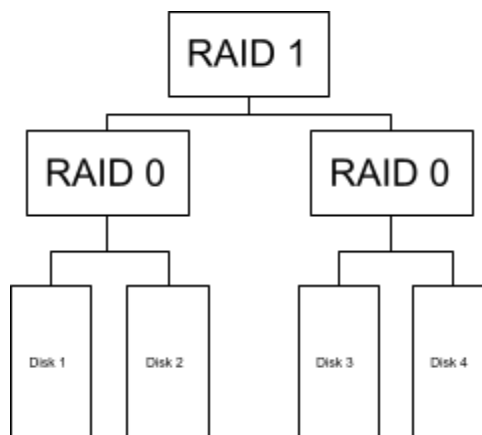b) Failure probability $F_1$ of a RAID 0 (mirroring) configuration of all $n$ disks is:

$$Probability\ of\ not\ failure\ for\ each\ disk\ =\ p$$
$Probability\ of\ any\ one\ of\ the\ disk\ fails\ =\ (Probability\ of\ none\ of\ the\ disks\ failing)$

$$General\ expression\ for\ n\ number\ of\ disks:\quad f_1(p,\ n)\ =\ (p)^n$$

c) *Assumptions*:
   - $n$ *is an even number*

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                    ┌─────────┐
                    │ RAID 1  │
                    └────┬────┘
              ┌──────────┴──────────┐
         ┌────┴────┐           ┌────┴────┐
         │ RAID 0  │           │ RAID 0  │
         └────┬────┘           └────┬────┘
          ┌───┴───┐             ┌───┴───┐
       ┌──┴─┐  ┌──┴─┐        ┌──┴─┐  ┌──┴─┐
       │Disk1│ │Disk2│       │Disk3│ │Disk4│
       └────┘  └────┘        └────┘  └────┘
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$$Failure\ probability\ of\ f_{10}(p,\ n)\ =\ f_0(f_1(p,2),\ \tfrac{n}{2})$$
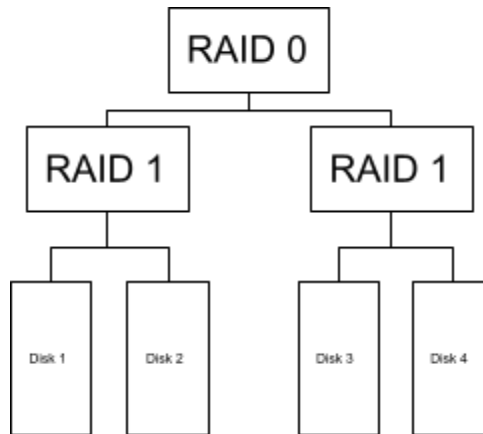
$$f_1(p, 2) = (p)^2$$

$$f_{10}(p, 2) = f_0(p^2, \tfrac{n}{2})$$

$$\textit{Failure probability of } f_{10}(p, 2) = 1 - (1 - p^2)^{\frac{n}{2}}$$

d) *Assumptions*:
   − *n is an even number*



$$\textit{Failure probability of } f_{01}(p, n) = f_1(f_0(p, \tfrac{n}{2}), 2)$$

$$f_0(p, \tfrac{n}{2}) = 1 - (1 - p)^{\frac{n}{2}}$$

$$f_{01}(p, 2) = f_1(1 - (1 - p)^{\frac{n}{2}}, 2)$$

$$\textit{Failure probability of } f_{01}(p, 2) = (1 - (1 - p)^{\frac{n}{2}})^2$$

e) I would prefer to use the smallest one which is RAID 10.

**Problem 12.2:** Logical volume management

a) $for\ i\ in\ \$(seq\ 0\ 4)\ ;\ do$
   $img = loop\$i.\,img$
   $dev = /dev/loop\$i$
   $sudo\ losetup\ -\ d\ \$dev$
   $rm\ \$img$
   $done$