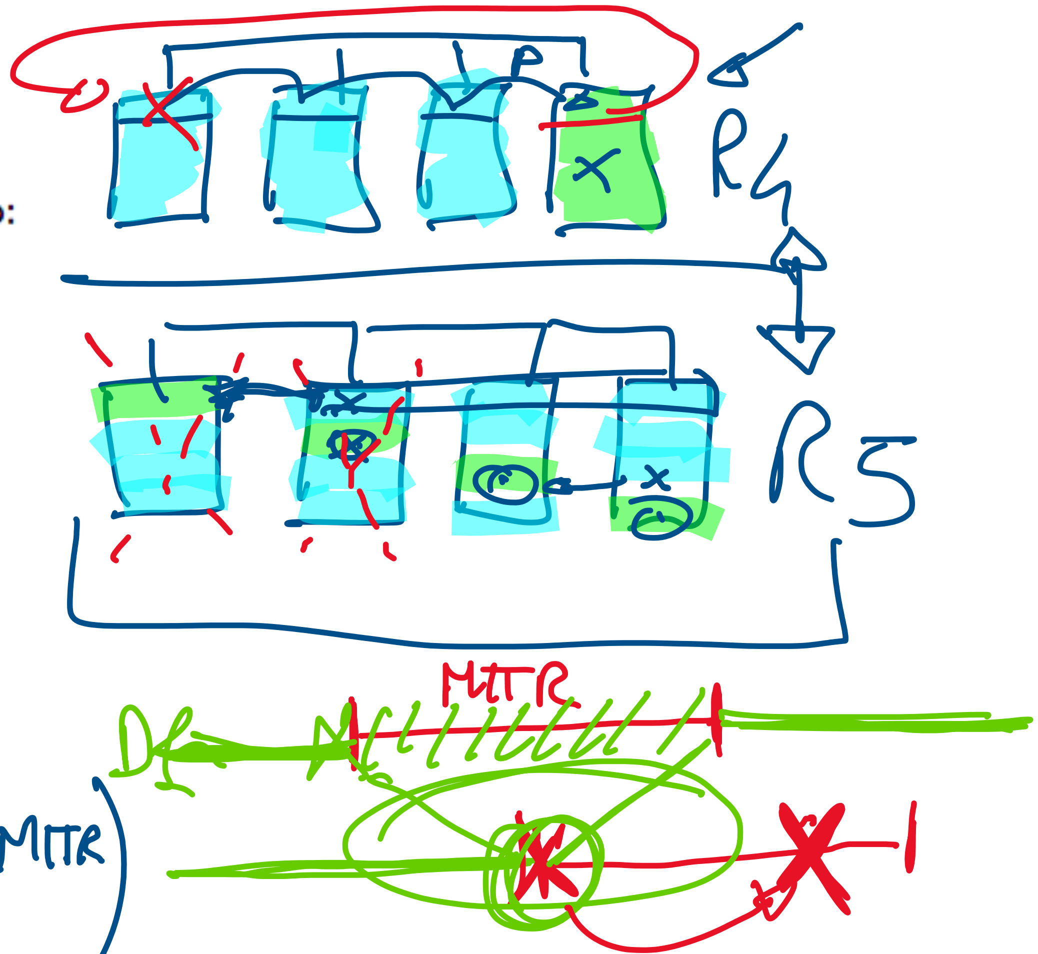
Ex_06 – RAID 5

mercoledì 4 marzo 2020 11:10

Consider the following RAID 5 setup:

- n = 4 disks
- MTTR = 3 days
- MTTF(one disk) = 1000 day

The MTTDL will be:



$$MTTDL \longrightarrow FR$$

$$FR = \frac{n^{4}}{MTTF}\left(\frac{n-1}{MTTF} * MTTR\right)$$

$$MTTDL = \frac{MTTF^2}{n*(n-1)*MTTR} = \frac{1000^2}{4*3*3} = \frac{1000^2}{36} = 27.7\ K\,days$$

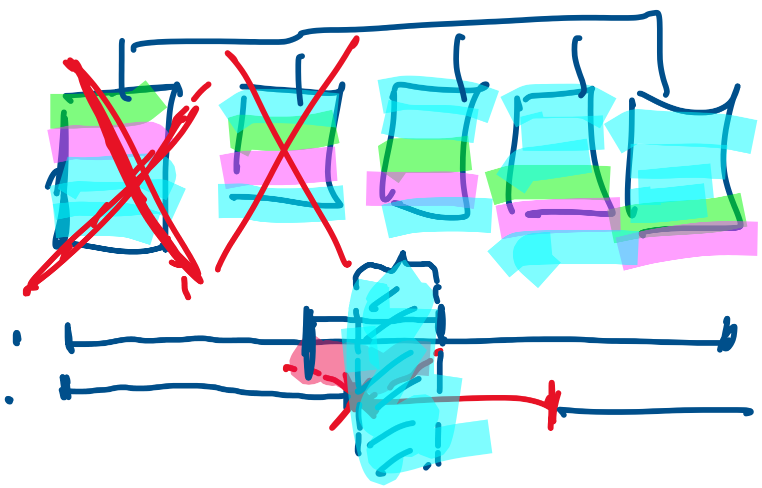
Ex_07 – RAID 6

mercoledì 4 marzo 2020 11:11

Consider the following RAID 6 setup:

- n = 5 disks
- MTTR = 2 days
- MTTF(one disk) = 1100 day

The MTTDL will be:



$$FR = \frac{\overset{n}{5}}{MTTF} * \left(\frac{\overset{n-1}{4}}{MTTF} * MTTR\right)\underbrace{\left(\frac{3}{MTTF}\,\frac{MTTR}{2}\right)}_{\text{3RD DISK}}$$

$$\Rightarrow MTTDL = \frac{2 * MTTF^3}{n*(n-1)*(n-2)*MTTR^2} \cong 11 * 10^6 \text{ DAYS}$$

Further Reading

lunedì 30 marzo 2020 22:21

Peter M. Chen, Edward K. Lee, Garth A. Gibson, Randy H. Katz, and David A. Patterson. 1994. RAID: high-performance, reliable secondary storage. ACM Comput. Surv. 26, 2 (June 1994), 145–185. DOI:https://doi.org/10.1145/176979.176981

Double-Columns
https://www.cs.cornell.edu/courses/cs4410/2017fa/schedule/slides/RAID.pdf

Single-Column:
http://meseec.ce.rit.edu/eecc722-fall2006/papers/io/3/chen94raid.pdf

RAID: High-Performance, Reliable Secondary Storage

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01 - Single Component – R

lunedì 20 aprile 2020 09:01

A heart pacemaker has a failure rate of λ = 0.25 × 10−8 per hour.

1. What is its MTTF?
2. What is the probability that it fails during the first five years of operation?

$$MTTF = \frac{1}{\lambda} = 4 * 10^8 \, h = Y \, \frac{4 * 10^8}{24 * 365} =$$

$$R(5y) = e^{-\frac{t}{MTTF}} = e^{-\frac{5y}{4*10^8}} = e^{-\frac{5}{45K}} \simeq 0.9998$$

$$F_{(5y)} = 1 - R(5y) = 1 - 0.9998 \simeq 0.0002$$

$$\to F = 1 - e^{-\frac{t}{MTTF}} \simeq \frac{t}{MTTF} = \frac{5}{45K} \simeq$$

02 - Single Component - MTTF

mercoledì 4 marzo 2020 11:14

Let us now consider a generic component D. Compute the minimum integer value of $MTTF_D$ in order to have at $t = 5$ *days* a reliability $R_D(t) \geq 0.96$.

$$R(5DAYS) \geq 0.96$$

$$e^{-\frac{5}{MTTF}} \geq 0.96 \rightarrow$$

$$-\frac{5}{MTTF} = \ln(0.96) \rightarrow MTTF = \frac{-5}{\ln(0.96)} \simeq 122.5$$

$$MTTF_D \geq 122.5 \text{ DAYS}$$

03 - Single Component - T

domenica 19 aprile 2020 22:58

A smartphone manufacturer determines that their products have a MTTF of 59 years in normal use. Estimate how long a warranty should be set if no more than 5% of the items are to be returned for repair.

$W' \quad MAX\, W$

$$R(W) \geq 95\%$$

$$R(W) = e^{-\frac{W}{MTTF}} = 0.95$$

$$-\frac{W}{MTTF} = \ln 0.95 \Rightarrow W = -MTTF * \ln 0.95$$
$$= 3.026 \text{ years}$$

$$W \leq 3Y$$

04 - RBD Server – MTTF and R

domenica 19 aprile 2020 23:40

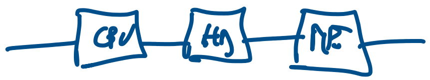
- Lets' consider a server architecture in terms only of its main 3 components: CPU, MEMORY and HardDrive. Considers that the components have a constant failure rates of 1/64, 1/58 and 1/28 per year respectively for CPU, MEMORY and HardDrive. Assuming that component failures are independent events, compute:
  1. Draw the RBD of the server architecture
  2. Compute the MTTF for the server
  3. Compute the reliability of the server for a 3-year mission

$MTTF_{CPU} = 64$ YEARS

$MTTF_{MEM} = 58$ Years

$MTTF_{HD} = 28$ Years

1



2

$$R_S = R_{CPU} \cdot R_{HD} \cdot R_{MEM} = e^{-\frac{t}{MTTF_{CPU}}} \cdot e^{-t/MTTF_{HD}} \cdot e^{-t/MTTF_{M}} =$$

$$= e^{-t\left(\frac{1}{MTTF_{CPU}} + \frac{1}{MTTF_{HD}} + \frac{1}{MTTF_{M}}\right)}$$

$$R_S = e^{-t/MTTF_S} \Rightarrow MTTF_S = \frac{1}{\frac{1}{MTTF_{CPU}} + \frac{1}{MTTF_{HD}} + \frac{1}{MTTF_{M}}} = 14.58 \text{ YEARS}$$

3

$$R_S(3Y) = e^{-\frac{3Y}{14.58Y}} \simeq 1 - \frac{3}{14.58} \simeq 80\%$$

05 - Complex RBD

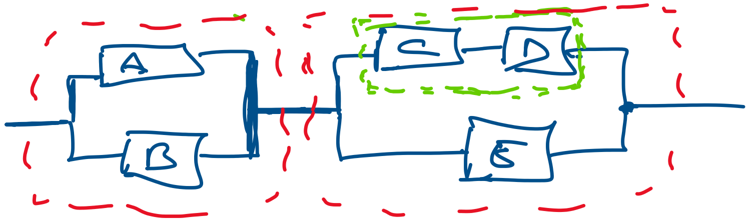
lunedì 20 aprile 2020 09:51

A system with four modules: A, B, C, D and, E has been designed, so that it operates correctly if

- (1) modules A or B operate correctly, and
- (2) modules C and D operate correctly, or module E operates correctly.

1. Draw an RBD of the system.
2. Write an expression for the reliability of the system.
3. Extra – Considering that the MTTF for modules A and B is 3412hours, while for modules C, D and E is 1245hours, calculate the reliability value after 1 month of the system.

1



2

$$R_{CD} = R_C \cdot R_D$$

$$R_{CDE} = 1 - F_{CDE} = 1 - (1 - R_{CD})(1 - R_E)$$

$$R_{AB} = 1 - F_{AB} = 1 - F_A F_B = 1 - (1 - R_A)(1 - R_B)$$

$$R_{ABCDE} = R_{AB} \cdot R_{CDE} = \left(1 - (1 - R_A)(1 - R_B)\right)\left(1 - (1 - R_C R_D)(1 - R_E)\right)$$

3

$$e^{-t/MTTF}$$

QUIZ - R – Additional Insurance

lunedì 20 aprile 2020 09:47

A computer system is designed to have a failure rate of one fault in 5 years in normal use. The system has no fault tolerance capabilities, so it fails upon occurrence of the first fault.

1. What is the MTTF of such a system? $\lambda = \frac{1}{5} \rightarrow MTTF = 5y$
2. What is the probability that the system will fail during its first year of operation?
3. (EXTRA) The usual warranty for the system is 2 years. The vendor wishes to offer an additional insurance against failures for the first 5 years of operation at extra cost. The vendor wants to charge $20 for each 1 % drop in reliability to offer such an insurance. How much should the vendor charge for such an insurance? (QUIZ)

(2) $F = 1 - R(1y) = 1 - e^{-\frac{1}{5}} = 0.18\%$

$R(2) = e^{-\frac{2}{5}} =$

$R(5) = e^{-\frac{5}{5}} =$

$R(2) - R(5) = \left(e^{-\frac{2}{5}} - e^{-\frac{5}{5}}\right) * 20\$ * 100$

$\simeq 67 - 37\% = 30\% * 100 * 20\$$

$\simeq \underline{600\$}$

07 - Availabilility if MTTR increases

lunedì 20 aprile 2020 09:36

$\Rightarrow MTTF = 4 * 10^4 h$

A complex system has a failure rate of λ = 0.25 × 10−4 per hour and an MTTR = 72 hours in normal use.

1. What is its steady-state availability?

2. If MTTR is increased to 120 h, what failure rate can be tolerated without decreasing the availability of the system?

(1)

$$A = \frac{MTTF}{MTTF + MTTR} = \frac{4 * 10^4}{4 * 10^4 + 72} = 0.9982$$

(2)

$$0.9982 = \frac{MTTF}{MTTF + 120}$$

$$(MTTF + 120) * 0.9982 = MTTF$$

$$MTTF * A + A * 120 = MTTF$$

$$MTTF = \frac{A * MTTR}{(1 - A)} = \frac{0.9982 * 120}{(1 - 0.9982)} = \frac{119.784}{(1-A)}$$

$$= 59892$$

$$\lambda = \frac{1}{59892} = \frac{1}{6} * 10^{-4}$$