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# IOT Homework - Exercise 2

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# Contents

# 1 | Exercise 2

## 1.1. 1

Setting $X \sim \text{Pois}(\lambda = 0.15)$ as the number of people in a frame, the PMF is:

$P(X = k) = \frac{e^{-\lambda}\lambda^k}{k!}$

In each of the 3 cases, the PMF is:

- $P(r = r_0) = P(X = 0) = e^{-0.15} = 0.86071$
- $P(r = r_1) = P(X = 1) = e^{-0.15} * 0.15 = 0.12911$
- $P(r = r_2) = P(X \geq 2) = 1 - P(X = 0) - P(X = 1) = 0.01018$
  (considering all the cases in which there are more than 1 people in the frame)

## 1.2. 2

At a bit rate of $R = 250$ kbps, the slot time for a packet of 128 bytes is:

$T_S = \frac{128*8 \text{ b}}{250000 \text{ bps}} = 4.096 \text{ ms}$

The slowest output rate comes from sending the smallest 1 KB frame every 10 s:

$\frac{1000*8 \text{ b}}{10 \text{ s}} = 800 \text{ bps}$

To calculate the beacon interval, we divide the packet length in bits by the slowest output rate:

$BI = \frac{128*8 \text{ b}}{800 \text{ bps}} = 1.28 \text{ s}$

The maximum number of slots a single camera may require corresponds to the worst-case scenario, in which a 6 KB payload must be transmitted. Since each 128 B packet fits exactly into one slot, this results in $\frac{6 \text{ KB}}{8*128 \text{ B}} \approx 6$ slots.

To ensure that every camera can always transmit its largest possible message within the CFP, we reserve 6 slots per camera. With 3 camera nodes in the system, the total number of CFP data slots is:

$N_{CFP} = 3 * 6 = 18$

Including 1 beacon slot, the active period is given by:

$T_{\text{active}} = (N_{CFP} + 1) * T_S = 19 * 4.096 \text{ ms} = 77.824 \text{ ms}$

The inactive period is:

$T_{inactive} = BI - T_{active} = 1280 \text{ ms} - 77.824 \text{ ms} = 1202.176 \text{ ms}$

And the duty cycle is given by:

$DC = \frac{T_{active}}{BI} = \frac{77.824 \text{ ms}}{1280 \text{ ms}} \approx 6.08\%$

## 1.3. 3

Setting $x$ as the number of cameras and allocating 6 slots per camera and adding one beacon slot gives the following active time:

$T_{active}(x) = (6x + 1) * T_s = (6x + 1) * 4.096 \text{ ms}$

The duty cycle is:

$DC(x) = \frac{T_{active}}{BI} = \frac{(6x+1)*4.096 \text{ ms}}{1280 \text{ ms}}$

To get $DC < 0.10$:

$\frac{(6x+1)*4.096}{1280} < 0.10 \implies 6x + 1 < 0.10 * \frac{1280}{4.096} \implies x < \frac{30.25}{6} \approx 5$

Since we already have 3 cameras, we can add up to 2 cameras to keep the duty cycle below 10%.