# Problem - Part 2

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PART 2

The company has noticed that most of the time some video-conferencing channels are not used by subscribers. It is decided to sell the service to occasional customers.

Subscribers will have a preemptive priority over the resources. If a suscriber wants to start a video-conference and no channel is available then the video-conference of an occasional customer is interrupted to free one channel for the subscriber (if at least one channel is used by an occasional customer)

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## Question 8

1 point possible (graded)

The subscribers complain that their quality of service (QoS) may decrease. Which of the following statement is true?

- They are right to complain. The introduction of occasional customers will increase the loss probability for subscribers.

- They should not complain. From the point of view of the QoS offered to subscribers everything will continue as if there were no occasional customers.

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## Question 9

1 point possible (graded)

Let N(t) be the number of ongoing videoconferences of subscribers. And let N'(t) be the number of ongoing videoconferences of occasional customers.

What is the set of possible values for (N(t),N'(t))?

- $N(t) \geq 0$, and $N'(t) \geq 0$
- $0 \leq N(t) \leq C$, and $0 \leq N'(t) \leq C$
- $0 \leq N(t), 0 \leq N'(t)$, and $N(t) + N'(t) \leq C$
- $0 \leq N(t), 0 \leq N'(t)$, and $N(t) + N'(t) = C$

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A market study has revealed that occasional customers will generate on average $\lambda' = 2$ video-conference requests per hour (according to a Poisson process). The duration of their video-conferences has the same distribution as for subscribers: Exp($\mu$) with $1/\mu = 1$ hour.

## Question 10

1 point possible (graded)

Which of the following statements are true?
Select the correct answer(s).

- [ ] N(t) is a continuous time Markov chain.
- [ ] N'(t) is a continuous time Markov chain.
- [ ] The pair (N(t),N'(t)) is a continuous time Markov chain.

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In what follows we are going to assume that C=1 to simplify calculations.

So, there cannot be more than one ongoing video-conference in the system.

## Question 11

1 point possible (graded)

Assume that the system is in state (N(t)=0,N'(t)=1) and that a subscriber

Assume that the system is in state $(N(t)=0,N'(t)=1)$ and that a subscriber arrives. What is the new state of the system?

- $(N(t)=0,N'(t)=0)$
- $(N(t)=0,N'(t)=1)$
- $(N(t)=1,N'(t)=0)$
- $(N(t)=1,N'(t)=1)$

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## Question 12

1 point possible (graded)

Which of the following figures corresponds to the state transition diagram of the pair (N(t),N'(t))?

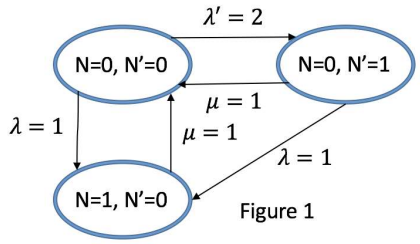

Figure 1

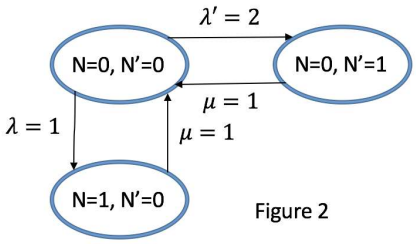

Figure 2

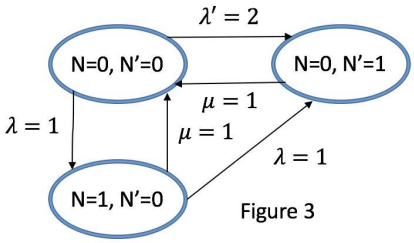

Figure 3

- Figure 1
- Figure 2
- Figure 3

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## Question 13

1 point possible (graded)

Let us consider $\pi_{ij} = P(N(t) = i, N'(t) = j)$the steady-state distribution of (N(t),N'(t)). Which of the following system(s) correspond to the load balance equations?

System 1:

$$\pi_{10} = \pi_{00} + \pi_{01},$$
$$3\pi_{00} = \pi_{01} + \pi_{10},$$
$$\pi_{00} + \pi_{01} + \pi_{10} = 1$$

System 2:

$$2\pi_{00} = \pi_{01},$$
$$\pi_{10} = \pi_{00},$$
$$\pi_{01} = \pi_{10},$$
$$\pi_{00} + \pi_{01} + \pi_{10} = 1$$

System 3:

$$\pi_{10} = \pi_{00} + \pi_{01},$$
$$3\pi_{00} = \pi_{01} + \pi_{10},$$
$$2\pi_{00} = 2\pi_{01},$$
$$\pi_{00} + \pi_{01} + \pi_{10} = 1$$

Select the correct answer(s).

- [ ] System 1
- [ ] System 2
- [ ] System 3

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## Question 14

3 points possible (graded)

What is the value of $\pi_{00}$?

What is the value of $\pi_{10}$?

What is the value of $\pi_{01}$?

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## Question 15

1 point possible (graded)

In which state(s) of the system is the arrival of a subscriber blocked?

- N(t)=0 and N'(t)=0
- N(t)=0 and N'(t)=1
- N(t)=1 and N'(t)=0

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## Question 16

1 point possible (graded)

In which state(s) of the system is the arrival of an occasional customer blocked?

- [ ] N(t)=0 and N'(t)=0
- [ ] N(t)=0 and N'(t)=1
- [ ] N(t)=1 and N'(t)=0

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## Question 17

3 points possible (graded)

What is the value of the loss probability for subscribers?

What is the value of the loss probability for occasional customers?

What would be the value of the loss probability for subscribers if there were no occasional customers?

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The business model of the company is as follows.

The price of the video-conference service is P dollars per video-conference for occasional customers.

If a video-conference is interrupted (because a subscriber needs a channel) then R dollars are reimbursed to the occasional customer.

## Question 18

1 point possible (graded)

What is the average number of video-conferences of occasional customers that start per hour?

Select the correct expression.

- $\lambda'$
- $\pi_{00}\lambda'$
- $(\pi_{00}+\pi_{10})\lambda'$

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## Question 19

1 point possible (graded)

What is the average number of occasional customers which are reimbursed per hour?

Select the correct expression.

- $\lambda\pi_{01}$
- $\lambda'\pi_{01}$
- $\lambda$
- $\lambda'$

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## Question 20

2 points possible (graded)

What is the value of the average number of occasional customers accepted per hour?

What is the value of the average number of occasional customers reimbursed per hour?

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## Question 21

1 point possible (graded)

What is the average income generated per hour by occasional customers for

the company?

- $\frac{1}{2}P - \frac{1}{4}R$
- $\frac{1}{4}P - \frac{1}{2}R$
- $P - R$
- $\frac{1}{2}(P - R)$

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## Question 22

1 point possible (graded)

Under which condition is the system profitable for the company?

- $R < P$
- $R < 2P$
- $P < 2R$

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