Data Networks WS 18/19
INTERNET ARCHITECTURE:
Assignment 11

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Question 1: (1.5 + 1.5 + 1.5 + 0.5 = 5 points) Soft State / Hard State: Car Rental

Assume the following scenario: A car pool startup offers cars for rent via the Internet under these revolutionary and game-changing conditions: The customers only have to pay for the duration of actually using (driving) a car. Merely reserving a car does not cost anything. After some issues with unfair customers exploiting this feature, the company grudgingly decided to only allow reservations for a limited and fixed time period (e.g., one hour). Hence, if a reserved car is not used during that time period, the reservation expires and the car becomes available for all customers once more. The reservation process is of course suspended while the car is in use and continues after the car stops being used, at which point the timer gets reset. Finally, after a lot of confusion and debugging, they also decided to add the rule that a car can only be reserved if there is no current reservation and the car is not in use.

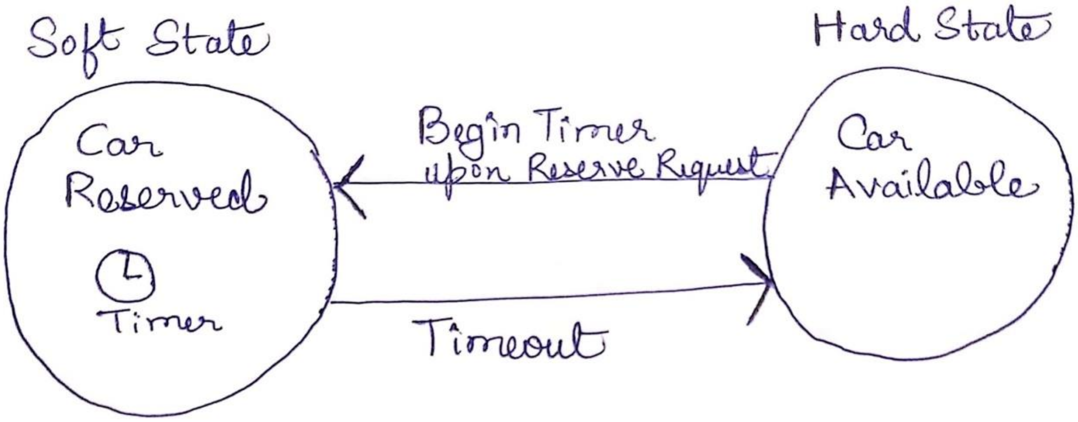
Note: Make sure that your state diagram reflects the scenario described above.

(a) Provide a state diagram that shows the reservation state of a car. That is, it contains only a
state where the car is reserved and a state where the car is available. Indicate for each of the two states whether it is a soft state or a hard state and why.

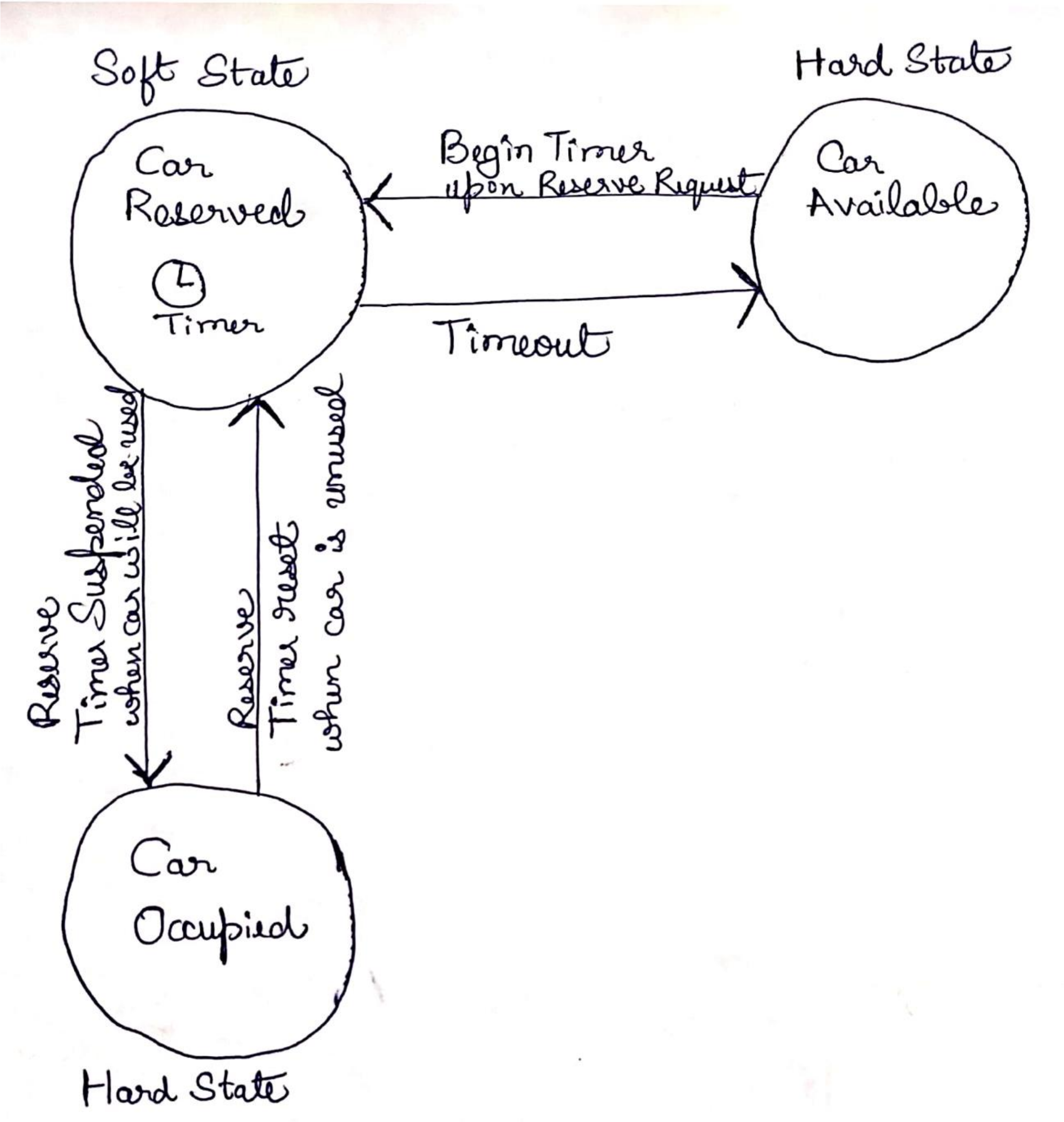
The required state diagram is provided below. It clearly indicates that the ***Car Available*** state is ***Hard State*** as an explicit action is required to move out of this state. It has no timer information to help end the state.

On the other hand, the ***Car Reserved*** state is ***Soft State*** . This is because it is possible to move out of this state without the requirement of any explicit action. We can move out of this state when the timer indicates that a timeout has occured after 60 minutes of inactivity.

The question mentioned that the Car Reserved state previously had no timer and the reserved status was allowed to be infinity. So, previously, the company had a Hard State for the Car Reserved State and switched to the Soft State where they could automatically terminate the reserved status for people who did not drive the cars within 60 minutes of the booking.



(b) Augment your state diagram with the information about the current usage of a car. That is,
add a third state where the car is used. Indicate whether this third state is a soft state of a
hard state and why.


Soft State
Hard State
Car Reserved
Timer
Begin Timer upon Reserve Request
Car Available
Timeout
Reserve Timer Suspended when car will be used
Reserve Timer reset when car is unused
Car Occupied
Hard State

The above state diagram indicates the current usage of the car by the ***Car Occupied*** state. This ***Car Occupied*** state is a ***Hard State*** as only the driver of the car has control to change the state. There is **no** timeout event that can happen to change the occupied state of a car.

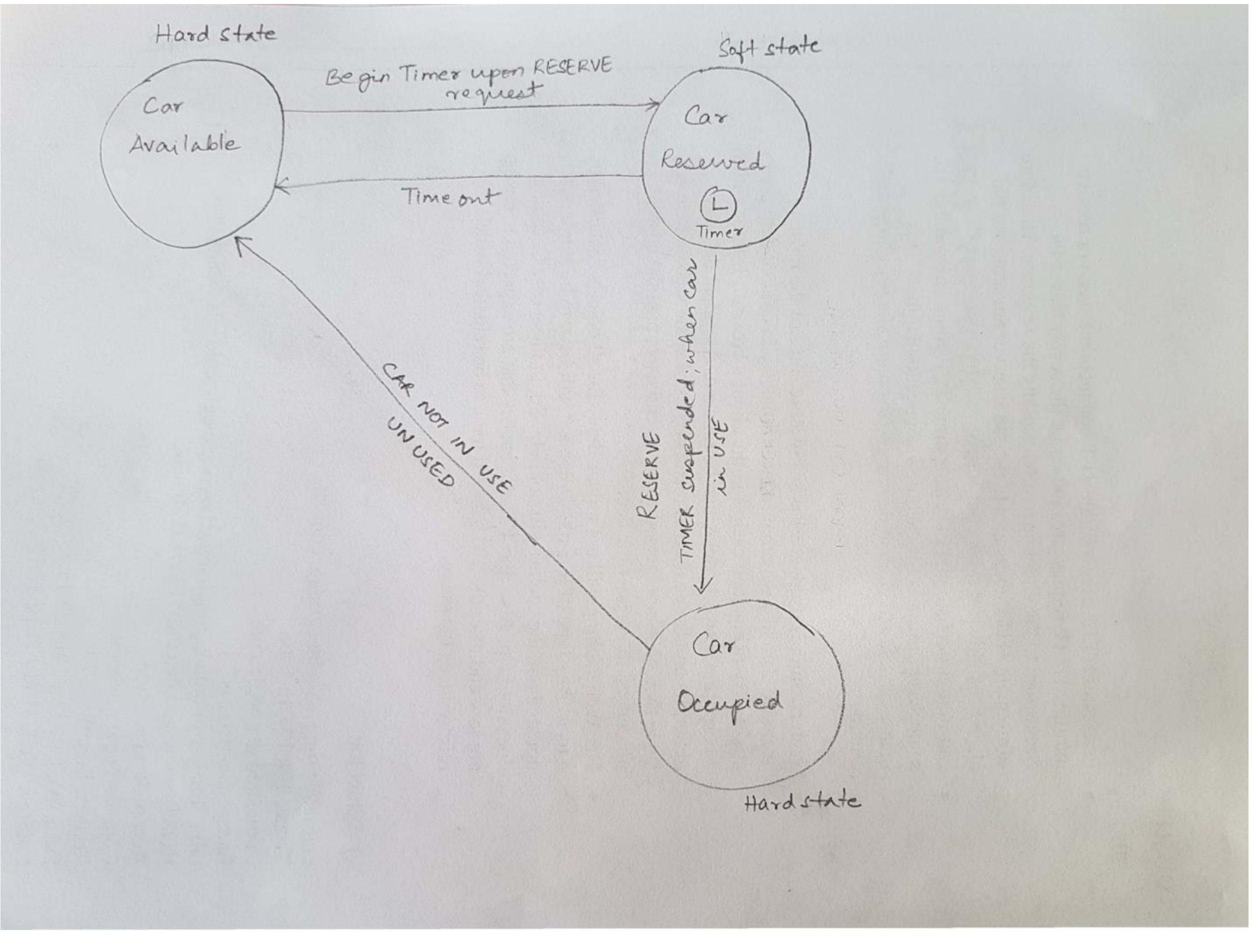
(c) How would the service change if the system were using only soft states or only hard states?

If the system used only soft states, then a car at the ***Car Available*** state, would have to keep informing the company that it is at the available state and the car can move to the ***Car Reserved*** state only upon a timeout occurring at the ***Car Available*** state. Similarly, the state of ***Car Occupied*** would change only if there is a timeout which would then lead to the car being reserved. The other state of ***Car Reserved*** is already soft state and will not change.

If the system were to use only hard states, then the ***Car Reserved*** state would become a Hard State. This would mean that a person could reserve a car for an unlimited number of time and the responsibility of making the reserved car available solely rests on that person. The other two states are already hard states and will not change.

(d) After one year of operation, the company is still operating at loss and faces bankruptcy. You
are hired as a consultant and they give you free reign to change or add one rule in the rental
process. They promise you a million Euros and unlimited free car rentals if you can find and
fix that one flaw that "everyone seems to be exploiting". What flaw do you point out and what
rule (change) will fix it?

A simple fix would be to make the car enter the ***Car Available*** state right when the car first becomes unused after the ***Car Occupied*** state. This way, a customer who uses the service, gets the benefit of reserving a car, then is allowed to reach his destination in the car and finally, when he is done using the car, it will not be entering the Reserved State. If it instead moved to the ***Car Available*** state, then people would not be able to cheat the company.



Question 2: (1 + 1 + 1 + 1 + 1 = 5 points) MQTT - Message Queuing Telemetry Transport

Bob and Alice recently installed a sprinkler system in their garden. The System uses sensors to
gather soil moisture data, uploads this data to a server, which makes decisions on how to adjust the sprinklers based on analyzing the soil moisture data. The sensors communicate with the server using the MQTT protocol.

(a) Look up the MQTT specification and list all control packet types.

The control packet types are:

1. CONNECT – Client requests a connection to a Server
2. CONNACK – Acknowledge connection request
3. PUBLISH – Publish message
4. PUBACK – Publish acknowledgement

5. PUBREC – Publish received (QoS 2 publish received, part 1)
6. PUBREL – Publish release (QoS 2 publish received, part 2)
7. PUBCOMP – Publish complete (QoS 2 publish received, part 3)
8. SUBSCRIBE - Subscribe to topics
9. SUBACK – Subscribe acknowledgement
10. UNSUBSCRIBE – Unsubscribe from topics
11. UNSUBACK – Unsubscribe acknowledgement
12. PINGREQ – PING request
13. PINGRESP – PING response
14. DISCONNECT – Disconnect notification

(b) MQTT uses TCP as the transport protocol. Explain why using UDP would not be suitable.

The system needs to upload the collected the information in its entirety to the server. This upload in its entirety is only possible if the underlying protocol provides reliable data transfer, which is a service provided by TCP, thus using TCP, a reliable transport protocol is more suitable than using an unreliable transport protocol such as UDP.

MQTT is also required to store the message at the broker when the Publisher is offline. The broker can realize that the Publisher is offline only from the ACKs or NAKs used in TCP which is not available in UDP. Therefore, TCP is necessary for MQTT.

(c) Is the sprinkler system soft-state or hard-state? Is one more suitable than the other? Give a
brief answer (2 to 3 sentences).

The sprinkler system is Hard State as it is the responsibility of the sprinkler system to upload the soil quality information to the server. There is no timer enforcing the sprinkler system to update the server at the end of every timeout. Therefore, the server system is hard state.

(d) Assume the moisture sensor suddenly shuts down due to failing batteries. Does MQTT provide any helping mechanism and how does it work?

One of the QoS guarantees of MQTT ensures delivery of messages at least once. So, if the MQTT is operating at this level of QoS and the server (which is the broker) realizes that the publisher device is offline, then the server will store the messages intended for this particular device in a queue. The server will then try periodically to deliver the message till it receives acknowledgement from the sprinkler system.

(e) Again, assume the sensor shuts down but this time you did not configure the helping MQTT
mechanism. How would this affect a system where the messages have the retain flag set?

If the MQTT mechanism described above is not set up, then in spite of the retain flag, the server will drop the messages.