

Database Rows

$$\begin{aligned} UserRow \triangleq [& \\ & subscribed : \text{BOOLEAN} , \\ & \text{Forget cancelled} \\ & inTrial : \text{BOOLEAN} , \\ & trialStartTime : \text{Nat}, \\ & billedForMonth : \text{Nat}, \\ & hasHadTrialOrSubscription : \text{BOOLEAN} , \\ & hasCancelled : \text{BOOLEAN} , \\ & cancelMonth : \text{Nat}, \\ & subscribeMonth : \text{Nat} \\ &] \end{aligned}$$

API endpoints

$$\begin{aligned} StartSubscription(u) \triangleq & \\ & \text{Not subscribed} \\ & \wedge \wedge database.users[u].subscribed = \text{FALSE} \\ & \wedge \vee database.users[u].inTrial = \text{FALSE} \\ & \vee database.users[u].trialStartTime = month \\ & \wedge database' = \\ & \quad [database \text{ EXCEPT} \\ & \quad \quad !["users"][u].subscribed = \text{TRUE}, \\ & \quad \quad !["users"][u].hasHadTrialOrSubscription = \text{TRUE}, \\ & \quad \quad !["users"][u].hasCancelled = \text{FALSE}, \\ & \quad \quad !["users"][u].inTrial = \text{FALSE}, \\ & \quad \quad !["users"][u].subscribeMonth = month, \\ & \quad \quad !["billQueue"] = \\ & \quad \quad \quad Append(database.billQueue, \\ & \quad \quad \quad [user \mapsto u, \\ & \quad \quad \quad fee \mapsto SubscriptionFee, \\ & \quad \quad \quad \text{bill not} \\ & \quad \quad \quad when \mapsto month]) \\ & \quad] \\ & \text{Observability required by stub} \\ & \wedge events' = Append(events, [type \mapsto "startsubscription", user \mapsto u]) \\ & \wedge \text{UNCHANGED } month \end{aligned}$$

$$\begin{aligned} CancelSubscription(u) \triangleq & \\ \text{LET } updatedBillQueue \triangleq & \\ \text{IF } \exists i \in 1 \dots Len(database.billQueue) : & \end{aligned}$$

$\wedge database.billQueue[i].user = u$
 $\wedge database.billQueue[i].fee = SubscriptionFee$
 THEN $database.billQueue$
 ELSE $Append(database.billQueue,$
 $[user \mapsto u, fee \mapsto SubscriptionFee, when \mapsto month])$
 IN
Subscribed
 $\wedge \vee database.users[u].subscribed = TRUE$
 $\vee \wedge database.users[u].inTrial = TRUE$
 $\wedge database.users[u].trialStartTime < month$
 $\wedge database' =$
 $[database \text{ EXCEPT}$
 $!["users"][u].subscribed = FALSE,$
 $!["users"][u].inTrial = FALSE,$
 $!["users"][u].hasCancelled = TRUE,$
 $!["users"][u].cancelMonth = month,$
Charge cancellation fee
 $!["billQueue"] =$
 $Append(updatedBillQueue,$
 $[user \mapsto u,$
 $fee \mapsto CancellationFee,$
 $when \mapsto month + 1])$
 $]$
Observability required by stub
 $\wedge events' = Append(events, [type \mapsto "cancelsubscription", user \mapsto u])$
 $\wedge \text{UNCHANGED } \langle month \rangle$

Recurring Operations

$BillSubscribedUsers \triangleq$
 $\wedge \exists u \in USERS :$
That is subscribed
 $\wedge \vee database.users[u].subscribed = TRUE$
Subscribed from a trial so bill
 $\vee \wedge database.users[u].inTrial = TRUE$
 $\wedge database.users[u].trialStartTime < month$
Ensure users are not double billed
 $\wedge database.users[u].billedForMonth < month$
 $\wedge database' =$
 $[database \text{ EXCEPT}$
Add subscription fee
 $!["billQueue"] =$

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        Append(database.billQueue,
              [user ↦ u,
               fee ↦ SubscriptionFee,
               when ↦ month]),
        !["users"][u].billedForMonth = month
    ]
    ∧ UNCHANGED ⟨events, month⟩

ProcessBills ≜
    ∧ Len(database.billQueue) > 0
    ∧ ∃ i ∈ 1 .. Len(database.billQueue) :
        LET bill ≜ database.billQueue[i] IN
        ∧ bill.when = month
        Charge cancellation fees only a month after cancelled
        and still cancelled
        ∧ ∨ bill.fee ≠ CancellationFee
          ∨ ∧ bill.fee = CancellationFee
            ∧ ∨ database.users[bill.user].subscribed = FALSE
              Subscribed too late to cancel cancellation fee
              ∨ database.users[bill.user].subscribeMonth ≥ bill.when

        ∧ Bill(bill.user, bill.fee)
        ∧ database' =
            [database EXCEPT
              Removes head of queue
              !["billQueue"] =
                SubSeq(database.billQueue, 1, i - 1) ∘
                SubSeq(database.billQueue, i + 1, Len(database.billQueue))
            ]
        ∧ UNCHANGED ⟨month⟩

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