

Database Rows

$$\begin{aligned}
 & \text{UserRow} \triangleq [\\
 & \quad \text{subscribed} : \text{BOOLEAN} , \\
 & \quad \text{Forget canceled} \\
 & \quad \text{inTrial} : \text{BOOLEAN} , \\
 & \quad \text{trialStartTime} : \text{Nat}, \\
 & \quad \text{billedForMonth} : \text{Nat}, \\
 & \quad \text{hasHadTrialOrSubscription} : \text{BOOLEAN} , \\
 & \quad \text{hasCancelled} : \text{BOOLEAN} , \\
 & \quad \text{cancelMonth} : \text{Nat} \\
 &] \\
 \\
 & \text{StartSubscription}(u) \triangleq \\
 & \quad \text{Not subscribed} \\
 & \quad \wedge \wedge \text{database.users}[u].\text{subscribed} = \text{FALSE} \\
 & \quad \wedge \vee \text{database.users}[u].\text{inTrial} = \text{FALSE} \\
 & \quad \vee \text{database.users}[u].\text{trialStartTime} = \text{month} \\
 \\
 & \quad \wedge \text{database}' = \\
 & \quad \quad [\text{database EXCEPT} \\
 & \quad \quad \quad !["users"][u].\text{subscribed} = \text{TRUE}, \\
 & \quad \quad \quad !["users"][u].\text{hasHadTrialOrSubscription} = \text{TRUE}, \\
 & \quad \quad \quad !["users"][u].\text{hasCancelled} = \text{FALSE} \\
 & \quad \quad] \\
 & \quad \text{Observability required by stub} \\
 & \quad \wedge \text{events}' = \text{Append}(\text{events}, [\text{type} \mapsto \text{"startsubscription"}, \text{user} \mapsto u]) \\
 & \quad \wedge \text{UNCHANGED month} \\
 \\
 & \text{CancelSubscription}(u) \triangleq \\
 & \quad \text{Subscribed} \\
 & \quad \wedge \vee \text{database.users}[u].\text{subscribed} = \text{TRUE} \\
 & \quad \vee \wedge \text{database.users}[u].\text{inTrial} = \text{TRUE} \\
 & \quad \wedge \text{database.users}[u].\text{trialStartTime} < \text{month} \\
 & \quad \wedge \text{database}' = \\
 & \quad \quad [\text{database EXCEPT} \\
 & \quad \quad \quad !["users"][u].\text{subscribed} = \text{FALSE}, \\
 & \quad \quad \quad !["users"][u].\text{inTrial} = \text{FALSE}, \\
 & \quad \quad \quad !["users"][u].\text{hasCancelled} = \text{TRUE}, \\
 & \quad \quad \quad !["users"][u].\text{cancelMonth} = \text{month}, \\
 & \quad \quad \quad \text{Charge cancellation fee} \\
 & \quad \quad \quad !["billQueue"] = \\
 & \quad \quad \quad \quad \text{Append}(\text{database.billQueue},
 \end{aligned}$$

$[user \mapsto u, fee \mapsto CancellationFee]$
 $]$

Observability required by stub
 $\wedge events' = Append(events, [type \mapsto "cancelsubscription", user \mapsto u])$
 $\wedge UNCHANGED \langle month \rangle$

$StartTrial(u) \triangleq$
 $\wedge database.users[u].inTrial = FALSE$
 $\wedge database.users[u].subscribed = FALSE$
 $\wedge database.users[u].hasHadTrialOrSubscription = FALSE$
 $\wedge database' = [database \text{ EXCEPT}$
 $\quad !["users"][u].inTrial = TRUE,$
 $\quad !["users"][u].trialStartTime = month,$
 $\quad !["users"][u].hasHadTrialOrSubscription = TRUE$
 $]$

Observability required by stub
 $\wedge events' = Append(events, [type \mapsto "starttrial", user \mapsto u])$
 $\wedge UNCHANGED \langle month \rangle$

$CancelTrial(u) \triangleq$
 In active trial
 $\wedge database.users[u].inTrial = TRUE$
 $\wedge database.users[u].trialStartTime = month$
 And not subscribed
 $\wedge database.users[u].subscribed = FALSE$
 $\wedge database' = [database \text{ EXCEPT}$
 $\quad !["users"][u].inTrial = FALSE$
 $]$

Observability required by stub
 $\wedge events' = Append(events, [type \mapsto "canceltrial", user \mapsto u])$
 $\wedge UNCHANGED \langle month \rangle$

$WatchVideo(u) \triangleq$
 $\wedge \vee database.users[u].subscribed = TRUE$
 $\vee database.users[u].inTrial = TRUE$
 Remove video access at the end of canceled month
 $\vee \wedge database.users[u].hasCancelled = TRUE$
 $\quad \wedge database.users[u].cancelMonth = month$

Observability required by stub
 $\wedge events' = Append(events, [type \mapsto "watchvideo", user \mapsto u])$
 $\wedge UNCHANGED \langle month, database \rangle$

Recurring Operations

$$\begin{aligned} \text{BillSubscribedUsers} &\triangleq \\ &\wedge \exists u \in \text{USERS} : \\ &\quad \text{That is subscribed} \\ &\quad \wedge \vee \text{database.users}[u].\text{subscribed} = \text{TRUE} \\ &\quad \quad \text{Subscribed from a trial so bill} \\ &\quad \quad \vee \wedge \text{database.users}[u].\text{inTrial} = \text{TRUE} \\ &\quad \quad \quad \wedge \text{database.users}[u].\text{trialStartTime} < \text{month} \\ &\quad \text{Ensure users are not double billed} \\ &\quad \wedge \text{database.users}[u].\text{billedForMonth} < \text{month} \\ &\quad \wedge \text{database}' = \\ &\quad \quad [\text{database EXCEPT} \\ &\quad \quad \quad \text{Add subscription fee} \\ &\quad \quad \quad !["\text{billQueue}"] = \\ &\quad \quad \quad \quad \text{Append}(\text{database.billQueue}, \\ &\quad \quad \quad \quad \quad [user \mapsto u, fee \mapsto \text{SubscriptionFee}]), \\ &\quad \quad \quad !["\text{users}"][u].\text{billedForMonth} = \text{month} \\ &\quad \quad] \\ &\quad \wedge \text{UNCHANGED } \langle \text{events}, \text{month} \rangle \end{aligned}$$

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