Interaction API between clients and vendors

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1 Interaction Protocol API

• client to vendor: "order(fl(St,Dest),payment(M),grace(T1),replyBy(T2),orderID(I))". This order is for one ticket for the specified flight, and a payment of "M" is included. The vendor is asked here to respond within "T2" seconds (his time). The client is asking for a "T1" seconds "grace period", within which he would be able to return the ticket and get his money back. "T1" is to be measured on the client's clock, starting from the time he gets his ticket. The "orderID" included in the order is required unique for all the orders issued by this client. The vendor can either accept the order, by sending the ticket, or reject it by sending the money back.

• vendor to client: vendor's response to an order. (Note that the order specified a "replyBy" period. We do not here specify what happens if the vendor does not respond within this time).

  -- Acceptance: Vendor sends a requested ticket, with the following message:
      "ticket(fl(St,Dest),orderID(I))".
  -- Rejection: via the following message:
      "rejectOrder(fl(St,Dest),moneyBack(M),orderID(I),reason(R))".
      "R" can be "noTicket", "priceTooLow" or "timeOut".

• client to vendor: "returnTicket(fl(St,Dest),orderID(I))". Client can return the ticket he previously purchased from the vendor (if this is done in time (client's time)); the ID of the original order needs to be specified.

• vendor to client: "moneyBack(money(M),orderID(I))". In fact, this message needs not to be sent by the vendor, the law should automatically reply that message back whenever the vendor receives a "returnTicket" message. We can see it in our example law.

• vendor to client: "offer(fl(St,Dest),price(P))". This is just an advertisement message and there is nothing bound with this information.

• controller of vendor to vendor: "replyOrderDue(orderID(I),from(C))". This happens when the vendor doesn't reply to the order of the client in time. Then the money of the client will be returned and the order will be cancelled automatically by the law.

• controller to client/vendor: "exception(sent(X,M,Y),msgCannotSent)". This happens when the client/vendor send a message but it doesn't conform to the law, e.g. client/vendor begins trading before the trading permit has been issued by the director or the client sends a return ticket message after the grace period has already expired.

2 Example rules to regulate the interaction of clients and vendors
\[ \text{R1.} \; \text{sent}(C, \text{order}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{replyBy}(\text{C2}), \text{orderID}(\text{I})), V) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{client}(\text{CS}), \text{curOrderID}(\text{I}) \text{OCs}, \text{budget}(B) \text{OCs}, B \geq M, \text{do}(\text{dcr}(\text{budget}(B), N)), \text{do}(\text{incr}(\text{curOrderID}(\text{I}, 1))), \text{do}(\text{forward}). \]

Any client \( C \) can send an order request to any vendor \( V \) that carries the money it could like to pay for that trip.

\[ \text{R2.} \; \text{arrived}(C, \text{order}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{replyBy}(\text{C2}), \text{orderID}(\text{I})), V) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{vendor}(\text{CS}), \text{do}(\text{imposeObligation}(\text{replyOrder}(\text{orderID}(\text{I}, \text{from}(\text{C}))) \text{OCs}, \text{do}(\text{orderRequest}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{C})), \text{do}(\text{deliver})). \]

Only the vendor can accept the order from client and it will impose an obligation to force the vendor to reply to the client about its order request.

\[ \text{R3.} \; \text{oiligationDue}(\text{replyOrder}(\text{orderID}(\text{I}, \text{from}(\text{C})))) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{vendor}(\text{CS}), \text{do}(\text{orderRequest}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{C})), \text{do}(\text{deliver}(\text{Self}, \text{rejectOrder}(\text{fg}(\text{St}, \text{Dest}), \text{moneyBack}(0), \text{orderID}(\text{I}), \text{reason}(\text{timeOut})), C)), \text{do}(\text{deliver}(\text{Self}, \text{rejectOrderDue}(\text{orderID}(\text{I}, \text{from}(\text{C})), \text{Self})). \]

When the time is due for the vendor to reply to the order request of the client, vendor will be enforced to return the money back to the client and reject that order request.

\[ \text{R4.} \; \text{sent}(V, \text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{orderID}(\text{I})), C) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{vendor}(\text{CS}), \text{ticket}(\text{St}, \text{Dest}) \text{OCs}, \text{orderRequest}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{C})), \text{do}(\text{repealObligation}(\text{replyOrder}(\text{orderID}(\text{I}, \text{from}(\text{C})))), \text{do}(\text{orderRequest}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{C})), \text{do}(\text{ticket}(\text{St}, \text{Dest})), \text{balance}(B) \text{OCs}, \text{do}(\text{dcr}(\text{ticket}(\text{St}, \text{Dest}))), \text{balance}(B) \text{OCs}, \text{do}(\text{dcr}(\text{ticket}(\text{St}, \text{Dest}))), \text{soldTicketNumber}(\text{SN} \text{OCs}, \text{do}(\text{dcr}(\text{soldTicketNumber}(\text{SN}))), \text{do}(\text{forward}(V, \text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I})), C)). \]

If the vendor accept that order request from the client in time, it will forward that ticket to the client and get the payment for that trip.

\[ \text{R5.} \; \text{sent}(V, \text{rejectOrder}(\text{fg}(\text{St}, \text{Dest}), \text{moneyBack}(0), \text{orderID}(\text{I}), \text{reason}(\text{R})), C) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{vendor}(\text{CS}), \text{orderRequest}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{C})), \text{do}(\text{repealObligation}(\text{replyOrder}(\text{orderID}(\text{I}, \text{from}(\text{C})))), \text{do}(\text{orderRequest}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{C})), \text{do}(\text{ticket}(\text{St}, \text{Dest})), \text{balance}(B) \text{OCs}, \text{do}(\text{dcr}(\text{ticket}(\text{St}, \text{Dest}))), \text{balance}(B) \text{OCs}, \text{do}(\text{dcr}(\text{ticket}(\text{St}, \text{Dest}))), \text{do}(\text{forward}(V, \text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I})), C)). \]

If the vendor reject the order request from the client, it will repeal the obligation and forward that reject message.

\[ \text{R6.} \; \text{arrived}(V, \text{rejectOrder}(\text{fg}(\text{St}, \text{Dest}), \text{moneyBack}(0), \text{orderID}(\text{I}), \text{reason}(\text{R})), C) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{client}(\text{CS}), \text{arrivedTime}(\text{T})), \text{gotTicketNumber}(\text{TN} \text{OCs}, \text{do}(\text{dcr}(\text{gotTicketNumber}(\text{TN}))), \text{do}(\text{ticket}(\text{St}, \text{Dest}))), \text{do}(\text{deliver}(V, \text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{orderID}(\text{I})), C)) \]

When the client receives the reject order message, it will get its money back.

\[ \text{R7.} \; \text{arrived}(V, \text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I})), C) :- \\
\quad \text{tradingPermit}(\text{CS}, \text{client}(\text{CS}), \text{Clock}=[\text{H}, \text{M}, \text{S}, \text{MS}], \text{H is H1*3600 + M1*60 + S1}, \text{do}(\text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(\text{Tl}), \text{orderID}(\text{I}), \text{from}(\text{V})), \text{arrivedTime}(\text{T})), \text{gotTicketNumber}(\text{TN} \text{OCs}, \text{do}(\text{dcr}(\text{gotTicketNumber}(\text{TN}))), \text{do}(\text{ticket}(\text{St}, \text{Dest}))), \text{do}(\text{deliver}(V, \text{ticket}(\text{fg}(\text{St}, \text{Dest}), \text{orderID}(\text{I})), C)) \]

When the ticket arrived, the arriving time is recorded to ensure the ticket returning service.

Figure 1: Law $L_{CV}$ of Trip Ticket Ordering System (part 1)
\( R1. \) sent\((C, \text{returnTicket}(f_{1}(\text{St}, \text{Dest}), \text{orderID}(I)), V) :\)
\( \text{trading Permit}(C), \text{client}(C), \)  
\( \text{ticket}(f_{1}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(T_{1}), \text{orderID}(I), \text{from}(V), \)  
\( \text{arrivedTime}(T)) \)  
\( \text{Clock} = [H_{1}, M_{1}, S_{1}, M_{S_{1}}], \)  
\( T_{2} = H_{1} * 3600 + M_{1} * 60 + S_{1} - T, \)  
\( \text{do}(- \text{ticket}(f_{1}(\text{St}, \text{Dest}), \text{payment}(0), \text{grace}(T_{1}), \text{orderID}(I), \text{from}(V), \)  
\( \text{arrivedTime}(T))), \)  
\( \text{gotTicketNum}(I) \)  
\( \text{do}(- \text{ticket}(\text{St}, \text{Dest})), \)  
\( \text{do}(- \text{forward}(C, \text{returnTicket}(f_{1}(\text{St}, \text{Dest}), \text{payment}(0), \text{orderID}(I)), V)). \)

The ticket can only be returned within the grace time period.

\( R2. \) arrived\((C, \text{returnTicket}(f_{1}(\text{St}, \text{Dest}), \text{payment}(0), \text{orderID}(I)), V) :\)
\( \text{trading Permit}(C), \text{vendor}(C), \)  
\( \text{do}(+ \text{ticket}(\text{St}, \text{Dest}))), \text{balance}(B) \)  
\( \text{do}(dcr(\text{balance}(B), X))), \)  
\( \text{leftTicketNum}(\text{LIN}) \)  
\( \text{do}(+ \text{ticket}(\text{St}, \text{Dest}))), \text{balance}(B) \)  
\( \text{do}(dcr(\text{balance}(B), X))), \)  
\( \text{soldTicketNum}(\text{STN}) \)  
\( \text{do}(dcr(\text{soldTicketNum}(\text{STN}), 1))), \)  
\( \text{do}(- \text{forward}(V, \text{moneyBack}(\text{money}(0), \text{orderID}(I), C))), \)  
\( \text{do}(\text{deliver}(C, \text{returnTicket}(f_{1}(\text{St}, \text{Dest}), \text{orderID}(I)), V)). \)

When the returned ticket is received by the vendor, it will get the returned ticket and return the money back to the client automatically.

\( R3. \) arrived\((V, \text{moneyBack}(\text{money}(0), \text{orderID}(I), C) :\)
\( \text{trading Permit}(C), \text{client}(C), \)  
\( \text{budget}(B) \)  
\( \text{do}(+ \text{budget}(B), X))), \text{do}(\text{deliver}). \)

When the returned money is received by the client, it will be added into its budget.

\( R4. \) sent\((V, \text{offer}(f_{1}(\text{St}, \text{Dest}), \text{price}(P)), C) :\)
\( \text{trading Permit}(C), \text{vendor}(C), \text{do}(\text{forward}). \)

\( R5. \) arrived\((V, \text{offer}(f_{1}(\text{St}, \text{Dest}), \text{price}(P)), C) :\)
\( \text{trading Permit}(C), \text{client}(C), \text{do}(\text{deliver}). \)

the vendor can send and the client can receive any kind of advertisement for the tickets.

\( R6. \) sent\((X, Y) :\)
\( \text{do}(\text{deliver}(X, \text{exception}(\text{sent}(X, Y)), \text{msgCanNotSent}, X)). \)

the sender who sends msg that does not conform to the law will be informed by exception message.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{Law $\mathcal{L}_{C_{V}}$ of Trip Ticket Ordering System}(part 2)
\end{figure}