## On-Line Auction

## System Requirements

The on-line auction service allows users to submit items for auction and to bid for items that are being auctioned. Users must be registered with the system in order to be able to submit items for auction and in order to place bids. When a user (seller) submits an item for auction, the system creates a new auction and opens the auction to bids from other users (bidders). When a seller submits an item, they must provide a description of the item, a duration for the auction and a reserve price for the item. When a bidder makes a bid, the bid must be higher than the current highest bid. When the auction duration has passed the auction is closed. A closed auction succeeds if the highest bid is at least as high as the reserve price, otherwise it fails.

## Tasks for you to complete:

1. Specify Event-B types, constants, variables and invariants to describe the states of the auction service. This should contain all the following information:
   1. The current users registered to use the service.
   2. The auctions that have been created.
   3. The seller for each auction.
   4. The item description for each auction.
   5. The reserve price for each auction.
   6. The closing time of each auction.
   7. The highest bid and highest bidder for each auction.
   8. The status of each auction (open, success, fail).

The invariants should clearly specify any constraints between different state variables. Before specifying the formal model, construct an entity-relationship diagram for the auction system similar to those used in lectures. The current time may be represented by including a *clock* variable and an event that increases the clock.

1. Specify each of the following operations in Event-B:
   1. Register a new user for the service
   2. Allow a user to submit an item for auction
   3. Allow a user to make a bid on an auction
   4. Close an auction

An operation may require more than one event to deal with different cases, for example, one event for successful closing of an auction and another event for closing an auction that fails to achieve a reserve price. You should treat error cases for each operation. In each case, specify clearly in English the conditions under which an event is valid. Ensure that these conditions are also expressed as part of the event guards.

You should check your Event-B model using the Rodin tool. Installation instructions for Rodin are available on the course web page. You will need to install the ProB plug-in.