CS4271 Assignment 1

January 5, 2012

1 Notes

- This assignment is due by **9:59 PM, Wednesday, 8th February, 2012**. *No late submissions!*

- This is an individual assignment. Acts of plagiarism are subjected to disciplinary action by the university. Please refer to `http://www.comp.nus.edu.sg/students/plagiarism/` for details on plagiarism and its associated penalties.

- We shall be using Rhapsody tool for this assignment. The tool is installed in all machines of Embedded Systems Teaching Lab 1 and Embedded Systems Teaching Lab 2. The assignment must be done with the version installed in respective teaching labs.

- *Submission Instructions*: (Failure to follow these instructions may result in deduction of marks)

    1. Create a folder named your matriculation number YourMatricNumber, e.g. U123456M. Create the following files in this folder (name these files exactly as instructed.):
        - **assignment1**: Rhapsody project folders of your assignment. The animated sequence diagrams must be included in the projects.
        - **report.pdf**: Please include your particulars (name, matriculation number and NUS email address), assumptions you made in system modeling (if any), and a brief description of all the external events used in modeling.

    2. Zip (using WinZip) the entire YourMatricNumber folder (including the folder itself and all files in it) into a file YourMatricNumber.zip.

    3. Submit YourMatricNumber.zip to the IVLE Workbin Folder Lab Assignment 1 Submission.

2 Problem Description

A telephone system consists of several switches and subscribers. A subscriber can make a call by lifting her telephone receiver and dialling a phone number. Successful completion of a telephone call results in a ringtone at the receiver's end (corresponding to the dialled number). An incoming telephone call is answered by a subscriber when she hears a ringtone and lifts the telephone receiver.

Each subscriber in the telephone network has a *local switch*. For each telephone call, the *caller* first contacts its own *local switch*, which in turn contacts the *local switch* of the *callee* (defined as *remote switch* with respect to the caller). The *remote switch* (with respect to the caller) finally contacts the callee. The process is more clearly explained with an example in Figure 1.

In Figure 1, $S1$ and $S2$ have local switch $C1$. On the other hand, $S3$ and $S4$ have local switch $C2$. Following message exchanges happen when $S1$ calls $S3$: 1) $S1$ sends message to $C1$, 2) $C1$ sends message to $C2$ (for this call, $C2$ is the remote switch with respect to $S1$) and 3) $C2$ sends message to $S3$. However, $S1$ may call $S2$ and in such cases, local and remote switch are the same ($C1$ in this case).

For the sake of simplicity in this assignment, we shall assume that there are no intermediary switches required between the local and remote switch. *Therefore, any telephone call may traverse at most two telephone switches.*
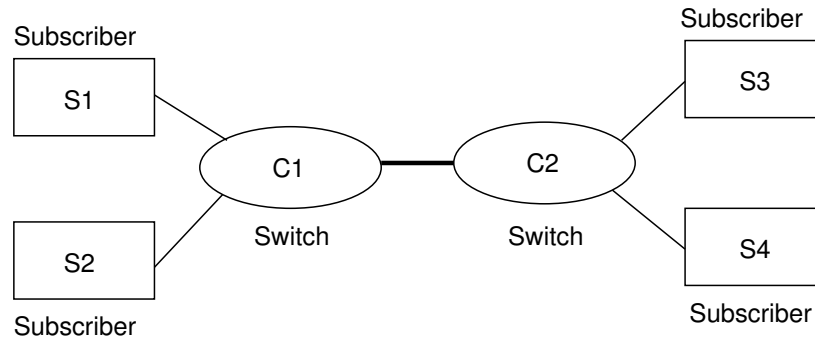
Figure 1: Telephone network

- *Subscriber*

  1. Subscribers can make *outgoing calls* or receive *incoming calls*. To make an *outgoing call*, the subscriber first lifts the telephone receiver and dials a telephone number. To answer an *incoming call*, the subscriber lifts the telephone receiver after hearing a ringtone. A subscriber may always choose not to answer an *incoming call*.

  2. A subscriber cannot receive multiple incoming calls and also cannot make multiple outgoing calls at the same time. Moreover, a subscriber cannot make an outgoing call and receive an incoming call at the same time.

- *Telephone Switch*

  1. The task of a telephone switch is to route different telephone calls. A telephone switch can either act as a *local switch* or a *remote switch*. When a subscriber lifts the telephone receiver, the local switch corresponding to the subscriber sends a `DialTone` message to the subscriber.

  2. A subscriber may dial an *invalid* number (a phone number for which no remote switch can be found). In this case, the local switch of the subscriber sends an appropriate *error* message to the caller.

  3. A local telephone switch can determine the remote switch for a particular outgoing call. After receiving the dialled number from the subscriber, the local telephone switch sends a message `Req` to the corresponding remote switch. When the remote switch receives the `Req` message, it does the following:

     (a) it first acknowledges receiving `Req` by sending a reply back to the local switch, and,

     (b) it sends a `RingTone` message to the callee to answer the call.

     Upon receiving the reply from the remote switch, the local switch sends a `WaitTone` message to the caller. If the callee answers the call, the remote switch sends another message `ConnectSuccess` to the local switch. The local switch then turns the `WaitTone` off and establishes the connection between the caller and the callee. The callee, however, may not receive the call or may be *busy* answering a different telephone call. In both the cases, therefore, the remote switch returns a `ConnectFailure` message to the local switch. The local switch then sends a `BusyTone` message to the caller.

  4. If a telephone call is terminated by the caller (*i.e.* the caller places the receiver first), a `Release` message is first sent to the remote switch by the local switch. The remote switch generates a `BusyTone` to the callee and acknowledges the `Release` message by a reply message `ReleaseConnection`. On the other hand, if the telephone call is terminated by the callee, the remote switch sends a `ReleaseConnection` message to the local switch to state that the call has been terminated. The local switch in turn sends a `NoTone` message to the caller.

- Telephone Call

  1. A telephone call consists of a caller and a callee. Both the caller and the callee must be subscribed to the telephone system for a valid telephone call.

2. There could be multiple established telephone calls in the telephone system. However, no two telephone calls share a caller or a callee.

More details

- For simplicity, you can assume a fixed number of switches and a fixed number of subscribers in your modeling. However, both the number of subscribers and the number of switches *must be more than three*. Moreover, more than one subscriber may have the same local switch.

- It is possible that both the caller and the callee have the same local switch. Therefore, the local switch and the remote switch might be same for a particular call. In that case, the message exchanges between the local and the remote switch are unnecessary. *It is recommended that your modeling put additional checks to eliminate such unnecessary messages.*

- Initially there are no *active* telephone calls and all subscribers are *idle*.

- *Caller* and *Callee* are just defined for a particular telephone call. Note that both the *caller* and the *callee* for any telephone call are *subscribers*.

- For simplicity, you may consider some fixed digit phone number (say 6 digit), in which the first 4 digits will help the local switch to connect to the remote switch.

- States in statechart should clearly reflect the status of the corresponding class/object. For example, the status of a subscriber is different when she is idle, waiting for a response or talking etc.

- You can use external events to initialize different objects (*e.g.* phone number of each subscriber).

3 Questions

1. (7 marks) Use **"Rhapsody in C"** to model the telephone system according to the specification given above. Your model should contain the class diagram and statechart for all classes. Your class diagram should contain at least three classes - the telephone switches, the subscribers and the telephone calls, as well as corresponding multiplicities and associations. Please state clearly in the report any assumptions you make during modeling of the system. Your model should comply with the requirement strictly, otherwise marks may be deducted accordingly. For example, a subscriber can only make an outgoing call when he is idle and his receiver is on-hook.

   Note: Some of the messages described in the specification *must not* be modeled as external events. A few examples include (but not limited to):

   - `DialTone`
   - `RingTone`
   - `ConnectSuccess`

2. (3+2 = 5 marks) Suppose there are three different subscribers s_1, s_2 and s_3 with three different local switches c_1, c_2 and c_3, respectively. Initially, all subscribers are *idle*.

   (a) Generate an animated sequence diagram named *q2Sequence* for the following scenario.
      - s_1 makes a call to s_2.
      - While the $s_1 \rightarrow s_2$ call is in process, s_3 makes a call to s_2.
      - $s_1 \rightarrow s_2$ call is established.
      - Since s_2 is busy in talking, outgoing call by s_3 is refused.
      - s_3 hangs up.
      - s_1 hangs up.

- s_2 hangs up.
- s_3 redials the number of s_2.
- s_2 does not like s_3 and therefore, she did not pick up.
- s_3 finally hears the busytone.
- s_3 hangs up.

(b) For the above system, produce a sequence of events that leads the system into a state as follows:

- Two subscribers, say s_1 and s_2 wanted to talk with each other with no other subscriber attempting any telephone call in between. Both s_1 and s_2 make call to each other, both calls fail to establish and both s_1 and s_2 hang up.

Generate an animated sequence diagram named *q3Sequence* corresponding to the above scenario.

END OF ASSIGNMENT 1