1995 Paper 4 Question 2

Concurrent Systems

An expansion card to manage a number of telephone lines is to be added to a workstation. The hardware is able to pick up and put down lines, dial a number and answer the phone. It generates interrupts to signal conditions such as a phone line being answered.

(a) What additions have to be made to the operating system to allow programs to use the phone hardware? [4 marks]

(b) Suggest a mechanism by which the operating system can block a user process until a phone line is answered. [4 marks]

A *voice mail server* is to be developed and given exclusive use of the lines. It is to be activated by a user clicking the button on his/her active badge, a mobile device allowing a user's location to be determined. The voice mail server then phones the user at the phone nearest to him/her. After authentication by typing a code, the server reads the user's mail to him/her using a speech synthesiser. The pseudo-code procedure shown below is part of this service. Every time a badge click is detected, a thread is forked to execute procedure `ActiveBadge_Click_Handler`.

```
VAR line : ARRAY [1..NUM_LINES] OF {Free,Busy};

PROCEDURE ActiveBadge_Click_Handler(user: STRING;
                                    location: STRING);
VAR which_line: INTEGER;
BEGIN
  which_line := 1;
  WHILE (line[which_line] = Busy) DO  (* Loop until a line *)
    which_line := which_line+1;       (* becomes free *)
    IF (which_line > NUM_LINES) THEN which_line := 1;
  END;
  line[which_line] := Busy;           (* Mark line as busy *)
  Pickup(which_line);
  Dial_Authenticate_Speak(which_line,user,location);
                                      (* Does clever stuff *)
  Hangup(which_line);
  line[which_line] := Free;           (* Mark line as free *)
END;
```

(c) Explain whether or not it is possible to implement the server using threads provided by a run-time system. [4 marks]

(d) Outline a possible race condition in the program. On what types of system could it occur? [4 marks]

(e) How could the program be amended to avoid the race condition? Note: Language-specific details are unimportant. [4 marks]