Tik-79.231 Parallel and distributed digital systems **Autumn 2000**
Home assignment #3
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Design of a data communications protocol

Our task is to design a data communications protocol. The architecture of the system is a *ring* comprising *nodes* and *connections* between the nodes. Each node is able to store one *frame*. The node may transit its frame to the next node, provided the next node is empty. Otherwise it will have to wait for the next node to become free. Having transmitted the frame to its successor, the node itself becomes free. As a consequence, the frames are going round the ring.

Connected to each node is a *user* which is able to put a frame to the node if the node is free. Otherwise the user will have to wait for the node to become free. If the frame in the node is addressed to the user connected to the node, the frame is delivered to the user, upon which the node becomes free. In its normal mode the user only receives frames. Sometimes it may need to send a frame to some other user. It will wait until the node is free and the frame has been transmitted. While waiting, the user is capable of receiving but it does not want to send a new frame before successful transmission of the previous frame.

The structure of a frame is simple: it contains the name of the recipient and data to be transmitted.

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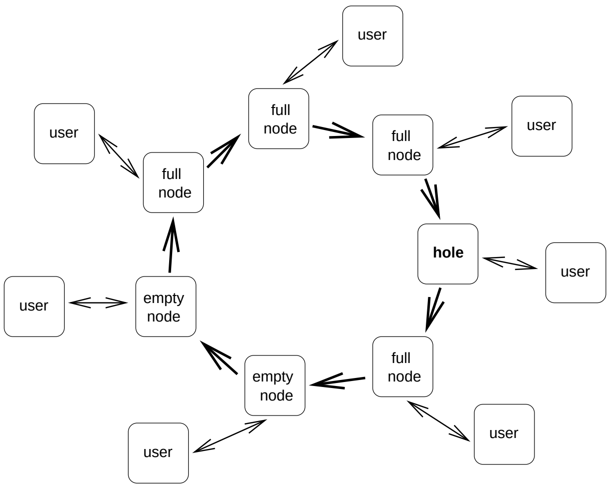
(a) Present a Pr/T net model of the protocol when there are N nodes. Write your net in the PROD description language and find a deadlock with a tester. When and how does the deadlock occur? Hint: try first by selecting a small N in PROD.

To avoid the deadlock we now modify the protocol. One of the free nodes is marked as the *hole*. Unlike other free nodes, the user cannot put a frame in a hole. When a node transmits its frame to a hole it becomes the hole itself.



(b) Modify your net model to comply with the protocol changes. Can the system still deadlock? Try to generate a complete reachability graph and make a table of graph sizes with different values for N (number of nodes in the ring).

(c) Examine if the waiting time of the user is bounded or if it may have to wait infinitely before transmission of a frame. Present your formula in LTL logics and as a PROD verify formula. How sure can you be that the properties you observed are valid in rings of arbitrary size? What do think about the usability of the protocol?

N.B.: The home assignment is an individual task. No signs of cooperation shall be visible in the returned assignments.

The deadline for the Home Assignment #3 is Nov 17, 2000; use the post box between rooms B336 and B337 in the Computer Science building. You can also return the home assignment by email in PostScript or LaTex formats. The homework assistant is Jukka Honkola (email: Jukka.Honkola@hut.fi).