Exercise Session 7
Terminating Reliable Broadcast

Problem 1

Can we implement TRB with the eventually perfect failure detector $\diamond P$, if we assume that at least one process can crash?

The answer is no. Consider an instance *trb* of TRB with sender process s. We show that it is impossible to implement TRB from an eventually perfect failure-detector primitive $\diamond P$, if even one process can crash.

Consider an execution E_1 , in which process s crashes initially and observe the possible actions for some correct process p: due to the termination property of TRB, there must be a time T at which p trb-delivers $\triangle$.

Consider a second execution E_2 that is similar to E_1 up to time T, except that the sender s is correct and *trb-broadcasts* some message m, but all communication messages to and from s are delayed until after time T. The failure detector behaves in E_2 as in E_1 until after time T. This is possible because the failure detector is only eventually perfect. Up to time T, process p cannot distinguish E_1 from E_2 and *trb-delivers*. According to the *agreement* property of TRB, process s must *trb-deliver* as well, and s delivers exactly one message due to the *termination* property. But this contradicts the *validity* property of TRB, since s is correct, has *trb-broadcast* some message $m \neq \triangle$, and must *trb-deliver* m.

Problem 2

Show that P is the weakest failure detector for Group Membership.

In order to show that P is the weakest failure detector for Group Membership, we need to show that:

- P can be used to implement Group Membership.
- Group Membership can be used to implement P.

The first direction stems directly from the Group Membership implementation in the class.

For the second direction, we assume that all processes run Group Membership algorithm. Whenever a new view is installed, all processes that are freshly removed from the view are added to the suspected set. This approach satisfies both *Strong Completeness* and *Strong Accuracy* of P, directly from the corresponding properties of Group Membership.