Exercise Session 3
Causal Broadcast

October 22, 2012

Exercise 1

Can we devise a broadcast algorithm that does not ensure the causal delivery *property but only its nonuniform variant: no correct process p_i delivers a message m_2 unless p_i has already delivered every message m_1 such that $m_1 \rightarrow m_2$?*

The answer is *no*. Assume by contradiction that some algorithm does not ensure the *causal delivery* property but ensures its nonuniform variant. This means that the algorithm has some execution in which some process p delivers some message m without delivering a message m' that causally precedes m. Given that we assume a model where processes do not self-destruct, p might as well be correct, in which case it violates even the nonuniform variant.

Exercise 2

Suggest an optimization of the garbage collection scheme of Algorithm 1' (slide 24).

When removing a message m from the past, we can also remove all the messages that causally precede this message — and then recursively those that causally precede these. This means that a message stored in the past must be stored with its own distinct past.

Exercise 3

Why the condition on slide 30 is $VC[pk] \geq VC_x[pk]$ and not just $VC[pk] = VC_x[pk]$? Can you construct an execution where the local vector clock is greater than the received local clock for one place?

The greater or equal condition is important in order to handle old, non-causal messages. Just consider the case when in the beginning all processes send a message. Each message will carry a vector clock with all zeroes. When a process delivers one such message, the vector clock of the process gets incremented at a position matching the rank of the sender. During the next iteration, the process needs to deliver a message containing all zeroes in its vector clock, while the process has a non-zero value in at least one position.