Traffic Light State Machines

In lecture, we discussed this state machine representing two interconnected traffic lights:

Looking at these two machines at the same time (the product machine + the original multi state-machine), can anyone see a problem with the product machine? Specifically, look at the "R" state of the original separate machines. What events can lead us out of the R state? (r2 or r1) Is that represented in our product machine? For example, assume that the first machine is in state W and the second is in state R (so the corresponding product state is WR). What events can lead us out of the product state WR? g1, but also r1. r1 is not represented in the product machine. The full product machine looks something like:
Which is very bad. It's now possible to reach the state GG from our initial state, and our invariant (at least one light is red) is not preserved on all transitions. Our problem is that we assigned events r1 and r2 some meaning, and assumed that that meaning was maintained in the state machine. r1 meant "machine one is transitioning to red", so we assumed that the only time when r1 would occur is when state one transitioned from green to red.

How can we fix this? We could add a third state machine, which enforces the idea that only certain sequences of events are valid. This is kind of what we did later in lecture, when we returned to the roadwork flag example. We could also add new transitions to the original separate states to handle this case:

Which, beside making our product machine nearly unreadable (grrr openoffice), also fixes the problem and allows us to maintain our invariant along all transitions which leave a state where the invariant holds.