

**MACHINE** ChangeLightR1

**REFINES** ChangeLight

**SEES** TrafficLights.ctx

**VARIABLES**

*xlights*    Extended lights, Red, Green and Amber lights  
*delay*     delay between Amber and Red or Red and Green  
*adir*  
*togreen*  
*tored*

**INVARIANTS**

*inv1* : *adir* ∈ *DIRECTION*  
*inv2* : *togreen* ∈ *BOOL*  
*inv3* : *tored* ∈ *BOOL*  
*inv4* : *togreen* = *TRUE* ⇒ *tored* = *FALSE*  
*inv5* : *xlights* ∈ *DIRECTION* → *LIGHTS*  
*inv6* : ∀*d*.*d* ∈ *DIRECTION* ∧ *xlights*[{*d*}] ⊆ {*Green*, *Amber*}  
          ⇒ *xlights*[*CONFLICT*[{*d*]}] ⊆ {*Red*}  
*inv7* : *togreen* = *TRUE* ⇒ *CONFLICT*[{*adir*}] ≪ (*lights* ≪ {*adir* ↦ *Green*}) = *CONFLICT*[{*adir*}] ≪  
          (*xlights* ≪ {*adir* ↦ *Green*})  
*inv8* : *togreen* = *TRUE* ⇒ (*xlights*(*adir*) = *Green* ⇒ *lights* = *xlights*)  
*inv9* : *delay* ⊆ *DIRECTION*  
*inv10* : *tored* = *TRUE* ⇒ (*xlights* ≪ {*adir* ↦ *Red*} = *lights* ≪ {*adir* ↦ *Red*})  
*inv11* : *togreen* = *FALSE* ∧ *tored* = *FALSE* ⇒ *lights* = *xlights*

**EVENTS**

**Initialisation**

**begin**  
  **with**  
    *lights'* : *lights'* = *xlights'*  
    *act1* : *xlights* : |*xlights'* ∈ *DIRECTION* → {*Red*, *Green*}  
          ∧ (∀*d*.*d* ∈ *DIRECTION* ∧ *xlights'*(*d*) = *Green*  
          ⇒ *xlights'*[*CONFLICT*[{*d*]}] ⊆ {*Red*})  
    *act2* : *delay* := ∅  
    *act3* : *togreen* := *FALSE*  
    *act4* : *tored* := *FALSE*  
    *act5* : *adir* := *DIRECTION*

**end**

**Event** ToGreen ≐

**Refines** ToGreen

**when**  
  *grd1* : *togreen* = *TRUE*

$grd2 : xlights(adir) = Red$   
 $grd3 : xlights[CONFLICT[\{adir\}]] \subseteq \{Red\}$   
 $grd4 : adir \notin delay$

**with**

$gdir : gdir = adir$

**then**

$act1 : xlights(adir) := Green$

$act2 : togreen := FALSE$

**end**

**Event** ToGreenInit  $\hat{=}$

**Refines** ToGreen

**any**

$gdir$

**where**

$grd1 : gdir \in DIRECTION$

$grd2 : togreen = FALSE$

$grd3 : tored = FALSE$

$grd4 : xlights(gdir) = Red$

**then**

$act1 : adir := gdir$

$act2 : togreen := TRUE$

**end**

**Event** ToGreenAmber  $\hat{=}$

**Which is** convergent

**any**

$dir$

**where**

$grd1 : togreen = TRUE$

$grd2 : dir \in CONFLICT[\{adir\}]$

$grd3 : xlights(dir) = Green$

**then**

$act1 : xlights(dir) := Amber$

$act2 : delay := delay \cup \{dir\}$

**end**

**Event** ToGreenRed  $\hat{=}$

**Which is** convergent

**any**

$dir$

**where**

$grd1 : togreen = TRUE$

$grd2 : dir \in DIRECTION$

$grd3 : dir \in CONFLICT[\{adir\}]$

$grd4 : xlights(dir) = Amber$

$grd5 : dir \notin delay$   
 $grd6 : xlights(adir) \neq Green$   
**then**  
 $act1 : xlights(dir) := Red$   
 $act2 : delay := delay \cup \{adir\}$   
**end**

**Event** Delay  $\hat{=}$

**Which is** convergent

**any**  
 $dir$   
**where**  
 $grd3 : dir \in delay$   
**then**  
 $act1 : delay := delay \setminus \{dir\}$   
**end**

**Event** ToRed  $\hat{=}$

**Refines** ToRed

**when**  
 $grd1 : tored = TRUE$   
 $grd2 : xlights(adir) = Amber$   
 $grd3 : adir \notin delay$   
**with**  
 $rdir : rdir = adir$   
**then**  
 $act1 : xlights(adir) := Red$   
 $act2 : tored := FALSE$   
**end**

**Event** ToRedInit  $\hat{=}$

**Refines** ToRed

**any**  
 $rdir$   
**where**  
 $grd1 : rdir \in DIRECTION$   
 $grd2 : xlights(rdir) = Green$   
 $grd3 : tored = FALSE$   
 $grd4 : togreen = FALSE$   
**then**  
 $act1 : adir := rdir$   
 $act2 : tored := TRUE$   
**end**

**Event** TeRedAmber  $\hat{=}$

**when**

*grd1* : *tored* = *TRUE*  
*grd2* : *xlights*(*adir*) = *Green*

**then**

*act1* : *xlights*(*adir*) := *Amber*  
*act2* : *delay* := *delay* ∪ {*adir*}

**end**

**VARIANT**

**END**