A Broadcast Distributed Manager Protocol: First Model

The specification is given below. In the following, for readability, rules like $p(x) \longrightarrow p(x') : x' = x$ will be written as $p(x) \longrightarrow p(x)$, thus, omitting the equalities that leave values unchanged.

Generation of the Initial States

1. $init \longrightarrow init_p(i,p) \;:\; true$
2. $init_p(i,p) \longrightarrow init_i(i,p) \mid init_p(i,p') \;:\; p' > p$
3. $init_p(i,p) \longrightarrow \epsilon \;:\; true$
4. $init_i(i,p) \longrightarrow pt(i,p,l,o,a) \mid init_i(i',p) \;:\; i' > i,\ l = \neg\mathbf{lck},\ o = \neg\mathbf{own},\ a = \mathbf{nil}$
5. $init_i(i,p) \longrightarrow pt(i,p,l,o,a) \;:\; l = \neg\mathbf{lck}, o = \mathbf{own}, a = \mathbf{rd}$

Detection of Read and Write Faults

6. $\epsilon \longrightarrow rf(i,p) \;:\; true$
7. $\epsilon \longrightarrow wf(i,p) \;:\; true$

Read Handler

8. $rf(i,p) \mid pt(j,q,l,o,a) \longrightarrow hrp(i,p) \mid pt(j,q,l',o,a) \;:\; i = j, p = q, l = \neg\mathbf{lck}, o = \neg\mathbf{own}, a = \mathbf{nil}, l' = \mathbf{lck}$
9. $hrp(i,p) \mid pt(k,q,l,o,a) \longrightarrow hre(i,p) \mid pt(k,q,l',o,a) \mid sr(k,p) \;:\; k \neq i, p = q, l = \neg\mathbf{lck},\ o = \mathbf{own}, l' = \mathbf{lck}$
10. $hre(i,p) \mid pt(j,q,l,o,a) \longrightarrow pt(j,q,p,l',o,a') \;:\; i = j, p = q, l = \mathbf{lck},\ l' = \neg\mathbf{lck},\ a' = \mathbf{rd}$

Read Server

11. $sr(i,p) \mid pt(j,q,l,o,a) \longrightarrow pt(j,q,l',o,a') \;:\; i = j, p = q, l = \mathbf{lck},\ l' = \neg\mathbf{lck},\ a' = \mathbf{rd}$

Write Miss

12. $wf(i,p) \mid pt(j,q,l,o,a) \longrightarrow hwp(i,p) \mid pt(j,q,l',o,a) \;:\; i = j, p = q, l = \neg\mathbf{lck},\ a = \mathbf{nil},\ l' = \mathbf{lck}$
13. $wf(i,p) \mid pt(j,q,l,o,a) \longrightarrow hwp(i,p) \mid pt(j,q,l',o,a) \;:\; i = j, p = q, l = \neg\mathbf{lck},\ o = \neg\mathbf{own},\ a = \mathbf{rd}, l' = \mathbf{lck}$
14. $wf(i,p) \mid pt(j,q,l,o,a) \longrightarrow hwi(i,p) \mid pt(j,q,l',o,a) \;:\; i = j, p = q, l = \neg\mathbf{lck},\ o = \mathbf{own},\ a = \mathbf{rd}, l' = \mathbf{lck}$
15. $hwp(i,p) \mid pt(k,q,l,o,a) \longrightarrow hwi(i,p) \mid pt(k,q,l',o,a) \mid sw(k,q) \;:\; k \neq i, p = q, l = \neg\mathbf{lck},\ o = \mathbf{own}, l' = \mathbf{lck}$

Invalidation

16. $hwi(i,p) \mid pt(j,q,l,o,a) \longrightarrow pt(j,q,l',o',a')\ \ [\, pt(k,r,m,s,b) \hookrightarrow pt(k,q,m,s,b')\,] \;:\; j = i, p = q, l = \mathbf{lck}, l' = \neg\mathbf{lck},\ o' = \mathbf{own},\ a' = \mathbf{wrt}, k \neq i,\ p = r,\ b' = \mathbf{nil}$

Write Server

17. $sw(i,p) \mid pt(j,q,l,o,a) \longrightarrow pt(j,q,l',o',a') \;:\; i = j,\ p = q,\ l = \mathbf{lck},\ o = \mathbf{own}, l' = \neg\mathbf{lck},\ o' = \neg\mathbf{own},\ a' = \mathbf{nil}$

Example 4. Below we describe one of the possible runs of the previous specifications in which read and write faults are handled on a system with two processors that after the first read fault will share (with read access) the same page.

$init \Rightarrow \ldots \Rightarrow\ pt(8,1,\neg\mathbf{lck},\neg\mathbf{own},\mathbf{nil}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_6 rf(8,1) \mid pt(8,1,\neg\mathbf{lck},\neg\mathbf{own},\mathbf{nil}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_8 hrp(8,1) \mid pt(8,1,\mathbf{lck},\neg\mathbf{own},\mathbf{nil}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_9 hre(8,1) \mid sr(5,1) \mid pt(8,1,\mathbf{lck},\neg\mathbf{own},\mathbf{nil}) \mid pt(5,1,\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_{11} hre(8,1) \mid pt(8,1,\mathbf{lck},\neg\mathbf{own},\mathbf{nil}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_{10} pt(8,1,\neg\mathbf{lck},\neg\mathbf{own},\mathbf{rd}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_7 wf(5,1) \mid pt(8,1,\neg\mathbf{lck},\neg\mathbf{own},\mathbf{rd}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_{14} hwi(5,1) \mid pt(8,1,\neg\mathbf{lck},\neg\mathbf{own},\mathbf{rd}) \mid pt(5,1,\mathbf{lck},\mathbf{own},\mathbf{rd})$
$\Rightarrow_{16} pt(8,1,\neg\mathbf{lck},\neg\mathbf{own},\mathbf{nil}) \mid pt(5,1,\neg\mathbf{lck},\mathbf{own},\mathbf{wrt})$