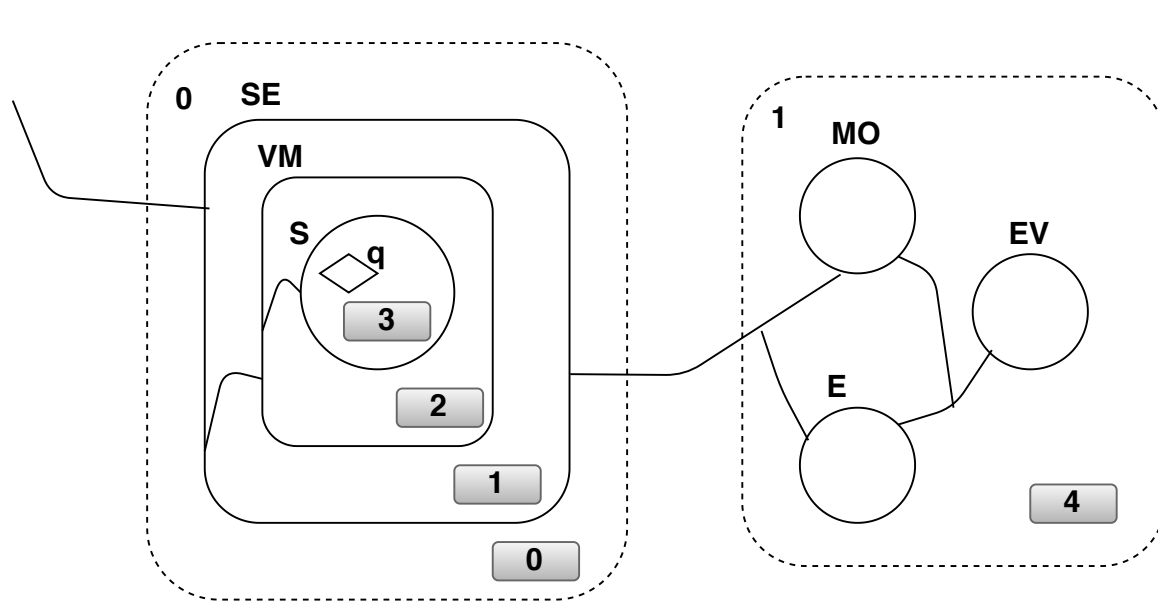


# Horizontal Scaling

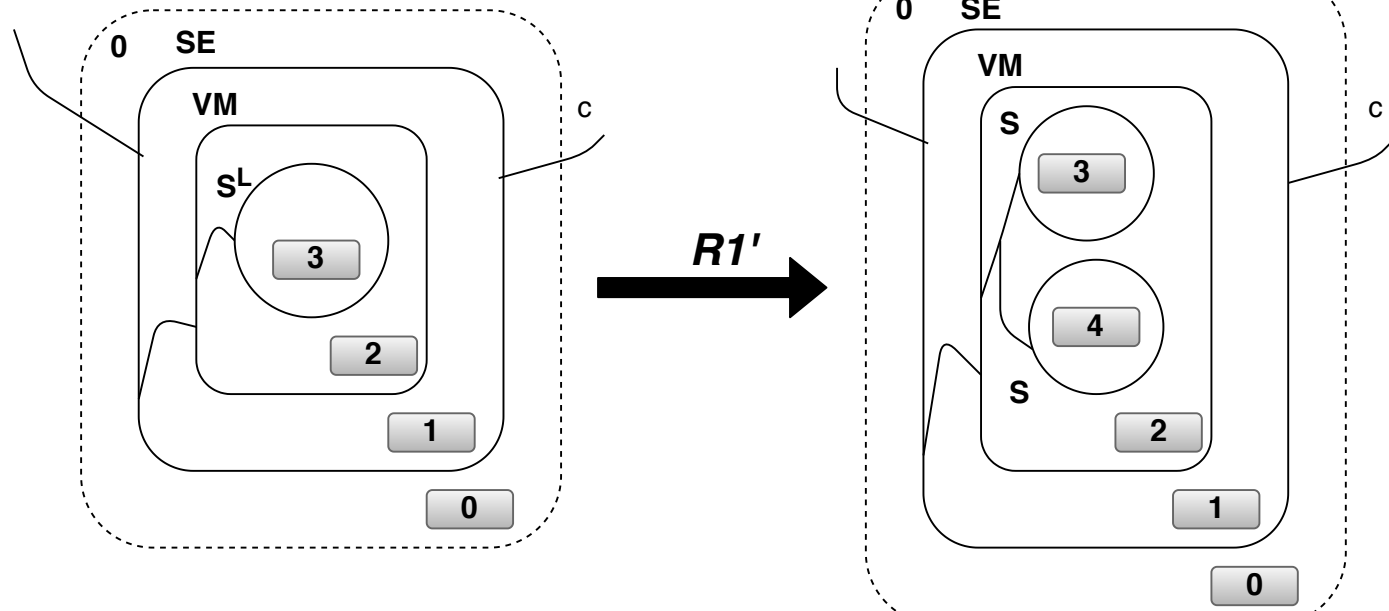
Notations  
MO : Monitor  
EV : Evaluator  
E : Effector  
SE : Server  
VM : Virtual Machine  
S : Service Instance  
q : request  
dx : site x

## Cloud Structure for horizontal scaling

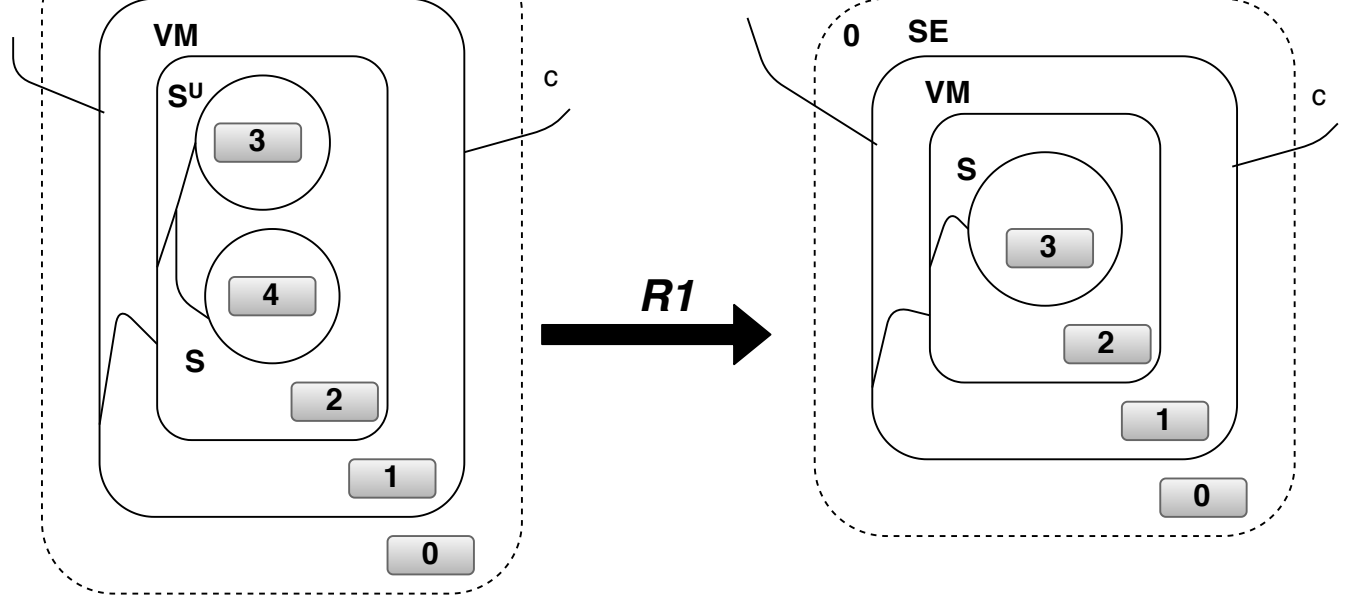


$$CS = (SE.(VM.(S.(qlq3)d2)d1)d0) \parallel (MO \mid EV \mid E \mid d4)$$

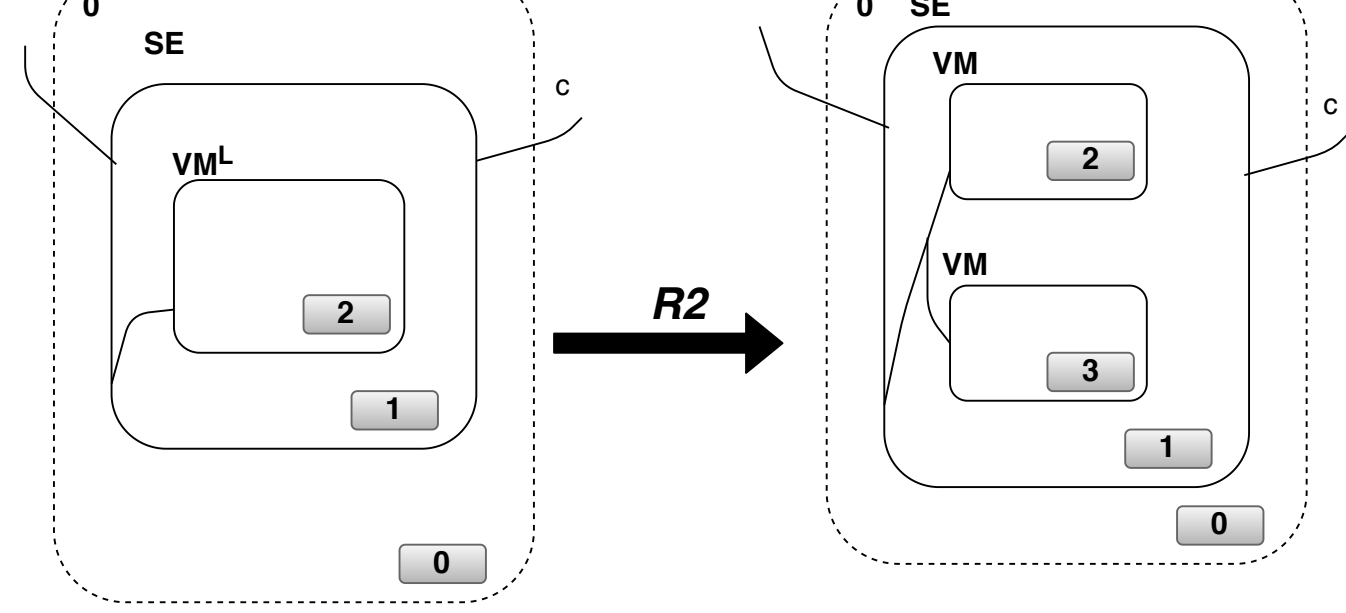
## Reaction rules for horizontal scaling



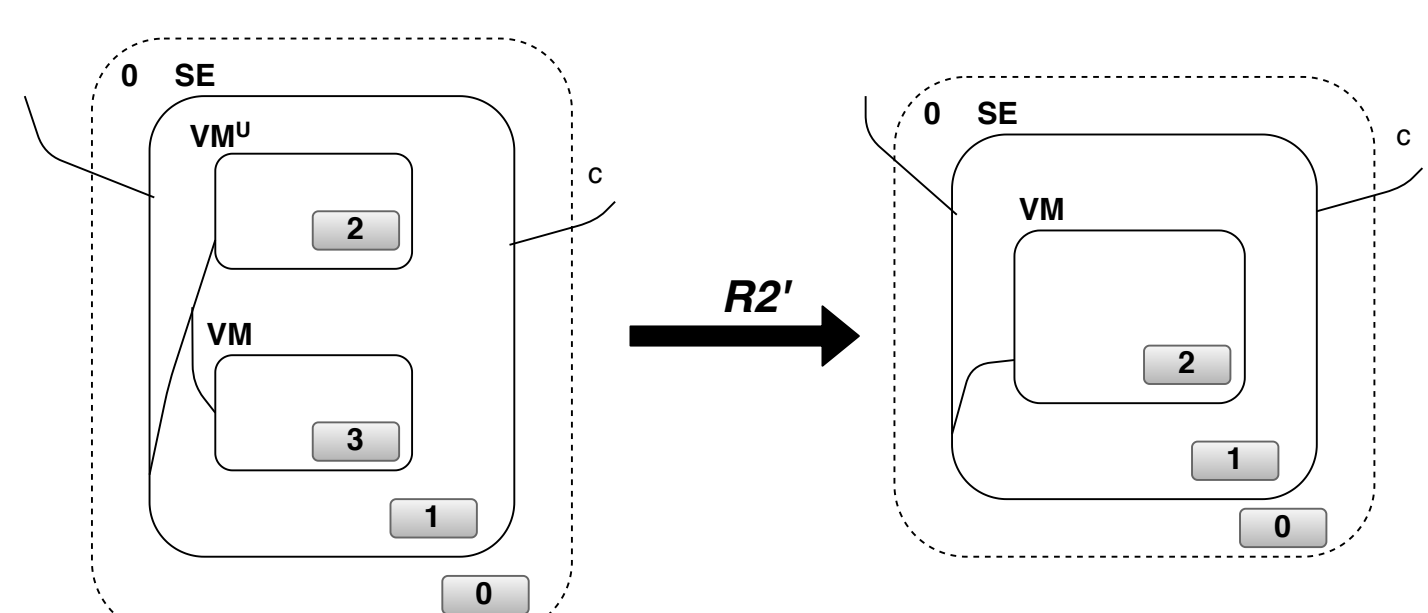
$$R1 = (SE.(VM.((S^L.d3) \mid d2) \mid d1)d0) \rightarrow (SE.(VM.((S.d3) \mid (S.d4) \mid d2) \mid d1)d0)$$



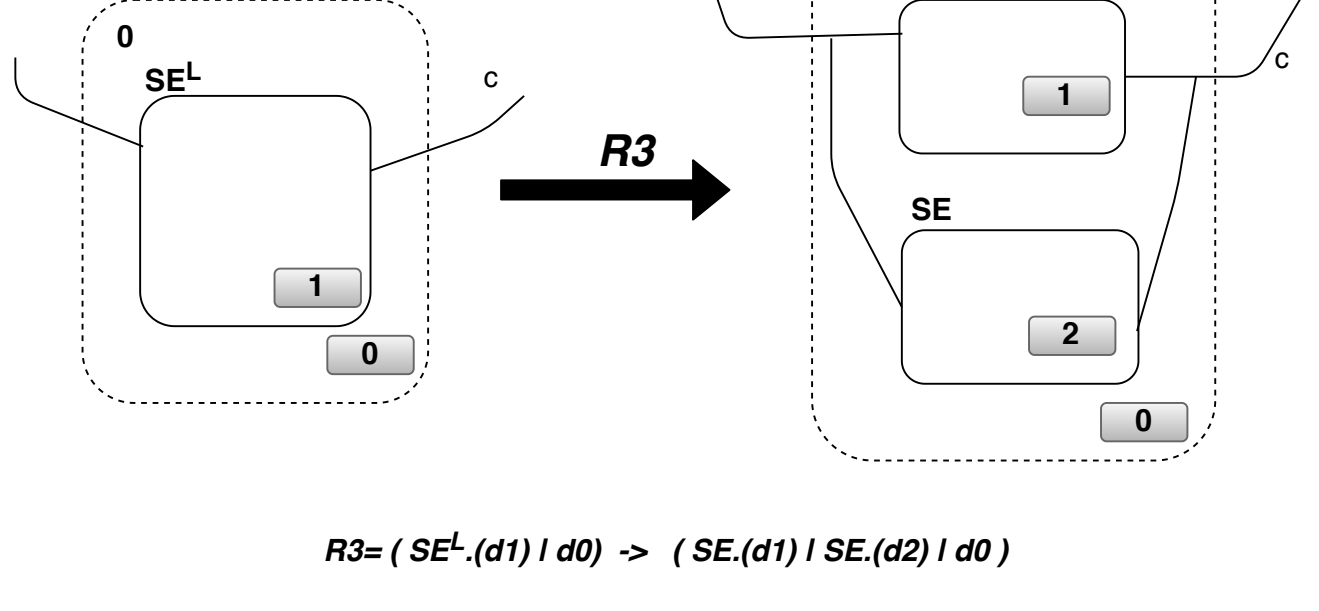
$$R1' = (SE.(VM.((S^U.d3) \mid (S.d4) \mid d2) \mid d1)d0) \rightarrow (SE.(VM.((S.d3) \mid d2) \mid d1)d0)$$



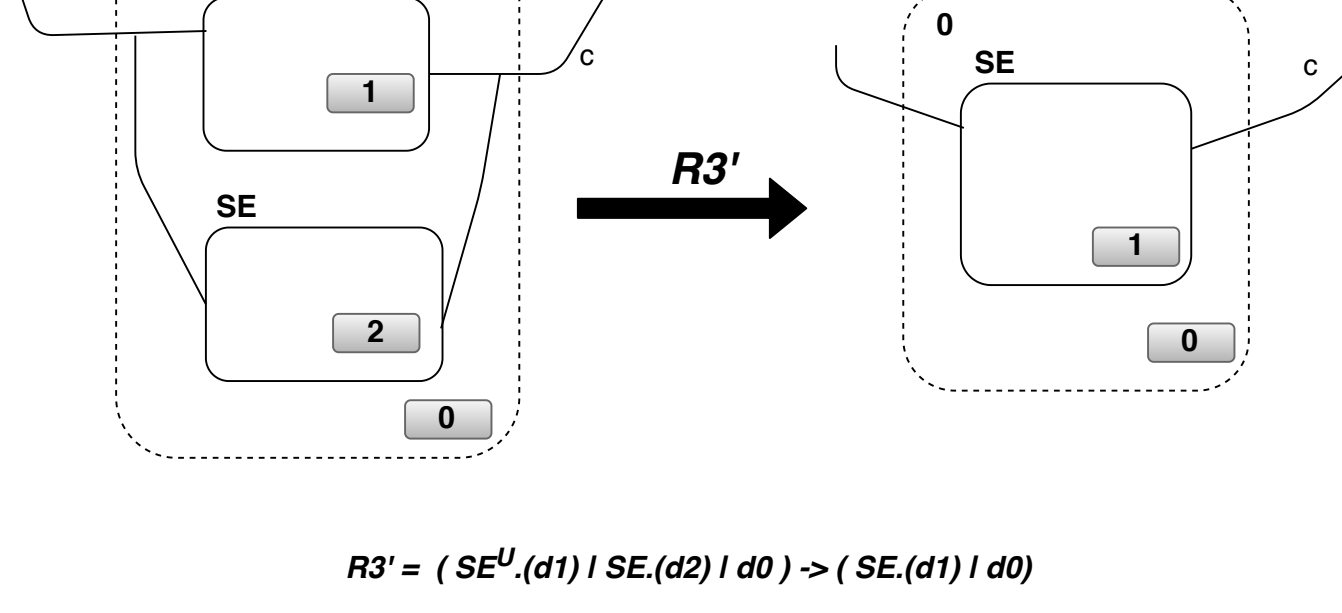
$$R2 = (SE.(VM^L.(d2) \mid d1) \mid d0) \rightarrow (SE.(VM.(d2) \mid VM.(d3) \mid d1) \mid d0)$$



$$R2' = (SE.(VM^U.(d2) \mid VM.(d3) \mid d1) \mid d0) \rightarrow (SE.(VM.(d2) \mid d1) \mid d0)$$



$$R3 = (SE^L.(d1) \mid d0) \rightarrow (SE.(d1) \mid SE.(d2) \mid d0)$$

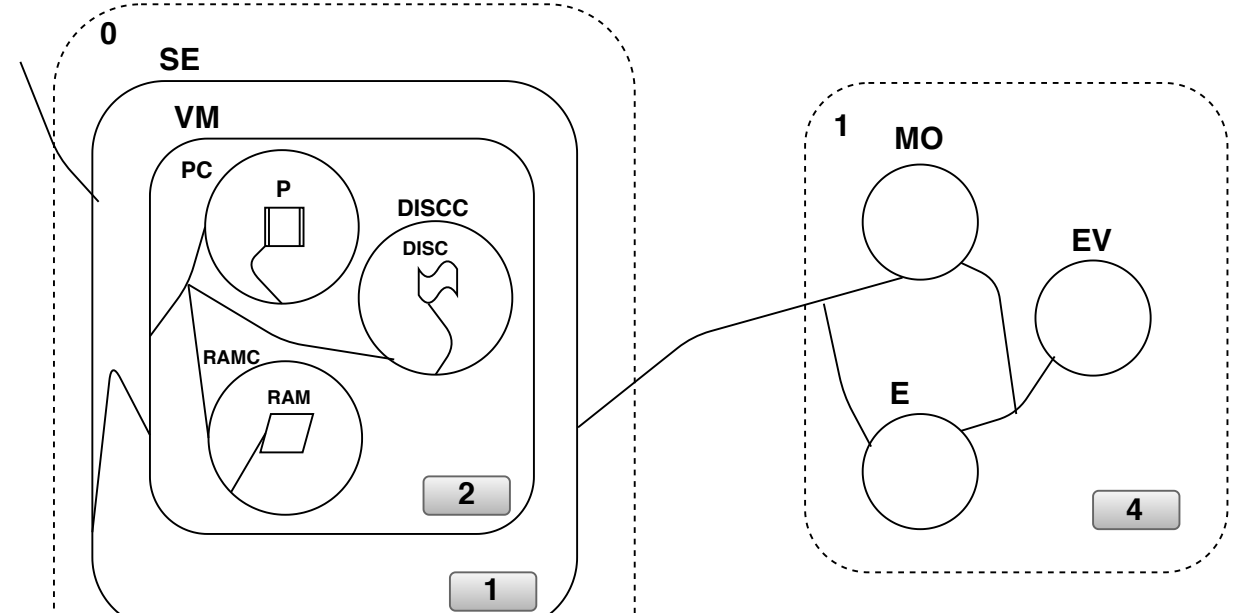


$$R3' = (SE^U.(d1) \mid SE.(d2) \mid d0) \rightarrow (SE.(d1) \mid d0)$$

# Vertical Scaling

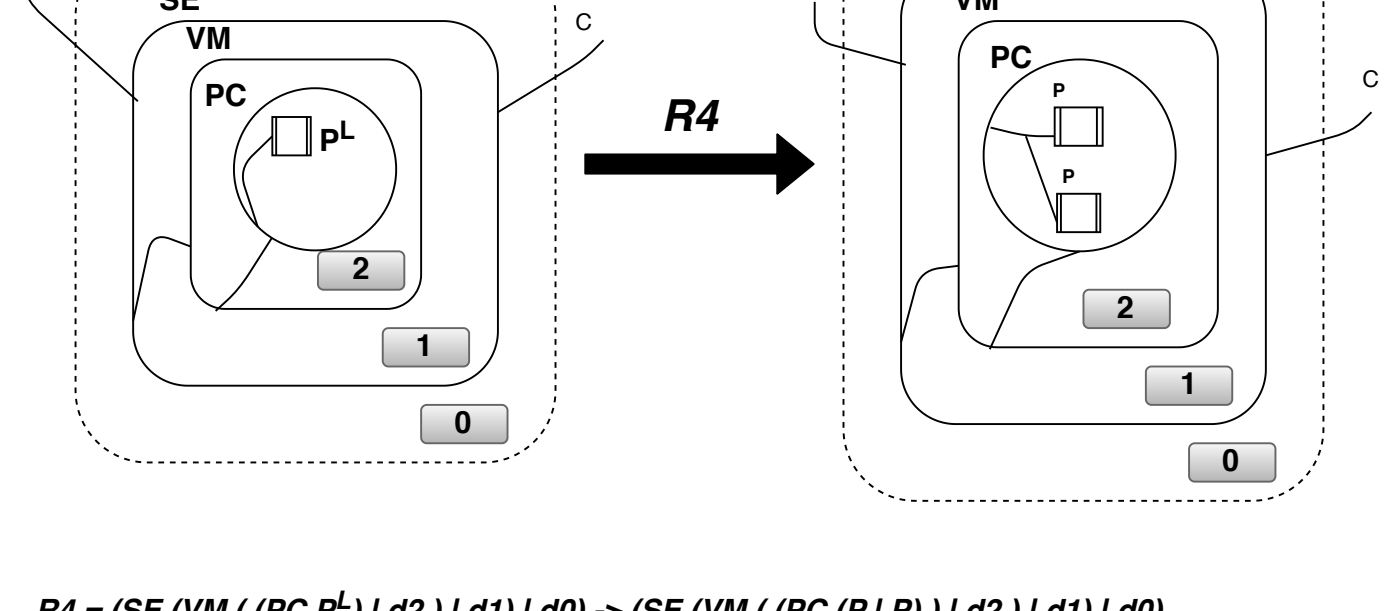
Notations  
SE : Server  
VM : Virtual Machine  
S : Service Instance  
PC : Space containing processors  
RAMC : Space containing RAM  
DISCC : Space containing DISC  
P : Processor  
RAM : Ram  
DISC : Disc  
dx : site x

## Cloud Structure for vertical scaling

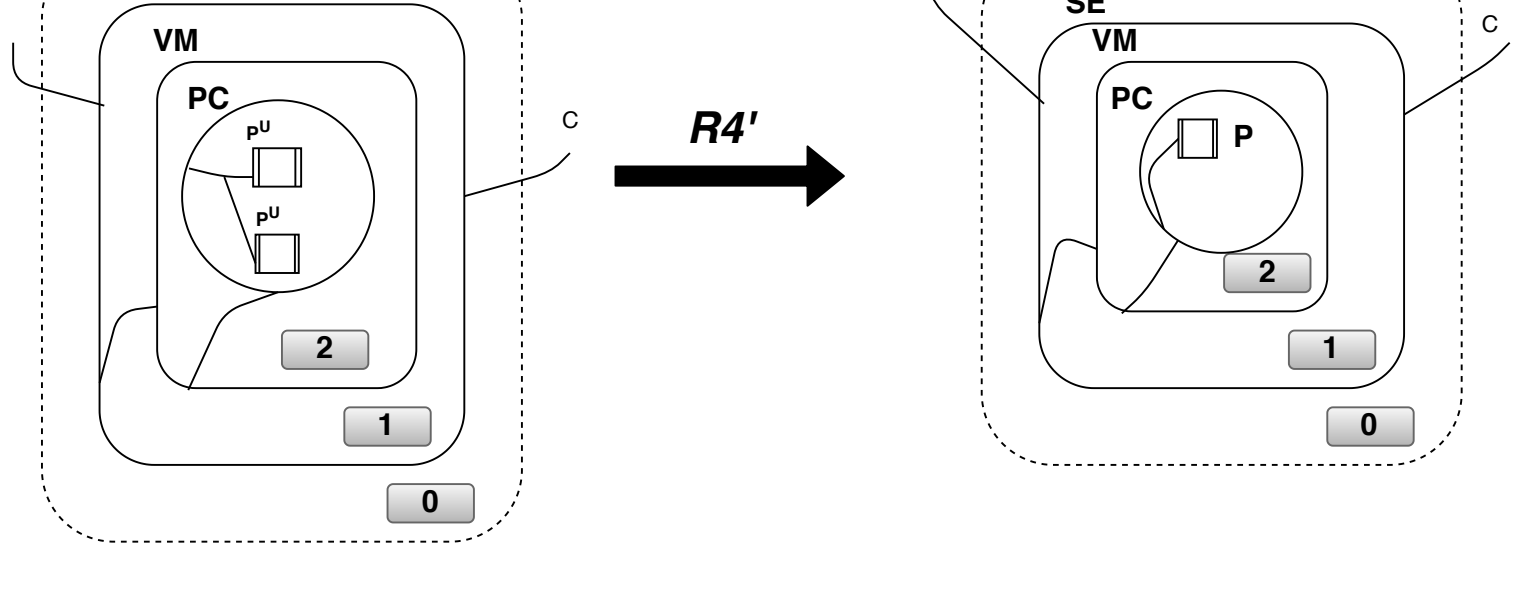


$$CS = (SE.(VM.((PC.P) \mid (RAMC.RAM) \mid (DISC.DISCC) \mid d2) \mid d1) \mid d0) \parallel (MO \mid EV \mid E \mid d4)$$

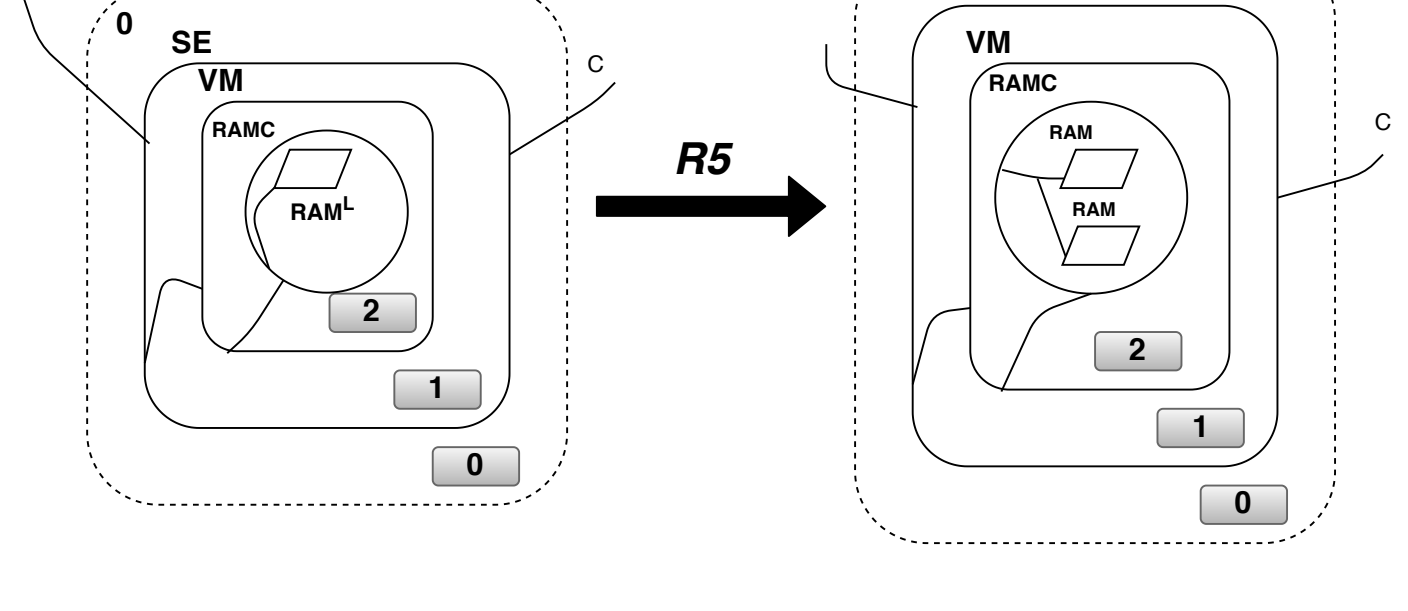
## Reaction rules for vertical scaling



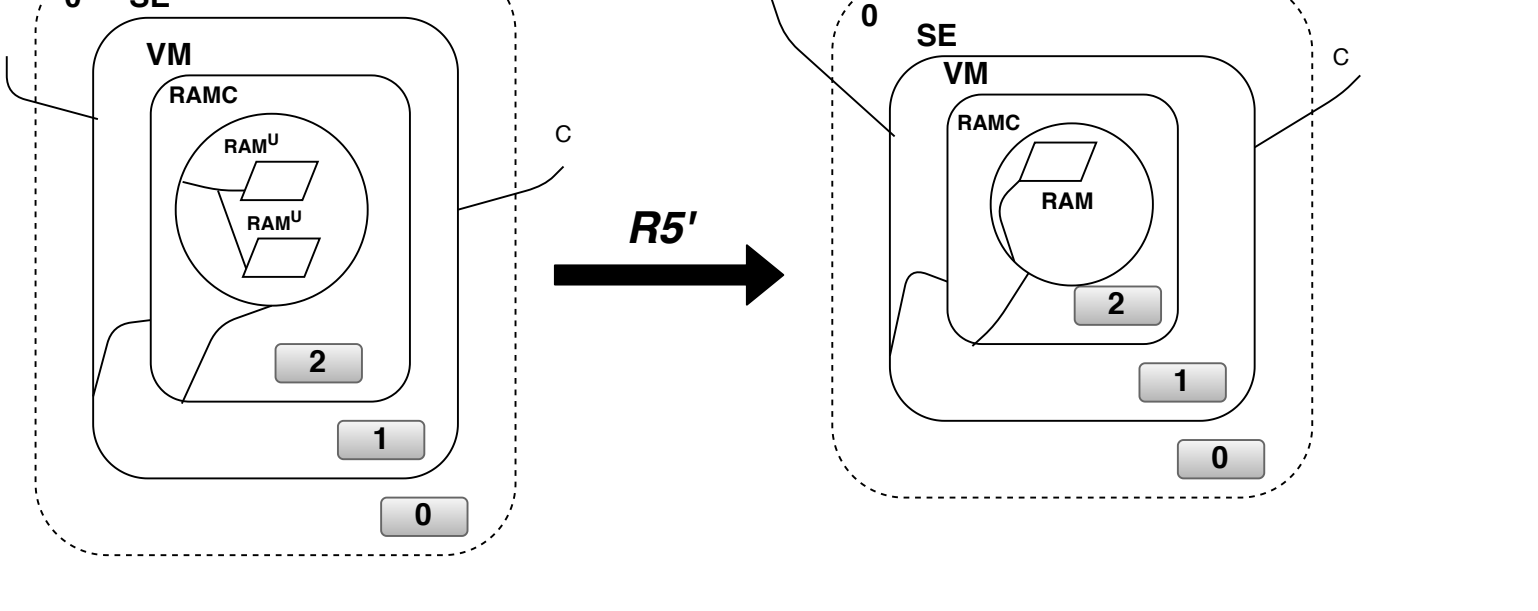
$$R4 = (SE.(VM.((PC.P^L) \mid d2) \mid d1) \mid d0) \rightarrow (SE.(VM.((PC.(P \mid P)) \mid d2) \mid d1) \mid d0)$$



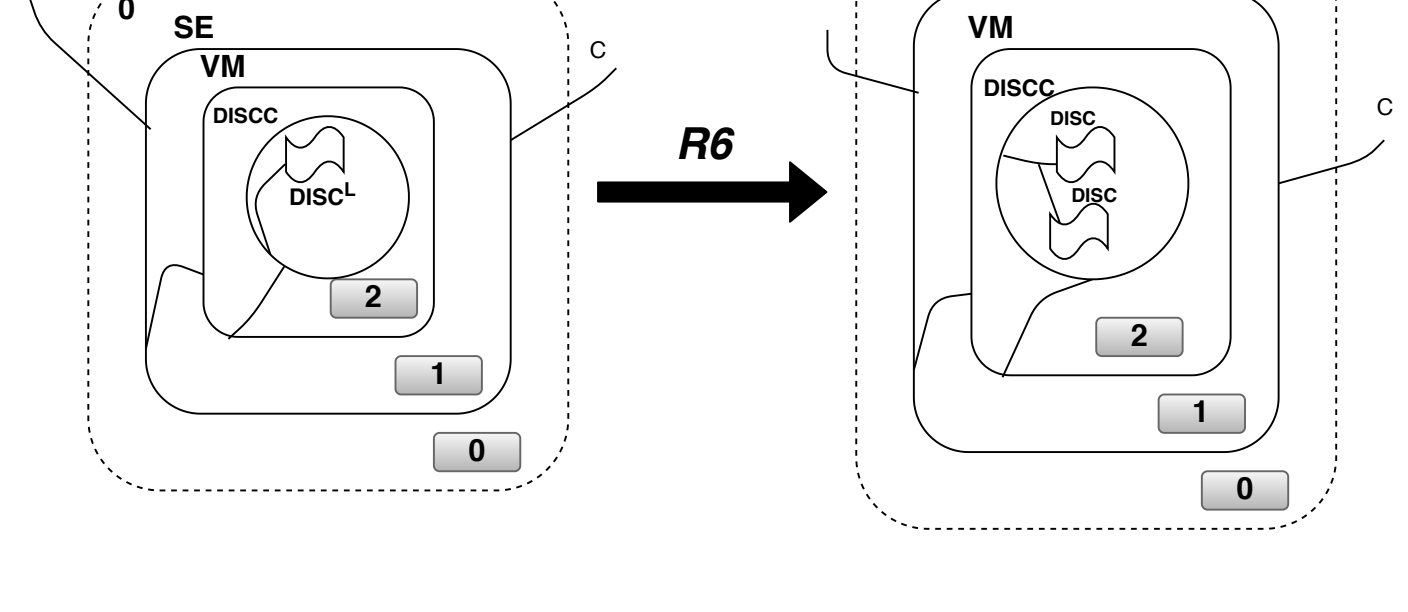
$$R4' = (SE.(VM.((PC.(P^U \mid P^U)) \mid d2) \mid d1) \mid d0) \rightarrow (SE.(VM.((PC.P) \mid d2) \mid d1) \mid d0)$$



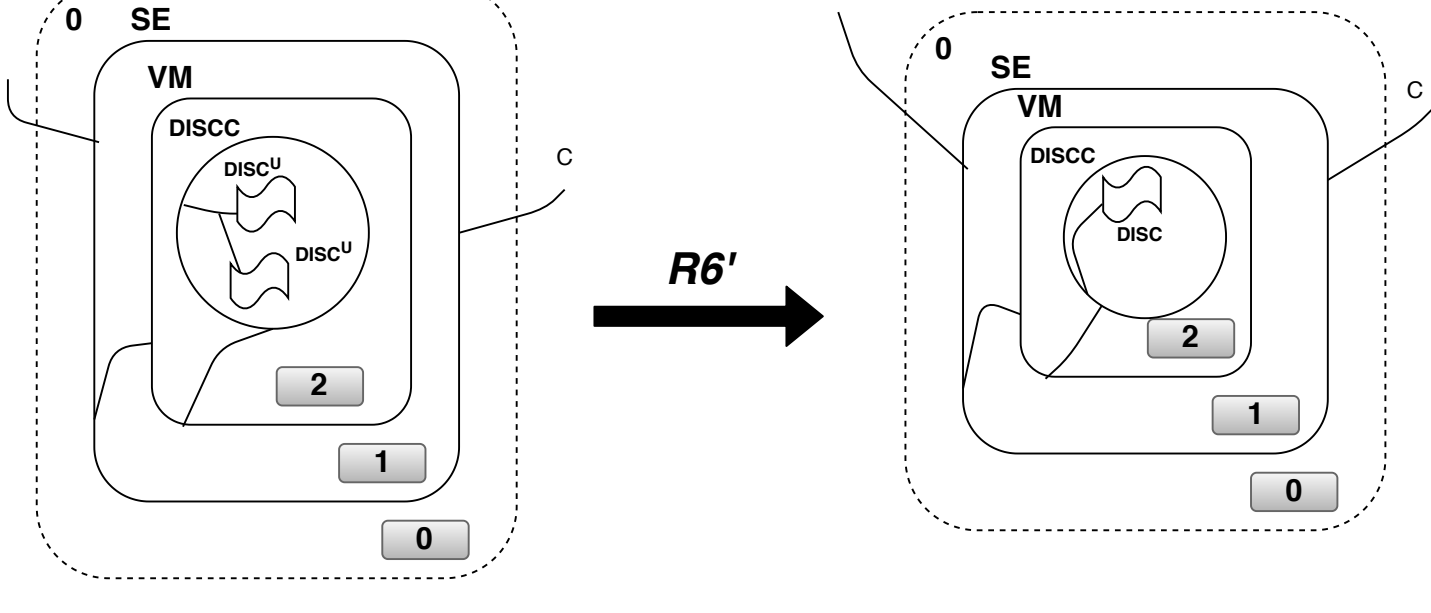
$$R5 = (SE.(VM.((RAMC.RAM^L) \mid d2) \mid d1) \mid d0) \rightarrow (SE.(VM.((RAMC.(RAM \mid RAM)) \mid d2) \mid d1) \mid d0)$$



$$R5' = (SE.(VM.((RAMC.(RAM^U \mid RAM^U)) \mid d2) \mid d1) \mid d0) \rightarrow (SE.(VM.((RAMC.RAM) \mid d2) \mid d1) \mid d0)$$



$$R6 = (SE.(VM.((DISCC.DISCC^L) \mid d2) \mid d1) \mid d0) \rightarrow (SE.(VM.((DISCC.(DISC \mid DISC)) \mid d2) \mid d1) \mid d0)$$



$$R6' = (SE.(VM.((DISCC.(DISC^U \mid DISC^U)) \mid d2) \mid d1) \mid d0) \rightarrow (SE.(VM.((DISCC.DISCC) \mid d2) \mid d1) \mid d0)$$

