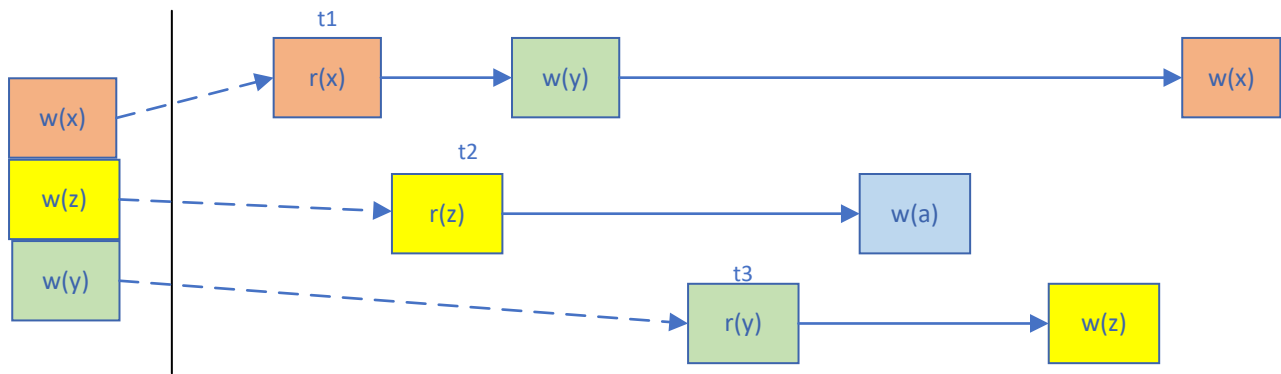
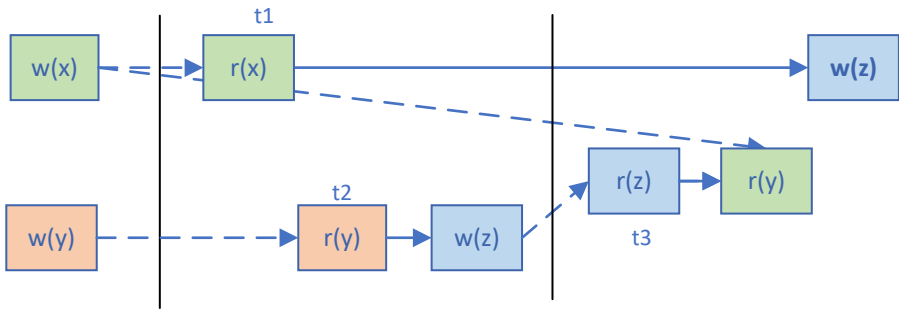


Sirakami False Positive

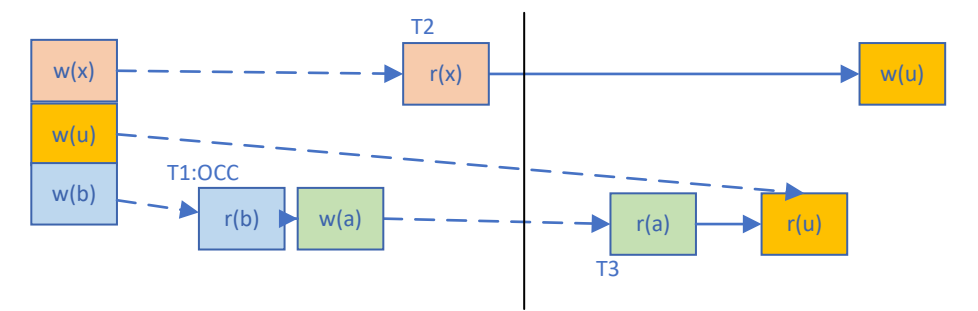


sirakami_false_positive																
write_conflict																
	3occ		2occ1ltx		1occ1ltx1occ		1ltx2occ		1occ2ltx		1ltx1occ1ltx		2ltx1occ		3ltx	
t1	OCC	c	OCC	c	OCC	c	LTX	c	OCC	c	LTX	c	LTX	c	LTX	c
t2	OCC	c	OCC	a:t3	LTX	c	OCC	c	LTX	c	OCC	a:t3	LTX	c	LTX	c
t3	OCC	a:t1	LTX	c bd1 r t1	OCC	a:t1	OCC	a:t1	LTX	a bd1 r t1 w t2	LTX	c bd1 r t1	OCC	a t1	LTX	a bd1 r t1 w t2

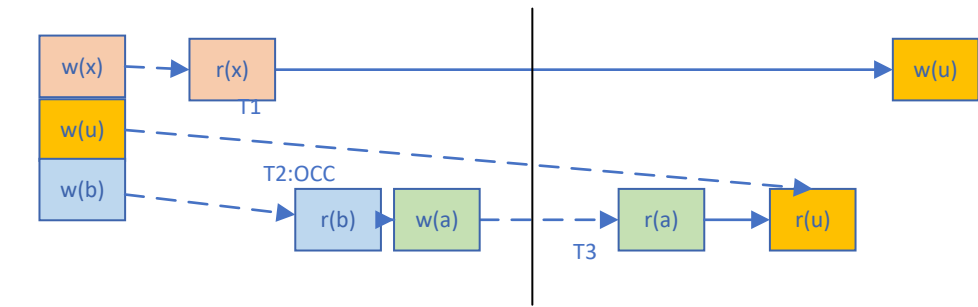


sirakami_false_positive																
read_crown																
	3occ		3occ1ltx		1occ1ltx1occ		1ltx1occ1occ		1occ2ltx		1ltx1occ1ltx		2ltx1occ		3ltx	
t1	OCC	c	OCC	c	OCC	c	LTX	c	OCC	c	LTX	c	LTX	c	LTX	c
t2	OCC	c	OCC	c	LTX	c	OCC	c	LTX	c	OCC	c	LTX	c	LTX	c
t3	OCC	a:t1	LTX	c bd3 RUB 2	OCC	a:t1	OCC	a:t1	LTX	a bd1 RUB 2	LTX	a bd1 RUB 2	OCC	a:t1	LTX	a bd1 RUB 2

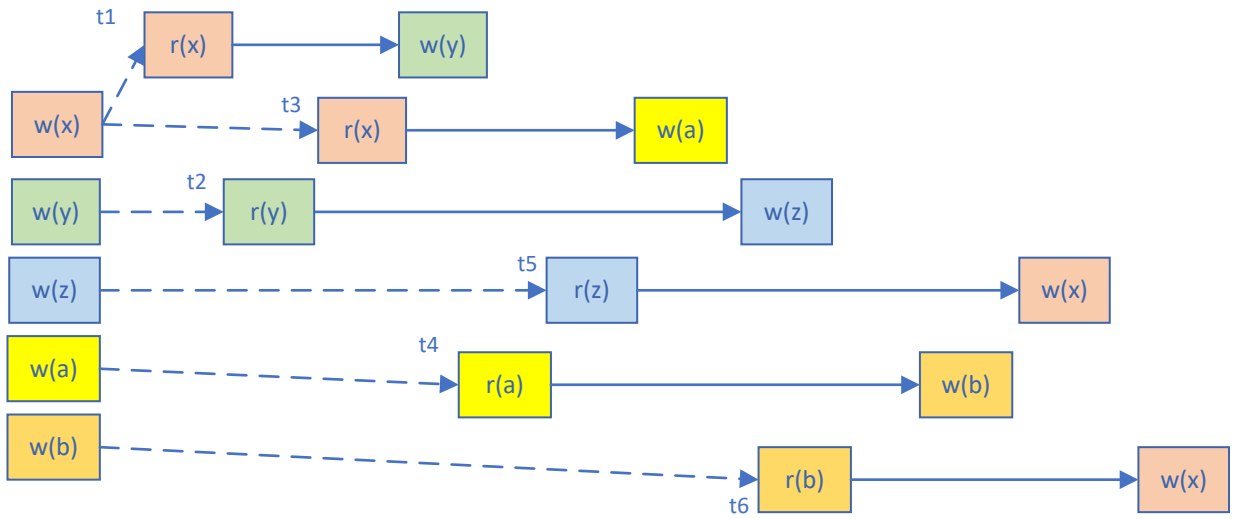
Sirakami False Positive OCC-LTX order



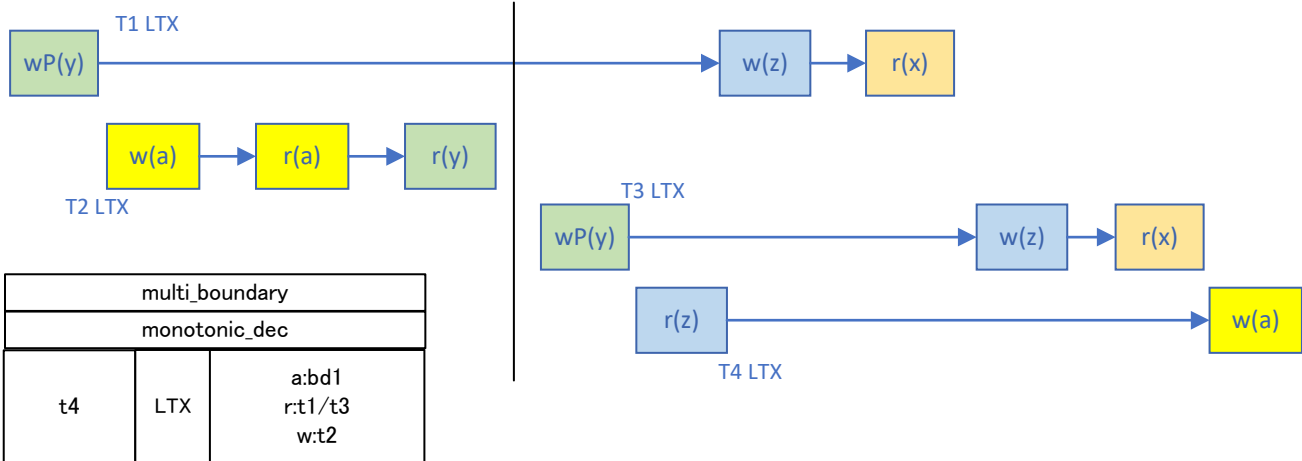
sirakami_false_positive				
out_of_boundary				
aborted			committable	
t2	LTX	c:bd2	OCC	c
t3	LTX	a:bd2 RUB:(2<)1	LTX	c:bd3 RUB:t1



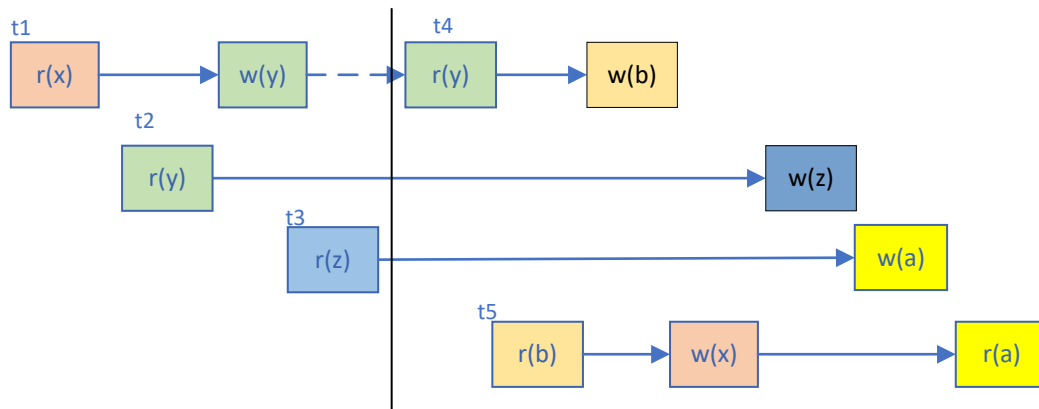
sirakami_false_positive				
inner_boundary				
aborted			committable	
t1	LTX	c:bd1	OCC	c
t3	LTX	a:bd1 RUB:2	LTX	c:bd3 RUB:t2



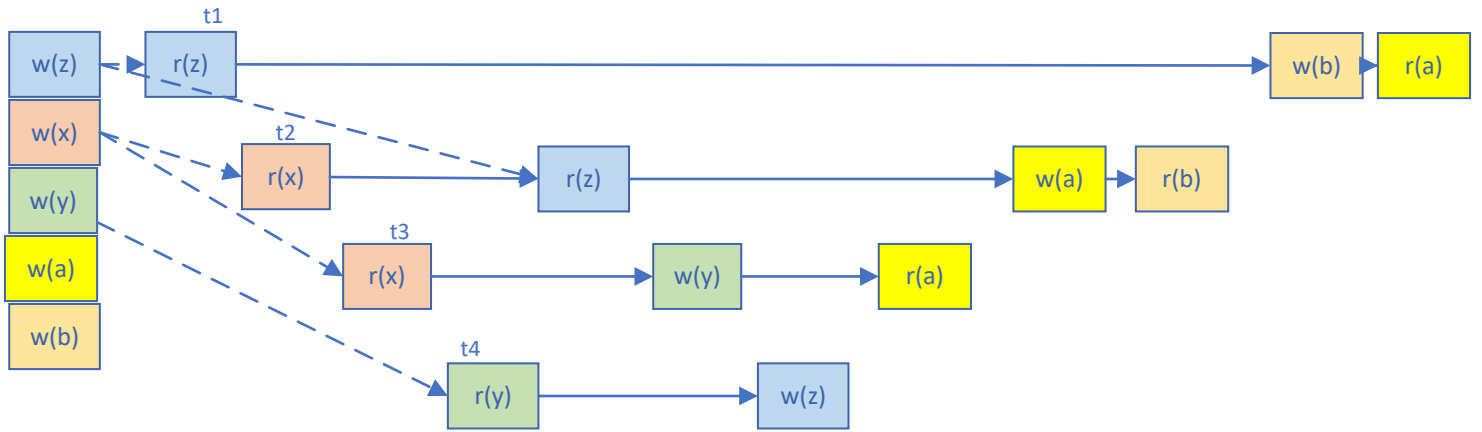
multi_boundary					
parallel					
t1	LTX	c:bd1	t4	LTX	c:bd3 r:t3
t2	LTX	c:bd1 r:t1	t5	LTX	c:bd1 r:t2
t3	LTX	c:bd3	t6	LTX	c:bd3 r:t4



multi_boundary		
monotonic_dec		
t4	LTX	a:bd1 r:t1/t3 w:t2



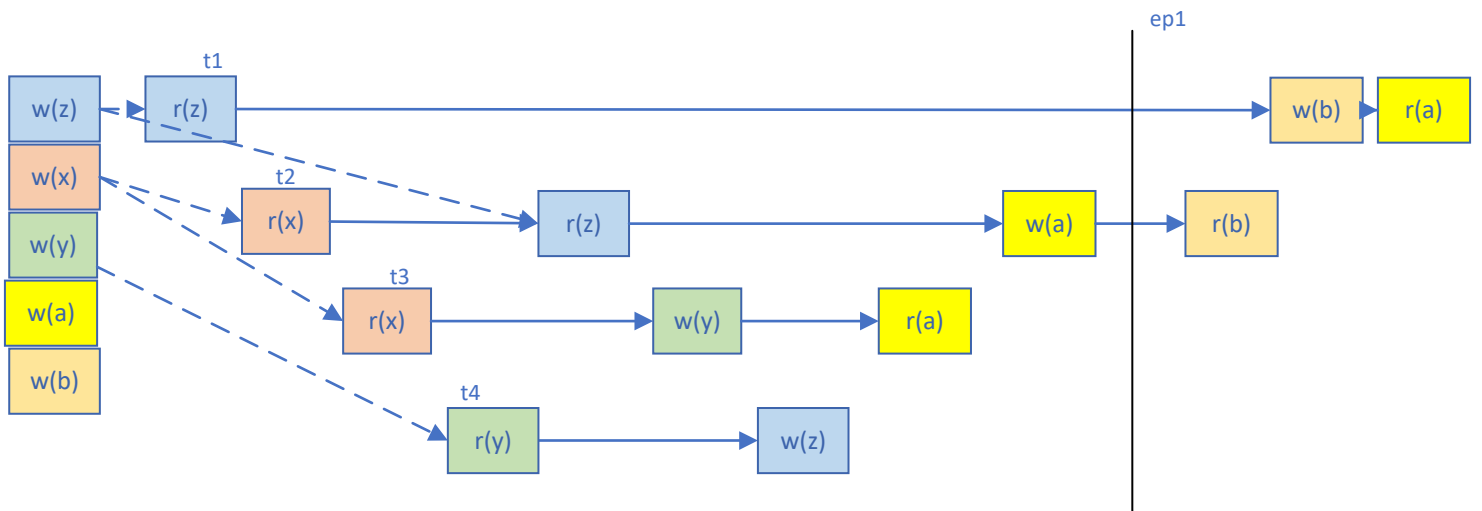
multi_boundary		
monotonic_dec_delayed		
t5	LTX	a:bd1 r:t3/t4 w:t1



cascading_wait					
eager_update			lazy_update		
t1	LTX	c:bd1	t1	LTX	c:bd1
t2	LTX	a:bd1 r:t1 w:t1	t2	LTX	a:bd1 r:t1 w:t1
t3	LTX	c:bd1 r:t2	t3	LTX	c:bd2 r:t2
t4	LTX	a bd2 r:t3 w:t2	t3	LTX	c:bd3 r:t3

t4 bd→3 wait
 t3 bd→2 wait
 t4 bd→3→2 t2::r(z) t4:abt
 t2 bd→1 wait
 t3 bd→2→1
 t1 commit
 t2 t1::r(a) t2::abt
 t3 c (bdは1のまま)

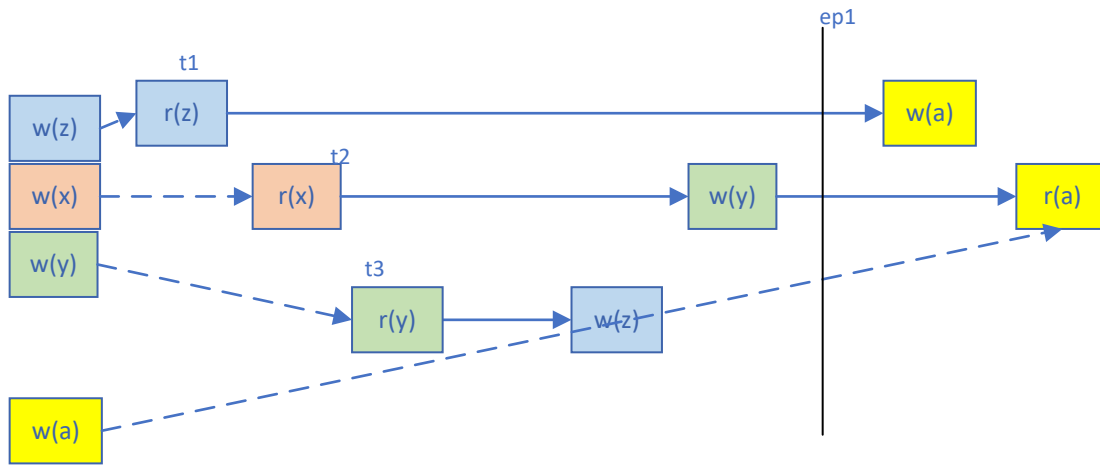
t4 bd→3 wait
 t3 bd→2 wait
 t2 bd→1 wait
 t1 commit
 t2 t1::r(a) t2::abt
 t3 t2がabtなので、bdは2のまま c
 t4 t2がabtなので、bdは3のまま c



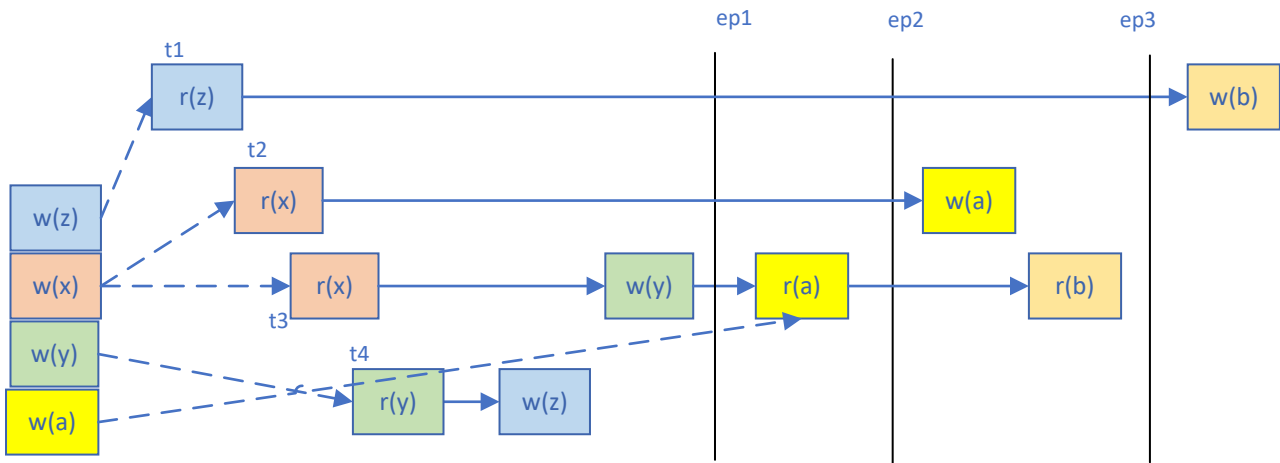
cascading_wait		
lazy_update_with_epoch		
t1	LTX	c:bd1
t2	LTX	user abort@ep1
t3	LTX	c:bd2 r:t2
t4	LTX	c:bd3 r:t3

ep1
going t1

t4 bd3 wait
 t3 bd2 wait (eagerならここでt4 abort)
 epoch end start
 t2 abort
 t3 validation → commit → waited release
 t4 validation → commit
 epoch end



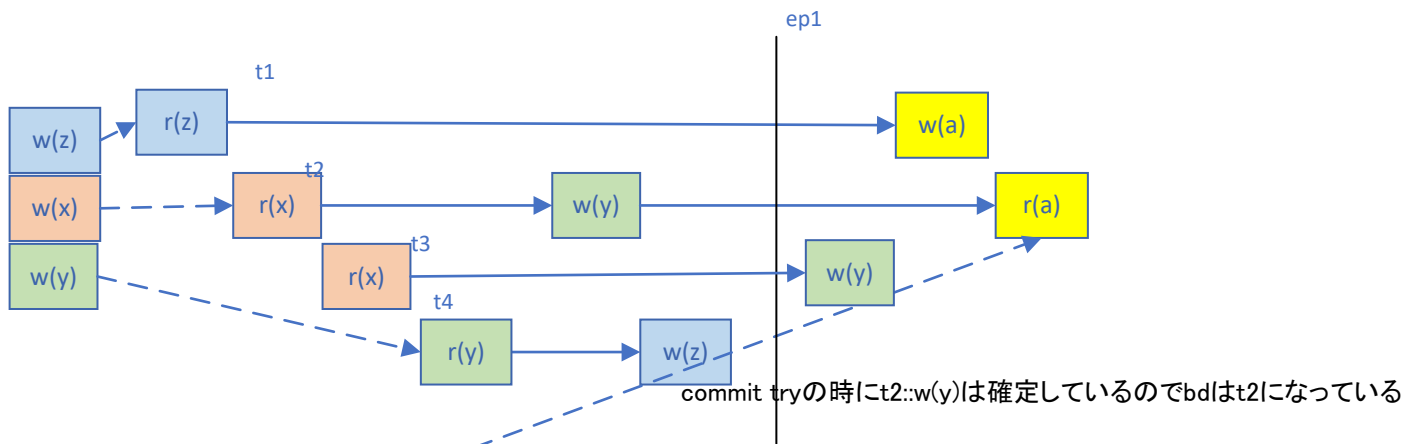
boundary_wait				
	1epoch		1epoch_with_abort	
t1	LTX	c bd1	LTX	c bd1
t2	LTX	c bd1 r:t1	LTX	user abort@ep1
t3	LTX	a bd1 r:t2 w:t1	LTX	c bd2 r:t2
ep1	on going t1/t2 waiting:t3 waited:t2		on going t1/t2 waiting:t3 waited:t2 t2:aborted	



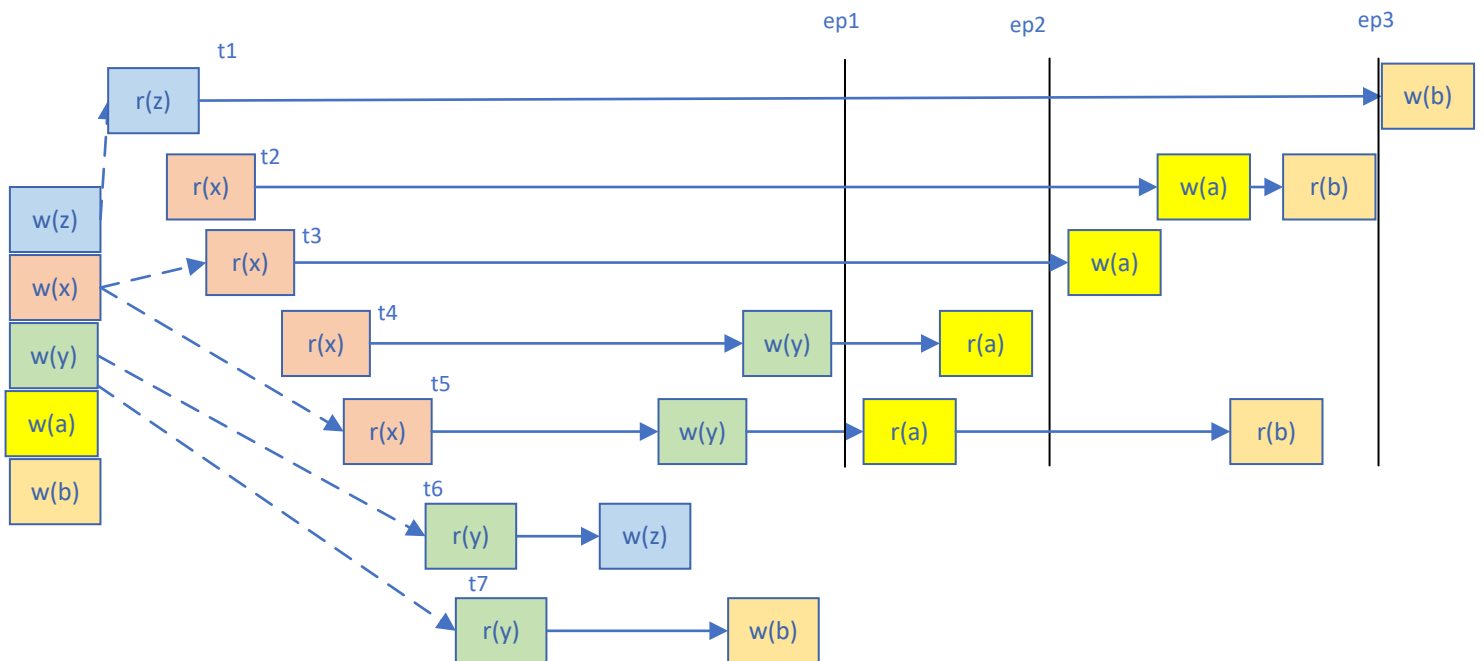
boundary_wait				
	3epoch		3epoch_with_abort	
t1	LTX	c bd1	LTX	c bd1
t2	LTX	c bd2	LTX	c bd2
t3	LTX	c bd1 r:t2/t1	LTX	user abort@ep3
t4	LTX	a bd1 r:t3 w:t1	LTX	c bd3 r:t3
ep1	on going t1/t2/t3 waiting:t4 waited:t3		on going t1/t2/t3 waiting:t4 waited:t3	
ep2	on going t1/t2/t3 waiting:t4 waited:t3		on going t1/t2/t3 waiting:t4 waited:t3	
ep3	on going t1 waiting:t3/t4 waited:t1/t3		on going t1 waiting:t3/t4 waited:t1/t3 t3:aborted	

BDはmonotonic

user abort→waiting整理→bd伝播→validation
 lazyなのでep3の直前では
 t4 waiting bd3
 t3 waiting bd1
 ep3で先にt3がabortなのでt4のbdは3のまま



boundary_wait				
2wait_1epoch			2wait_1epoch_with_abort	
t1	LTX	c bd1	c bd1	
t2	LTX	c bd1 r:t1	user abort@ep1	
t3	LTX	c bd3	user abort@ep1	
t4	LTX	a bd1 r:t2/t3 w:t1	c bd2 r:t2/t3	
ep1	on going t1/t2/t3 waiting:t4 waited:t2/t3			on going t1 t2/t3:aborted

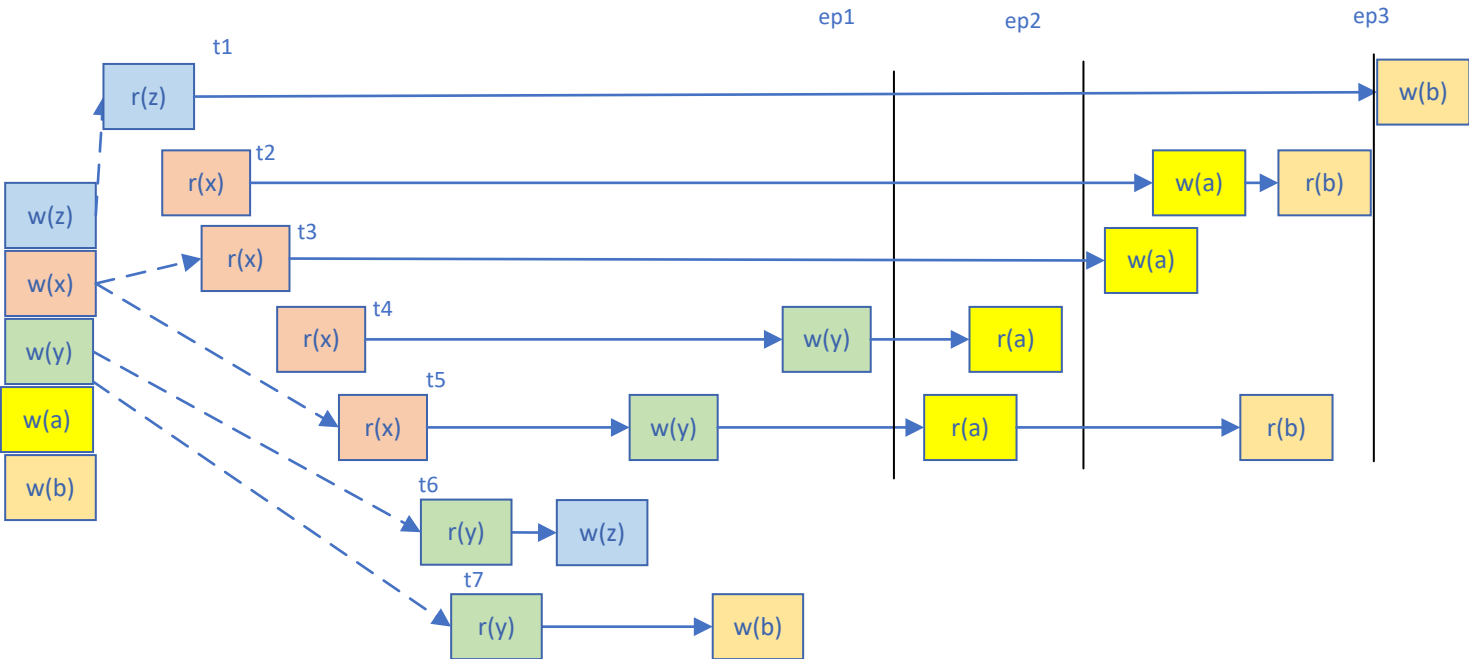


boundary_wait					
2wait_3epoch					
t1	LTX	c bd1	t5	LTX	c bd1 r:t2.t3 RUB 0
t2	LTX	c bd1 r:t1	t6	LTX	a bd1 r:t4/t5 w:t1
t3	LTX	c bd3	t7	LTX	a bd4 r:t4/t5 w:t5
t4	LTX	c bd1 r:t2/t3 RUB 0			

本来はbd1だがlazyなので

t7はt5をwaitしていて、t5はt1をwaitしているが
t1の決着がつく前にt7はabortが確定になる

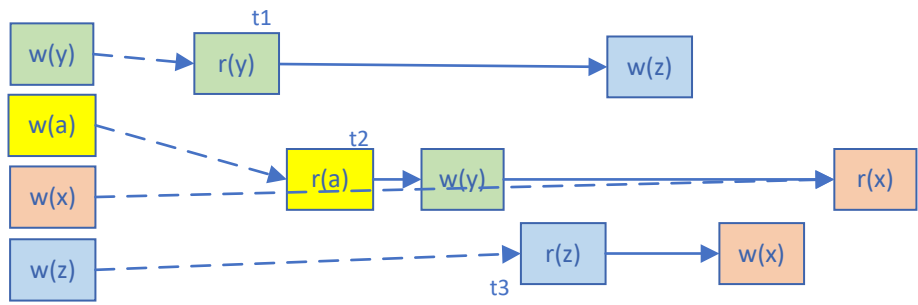
ep1	on going t1/t2/t3/t4/t5 waiting:t6/t7 waited:t4/t5
ep2	on going t1/t2/t3/t5 waiting:t6/t7/t4 waited:t4/t5/t2/t3
ep3	on going t1 waiting:t6/t5/t4/t2 waited:t4/t5/t3/t2/t1



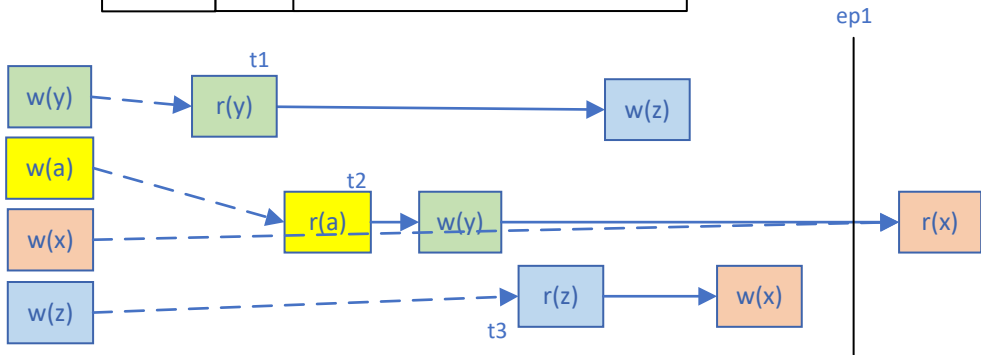
boundary_wait					
2wait_3epoch_abort					
t1	LTX	c bd1	t5	LTX	user abort@ep3
t2	LTX	c bd1 r:t1 RUB 0	t6	LTX	c bd4 r:t4/t5
t3	LTX	c bd3	t7	LTX	a bd4 rt:4/t5 w:t5
t4	LTX	user abort@ep3			

t5:precommit→wait
t7:abort
t5:user abort

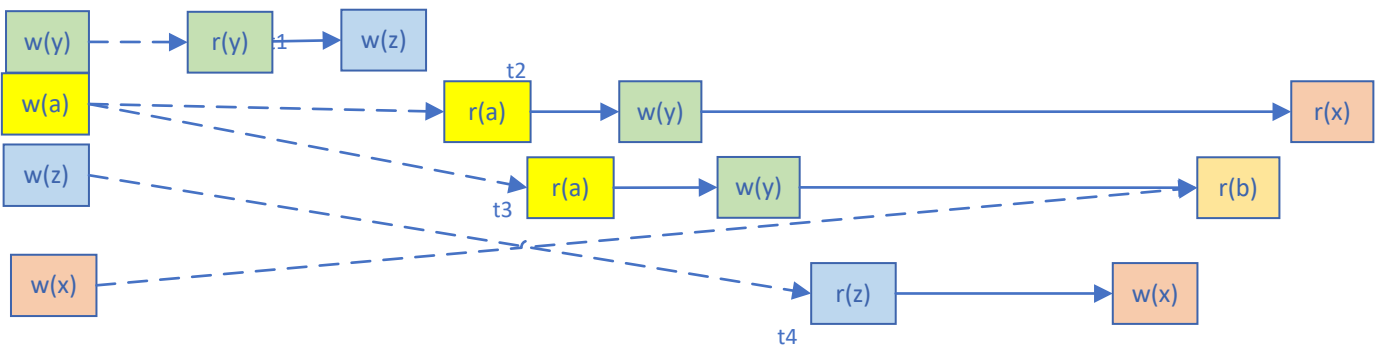
ep1	on going t1/t2/t3/t4/t5 waiting:t6/t7 waited:t4/t5
ep2	on going t1/t2/t3/t5 waiting:t6/t7/t4 waited:t4/t5/t2/t3
ep3	on going t1 waiting:t2 waited:t1 t4/t5:aborted



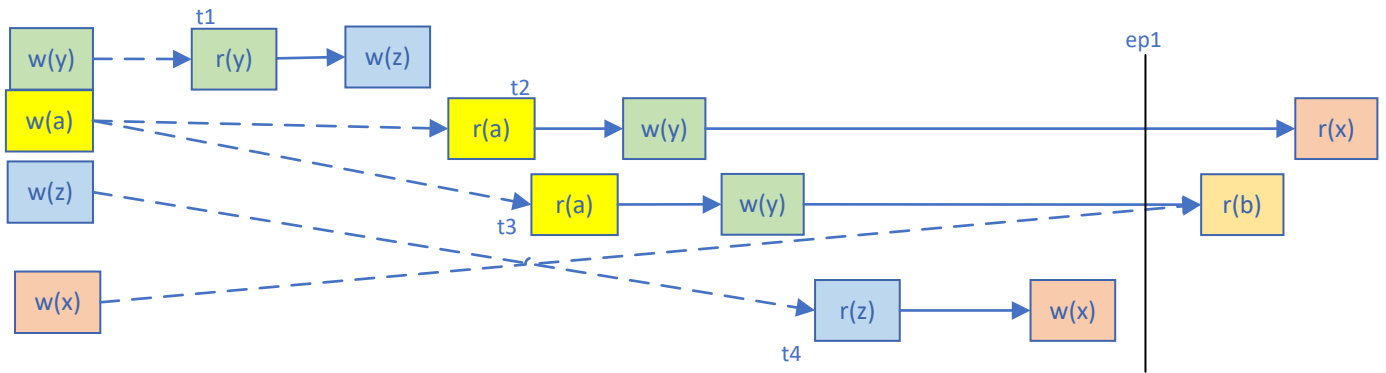
read_wait		
within_epoch		
t1	LTX	c bd1
t2	LTX	c bd2 RUB 0
t3	LTX	a bd1 r:t1 w:t2



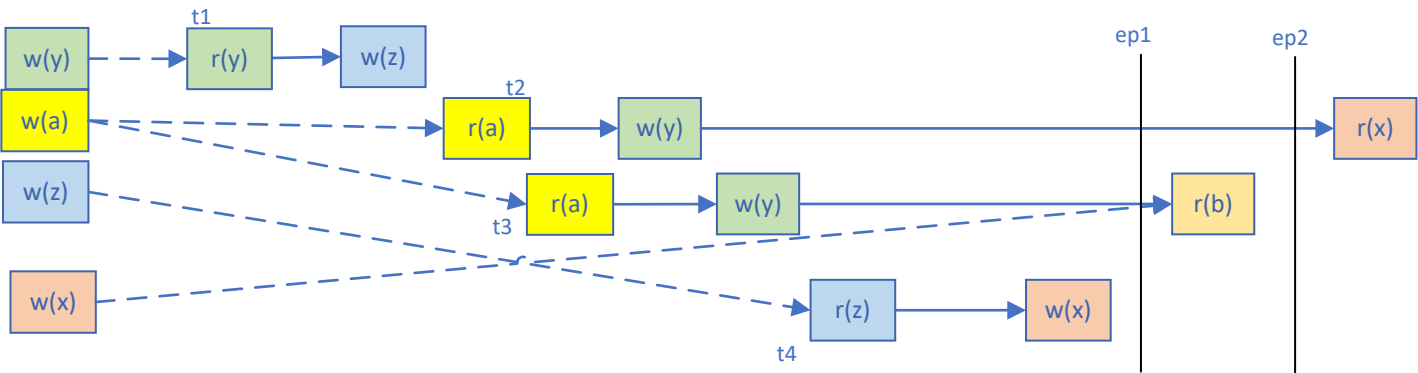
read_wait					
1epoch			1epoch_with_abort		
t1	LTX	c bd1	LTX	c bd1	
t2	LTX	c bd2 RUB 0	LTX	user abort@ep1	
t3	LTX	a bd1 r:t1 w:t2	LTX	c bd1 r:t1	
ep1	on going t2 waiting:t3 waited:t2			t2:aborted	



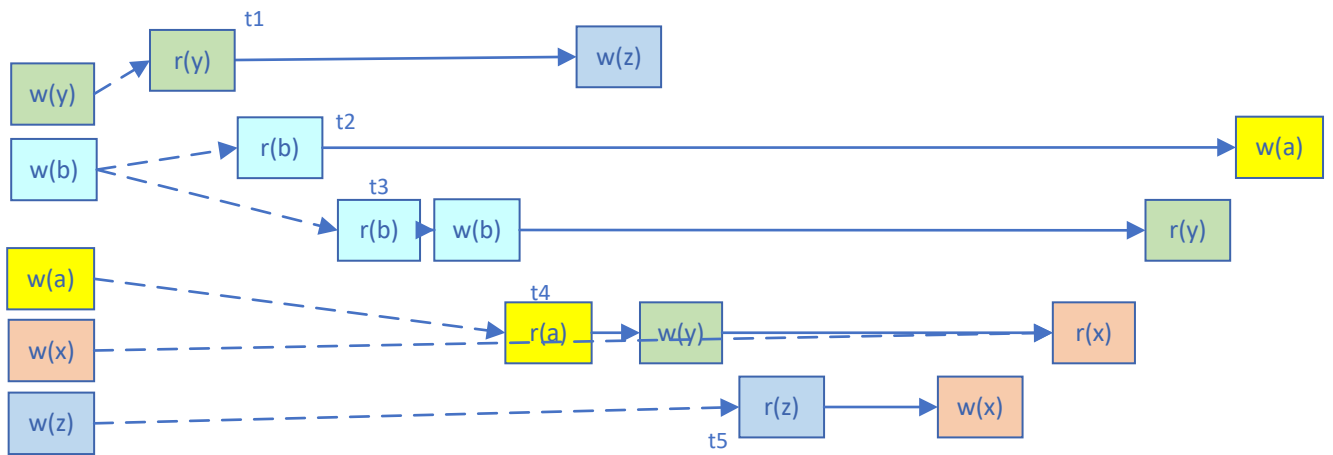
read_wait		
2wait_within_epoch		
t1	LTX	c bd1
t2	LTX	c bd2 RUB 0
t3	LTX	c bd3 RUB 0
t4	LTX	a bd1 r:t1 w:t2



read_wait				
2wait_1epoch			2wait_1epoch_with_abort	
t1	LTX	c bd1	LTX	c bd1
t2	LTX	c bd2 RUB 0	LTX	user abort@ep1
t3	LTX	c bd3 RUB 0	LTX	user abort@ep1
t4	LTX	a bd1 r:t1 w:t2	LTX	c bd1 r:t1
ep1	on going t2/t3 waiting:t4 waited:t2/t3			t2/t3:aborted



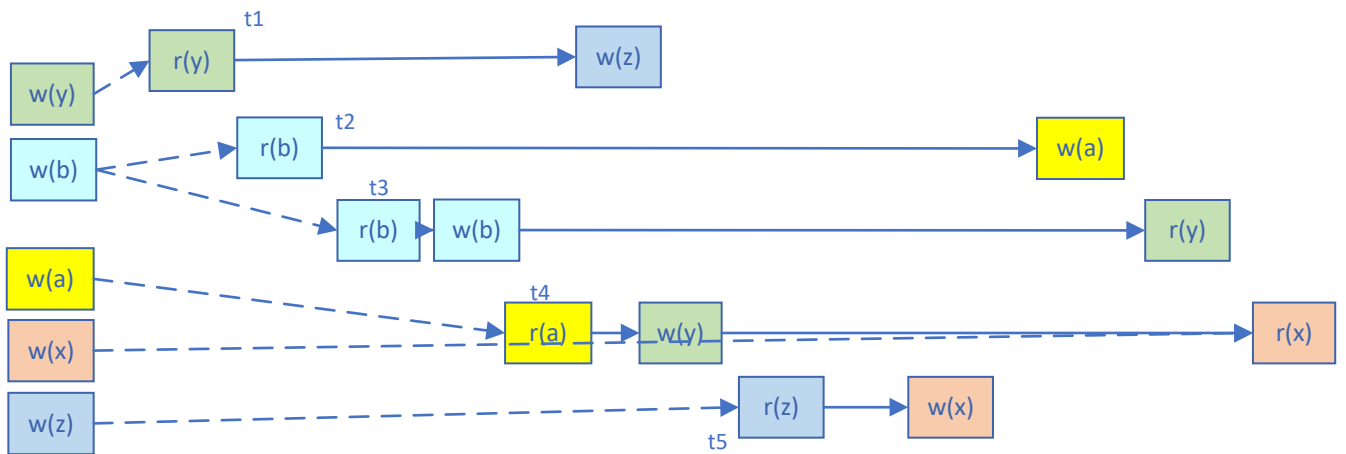
read_wait				
2wait_2epoch			2wait_2epoch_with_abort	
t1	LTX	c bd1	LTX	c bd1
t2	LTX	c bd2	LTX	user abort@ep2
t3	LTX	c bd3 RUB0	LTX	c bd 3 RUB0
t4	LTX	a bd1 r:t1 w:t2	LTX	c bd1 r:t1
ep1	on going t2/t3 waiting:t4 waited:t2/t3			on going t2/t3 waiting:t4 waited:t2/t3
ep2	on going t2 waiting:t4 waited:t2			t2:aborted



read_wait		
2cascading_ascending_within_epoch		
t1	LTX	c bd1
t2	LTX	c bd2
t3	LTX	c bd3
t4	LTX	a bd2 r:t2 w:t3 RUB 0
t5	LTX	a bd1 r:t1 w:t4

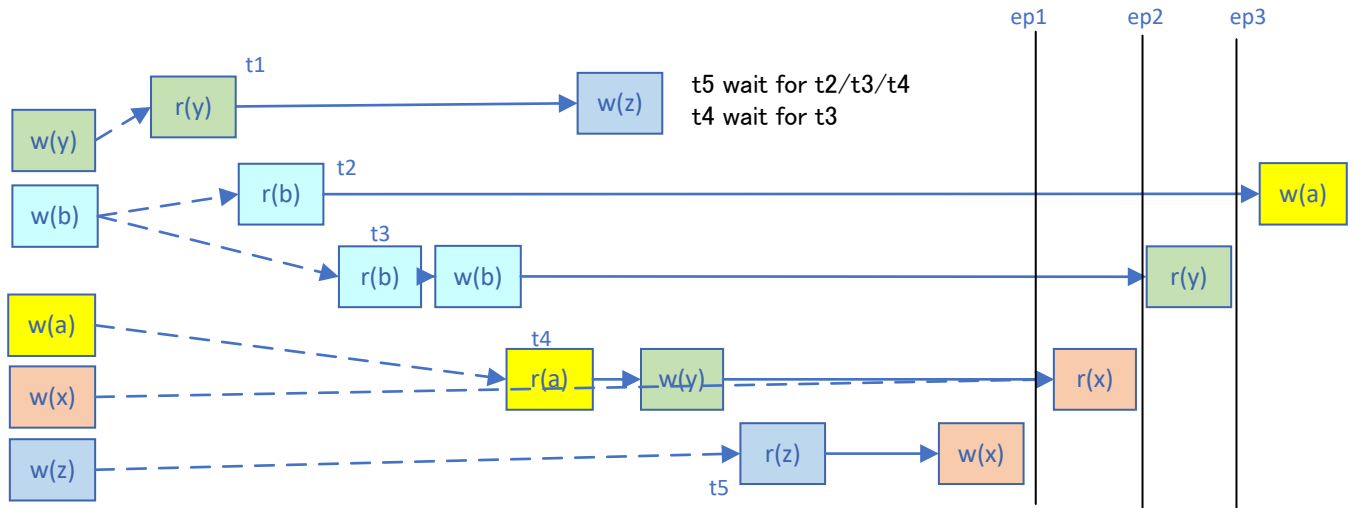
t5 wait for t2/t3/t4
t4 wait for t3

偽陽性
t5 wait
t4 wait
t5 abort
t4 abort

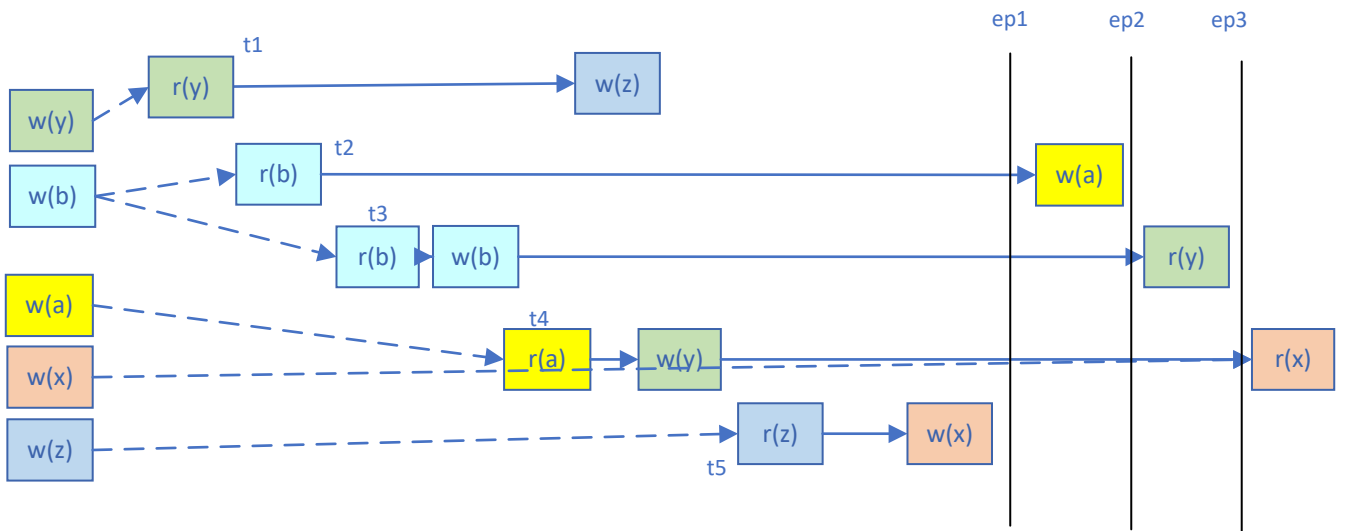


read_wait		
2cascading_dscending_within_epoch		
t1	LTX	c bd1
t2	LTX	c bd2
t3	LTX	c bd3
t4	LTX	a bd2 r:t2 w:t3 RUB 0
t5	LTX	c bd1 r:t1

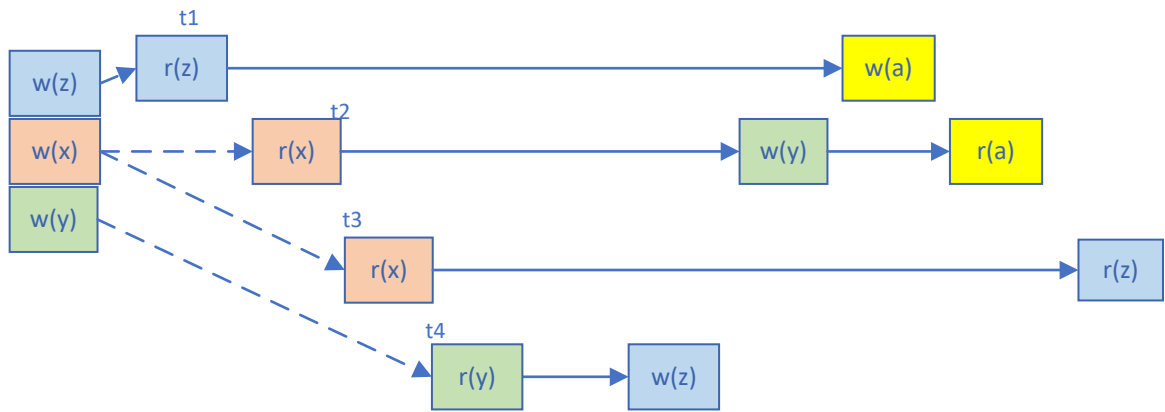
t5 wait
t4 abort
t5 commit



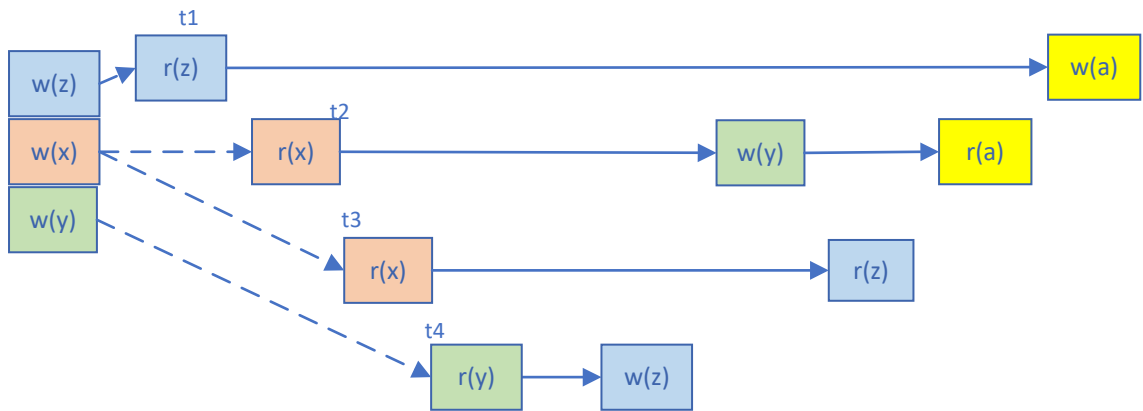
read_wait				
2cascading_ascending_within_epoch			2cascading_ascending_within_epoch_abort	
t1	LTX	c bd1	LTX	c bd1
t2	LTX	c bd2	LTX	c bd2
t3	LTX	c bd3	LTX	aborted @ep2
t4	LTX	a bd2 r:t2 w:t3 RUB 0	LTX	c bd2 RUB 0
t5	LTX	a bd1 r:t1 w:t4	LTX	a bd1 r:t1 w:t4
ep1	on go t2/t3/t4 wait t5 waited t2/t3/t4		on go t2/t3/t4 wait t5 waited t2/t3/t4	
ep2	on go t2/t3 wait t4 waited t2/t3		on go t2 wait t4 waited t2	
ep3	on going t2		on go t2 wait t4 waited t2	



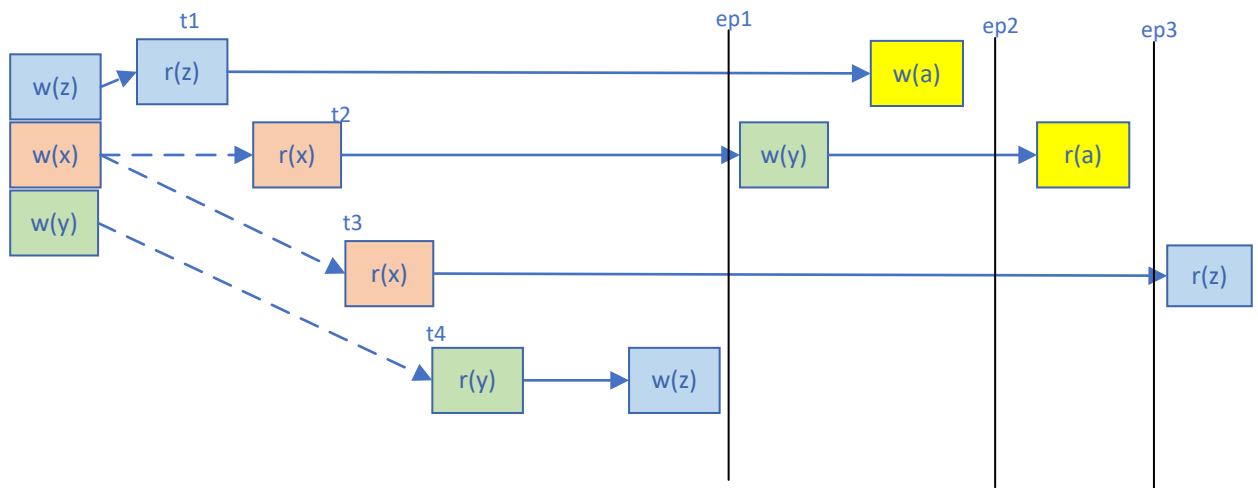
read_wait				
2cascading_descending_within_epoch			2cascading_descending_within_epoch_abort	
t1	LTX	c bd1	LTX	c bd1
t2	LTX	c bd2	LTX	c bd2
t3	LTX	c bd3	LTX	user abort @ep2
t4	LTX	a bd2 r:t2 w:t3 RUB 0	LTX	c bd2 r:t2
t5	LTX	c bd1 r:t1	LTX	a bd1 r:t1 w:t4
ep1	on go t2/t3/t4 wait t5 waited t2/t3/t4		on go t2/t3/t4 wait t5 waited t2/t3/t4	
ep2	on go t3/t4 wait t5 waited t3/t4		on go t4 wait t5 waited t4	
ep3	non		on go t4 wait t5 waited t4	



read_and_boundary_wait		
boundary_abort		
t1	LTX	c bd1
t2	LTX	c bd1 r:t1 RUB 0
t3	LTX	c bd3 RUB 0
t4	LTX	a bd1 r:t2 w:t1

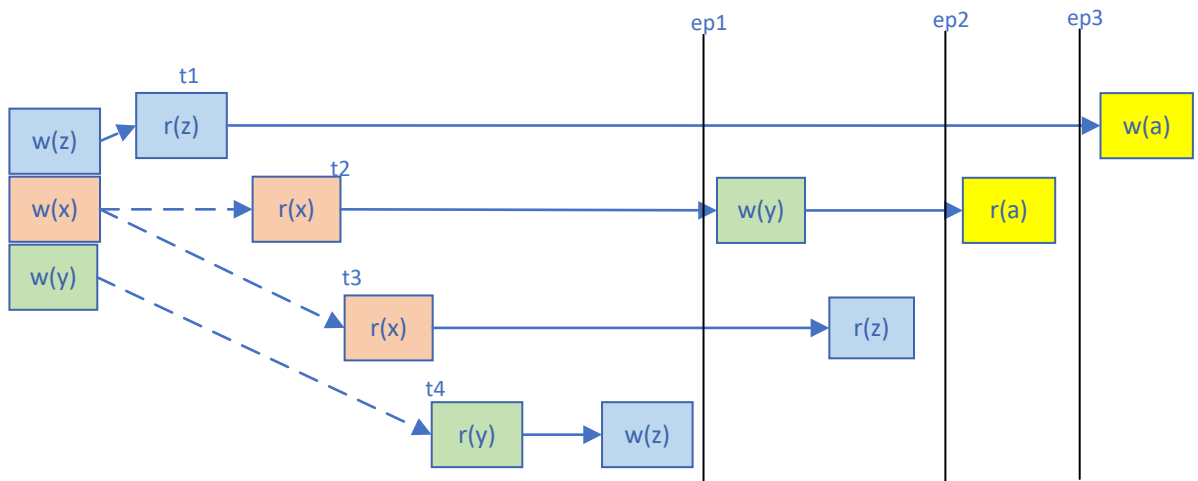


read_and_boundary_wait		
read_abort		
t1	LTX	c bd1
t2	LTX	c bd1 r:t1 RUB 0
t3	LTX	c bd3 RUB 0
t4	LTX	a bd2 r:t2 w:t3



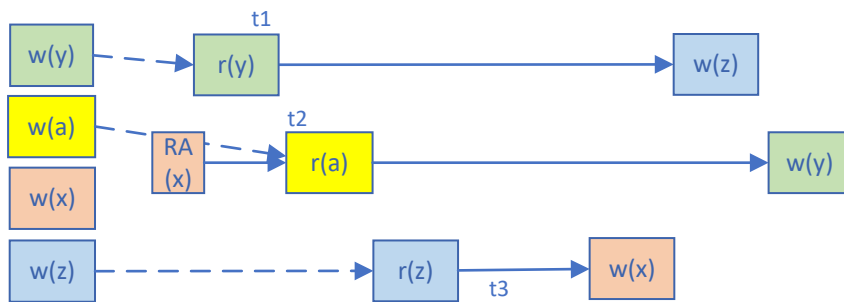
read_and_boundary_wait		
boundary_abort_with_epoch		
t1	LTX	c bd1
t2	LTX	c bd1 r:t1 RUB 0
t3	LTX	c bd3 RUB 0
t4	LTX	a bd1 r:t2 w:t1

ep1	going t1/t2/t3 wait t4 waited t2/t3
ep2	going t2/t3 wait t4 waited t2/t3
ep3	going t3

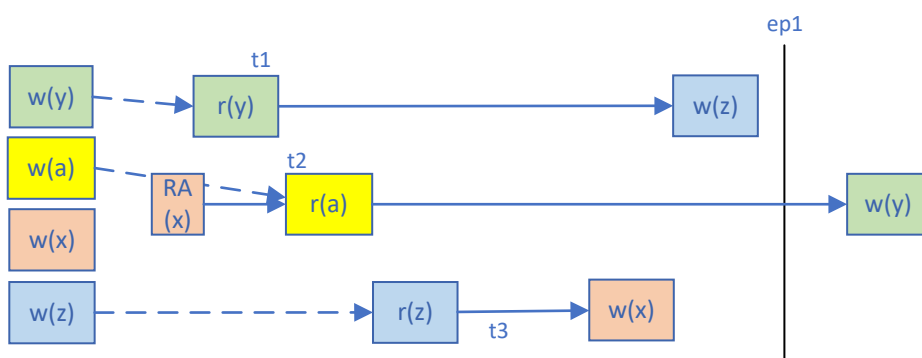


read_and_boundary_wait		
read_abort_with_epoch		
t1	LTX	c bd1
t2	LTX	c bd1 r:t1 RUB 0
t3	LTX	c bd3 RUB 0
t4	LTX	a bd2 r:t2 w:t3

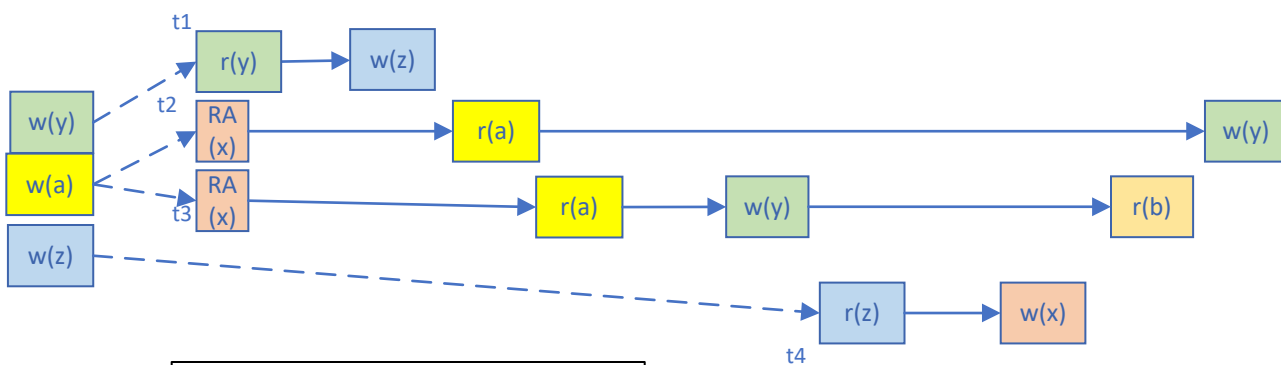
ep1	going t1/t2/t3 wait t4 waited t2/t3
ep2	going t1/t2
ep3	going t1 wait t2 waited t1



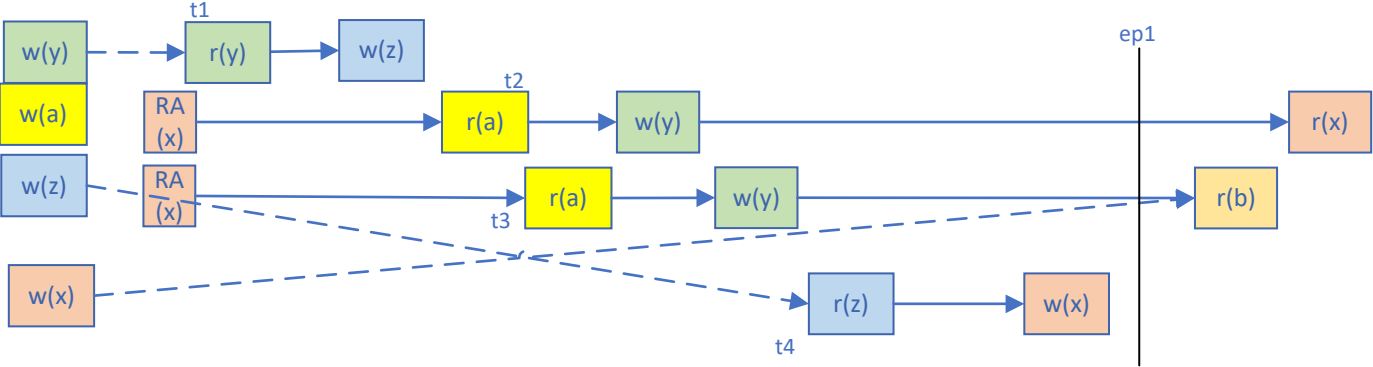
read_areas		
within_epoch		
t1	LTX	c bd1
t2	LTX	c bd2
t3	LTX	c bd1 r:t1



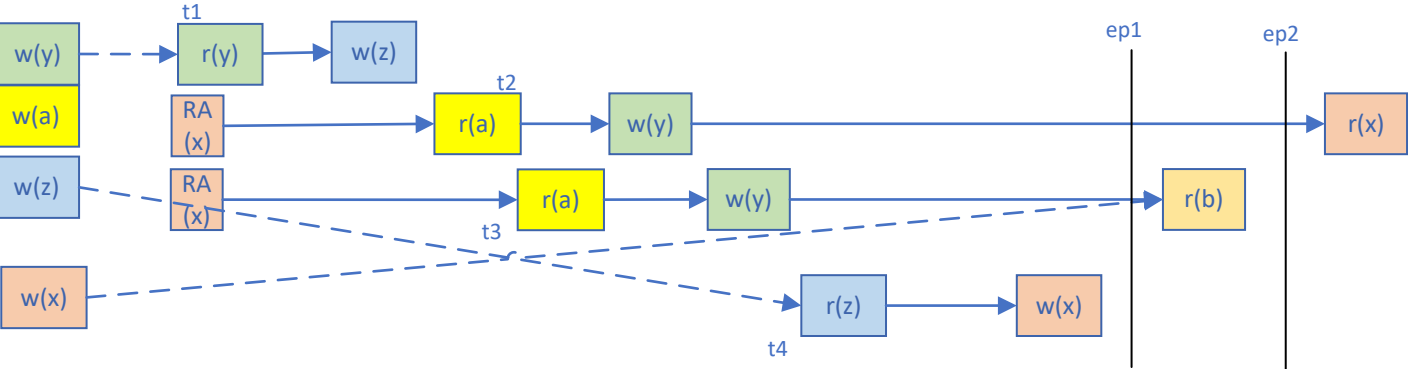
read_areas		
1epoch		
t1	LTX	c bd1
t2	LTX	c bd2
t3	LTX	c bd1 r:t1
ep1	on going t2	



read_areas		
2wait_within_epoch		
t1	LTX	c bd1
t2	LTX	c bd2 RUB 0
t3	LTX	c bd3 RUB 0
t4	LTX	c bd1 r:t1



read_areas		
2wait_1epoch		
t1	LTX	c bd1
t2	LTX	abort by RA violation
t3	LTX	c bd3 RUB 0
t4	LTX	c bd1 r:t1
ep1	on going t2/t3	



read_areas		
2wait_2epoch		
t1	LTX	c bd1
t2	LTX	aborted by RA violation
t3	LTX	c bd3 RUB0
t4	LTX	c bd1 r:t1
ep1	on going t2/t3	
ep2	on going t2	