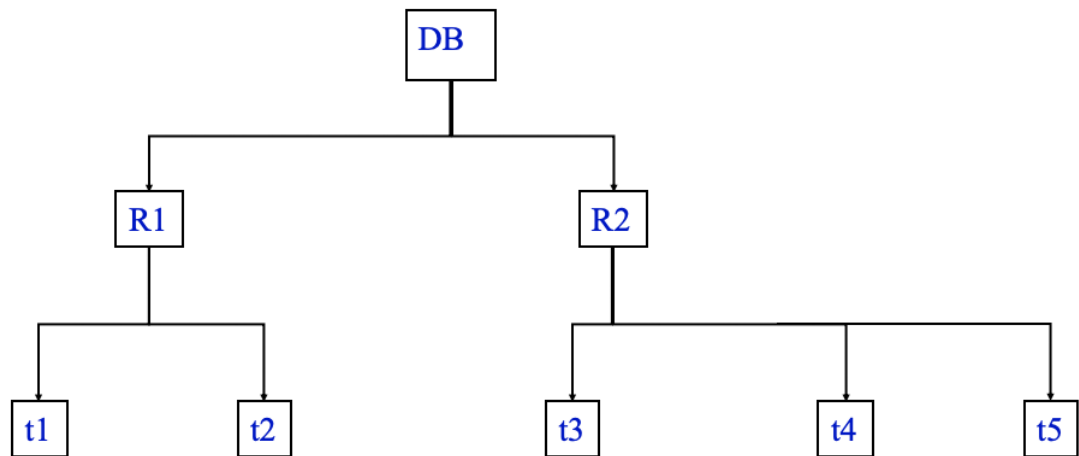


1.



T1: R(t1), T2: W(t2), T2: R(t3), T1: W(t4)

T1: R(t1) -----

- ① Add the IS lock to DB
- ② Add the IS lock to R1
- ③ Put the S lock to t1

T2: W(t2) -----

- ④ Add the IX lock to DB (it is OK, because the lock IS can compatibility the lock IX)
- ⑤ Add the IX to R1(it is OK, because the lock IS can compatibility the lock IX)
- ⑥ Put the X lock to t2

T2: R(t3) -----

- ⑦ Do not need to put the IS lock on DB, because T2 already has the IX lock, which is stronger than the IS lock
- ⑧ Put the IS lock to R2
- ⑨ Add the S lock to t3
- ⑩ Releasing all the locks on T2

T1: W(t4) -----

- ⑪ Add the IX lock to DB
- ⑫ Add the IX lock to R2
- ⑬ Add the X lock to t4
- ⑭ Releasing all the locks on T1

2.

time	LSN	Log	Buffer actions
0	00	update: T1 updates P7	P7 brought in to the buffer
1	10	update: T0 updates P9	P9 brought into the buffer; P9 flushed to disk
2	20	update: T1 updates P8	P8 brought into the buffer; P8 flushed to disk
3	30	begin_checkpoint	
4	40	end_checkpoint	
5	50	update: T1 updates P9	P9 brought into the buffer
6	60	update: T2 updates P6	P6 brought into the buffer
7	70	update: T1 updates P5	P5 brought into the buffer
8	80	update: T1 updates P7	P6 flushed to disk
9		CRASH RESTART	

(a)

After time 0-----

Transaction Table (XT)

transID	lastLSN	status
T1	00	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00

After time 1-----

Transaction Table (XT)

transID	lastLSN	status
T1	00	Active
T0	10	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00

After time 2-----

Transaction Table (XT)

transID	lastLSN	status
T1	20	Active
T0	10	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00

After time 3-----

Transaction Table (XT)

transID	lastLSN	status
T1	20	Active
T0	10	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00

After time 4-----

Transaction Table (XT)

transID	lastLSN	status
T1	20	Active
T0	10	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00

After time 5-----

Transaction Table (XT)

transID	lastLSN	status
T1	50	Active
T0	10	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50

After time 6-----

Transaction Table (XT)

transID	lastLSN	status
T1	50	Active
T0	10	Active
T2	60	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50
P6	60

After time 7-----

Transaction Table (XT)

transID	lastLSN	status
T1	70	Active
T0	10	Active
T2	60	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50
P6	60
P5	70

After time 8-----

Transaction Table (XT)

transID	lastLSN	status
T1	80	Active
T0	10	Active
T2	60	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50
P5	70

(b)

After time 5-----

Transaction Table (XT)

transID	lastLSN	status
T1	50	Active
T0	10	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50

After time 6-----

Transaction Table (XT)

transID	lastLSN	status
T1	50	Active
T0	10	Active
T2	60	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50
P6	60

After time 7-----

Transaction Table (XT)

transID	lastLSN	status
T1	70	Active
T0	10	Active
T2	60	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50
P6	60
P5	70

After time 8-----

Transaction Table (XT)

transID	lastLSN	status
T1	80	Active
T0	10	Active
T2	60	Active

Dirty Page Table (DPT)

pageID	recLSN
P7	00
P9	50
P5	70

(c)

Redo happens after analysis. we need to find the smallest recLSN in DPT, which is P7 00

Dirty Page Table (DPT)	
pageID	recLSN
P7	00
P9	50
P5	70

time	LSN	Log	Buffer actions
0	00	update: T1 updates P7	P7 brought in to the buffer
1	10	update: T0 updates P9	P9 brought into the buffer; P9 flushed to disk
2	20	update: T1 updates P8	P8 brought into the buffer; P8 flushed to disk
3	30	begin_checkpoint	
4	40	end_checkpoint	
5	50	update: T1 updates P9	P9 brought into the buffer
6	60	update: T2 updates P6	P6 brought into the buffer
7	70	update: T1 updates P5	P5 brought into the buffer
8	80	update: T1 updates P7	P6 flushed to disk
9		CRASH RESTART	

LSN	Redo
00	Y
10	Y
20	Y
30	Checkpoint N
40	Checkpoint N
50	Y
60	Y
70	Y
80	Y

(d)

There are nothing committed, so all things need to be undo (from 80--00) except the two checkpoints.