

# MEMORY

Stal used?

YES! 108 modified  
by an uncommitted  
XACT & written to  
disk

FORCE used?

MAY BE! only page  
modified by T3 is  
written to disk  
(No evidence against)

ON  
DISK  
AFTER  
CRASH

LSN	Operation	PrevLSN
101	T1 update P1	-
102	T2 update P2	-
103	T3 update P3	-
104	T2 update P4	102
105	T4 update P5	-
106	T2 update P6	104
107	T3 commit	103
108	T4 update P3	105
109	T1 update P4	101
110	T4 abort	108

## Data Pages After Crash

PageId	PageLSN
P1	101
P2	-
P3	108
P4	-
P5	105
P6	106

DPT (dirty page table)

P1	101
P2	102
P3	103
P4	104
P5	105
P6	106

TT (transaction table)

T1	109
T2	106
T4	<del>110</del> 108

LSN Operation PrevLSN

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101	T1 update P1	-
102	T2 update P2	-
103	T3 update P3	-
104	T2 update P4	102
105	T4 update P5	-
106	T2 update P6	104
107	T3 commit	103
108	T4 update P3	105
109	T1 update P4	101
110	T4 abort	108

Data Pages After Crash

PageId PageLSN

-----	
P1	101
P2	-
P3	108
P4	-
P5	105
P6	106

DPT (dirty page table)

P1	101
P2	102
P3	103
P4	104
P5	105
P6	106

TT (transaction table)

T1	109
T2	106
T4	110

REDU 103  
 108 > 103  
 then 103  
 is written  
 No change  
 to P3 is  
 necessary

P3      108

LSN	Operation	PrevLSN
101	T1 update P1	-
102	T2 update P2	-
103	T3 update P3	-
104	T2 update P4	102
105	T4 update P5	-
106	T2 update P6	104
107	T3 commit	103
108	T4 update P3	105
109	T1 update P4	101
110	T4 abort	108

Data Pages After Crash

PageId	PageLSN
P1	101
P2	-
P3	108
P4	-
P5	105
P6	106

UNDO

- 11 abort T2
- 112 abort T1
- 113 undo 109
- 114 undo 108
- 115 undo 106
- 116 undo 105
- 117 undo 104
- 118 undo 102
- 119 undo 101

DPT (dirty page table)

P1	101
P2	102
P3	103
P4	104
P5	105
P6	106

TT (transaction table)

T1	<del>109</del>	(10)
T2	<del>106</del>	<del>104</del> <del>107</del>
T4	<del>110</del>	<del>108</del> <del>105</del>

P4 not changed!

nothing to do

P3 108

reverse 108

P6 106

P5 105

LSN	Operation	PrevLSN
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101	T1 update P1	-
102	T2 update P2	-
103	T3 update P3	-
104	T2 update P4	102
105	T4 update P5	-
106	T2 update P6	104
107	T3 commit	103
108	T4 update P3	105
109	T1 update P4	101
110	T4 abort	108

Data Pages After Crash

PageId	PageLSN
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P1	101
P2	-
P3	108
P4	-
P5	105
P6	106

UNDO  
ALL ACTIVE  
TRANSACTIONS  
(NOT COMMITTED)

A vertical arrow pointing upwards, starting from the bottom and ending with a curved arrowhead at the top.

REDO  
ALL  
COMMITTED  
XACTS

A vertical arrow pointing downwards, starting from the top and ending with a curved arrowhead at the bottom.

ANALYSIS

A vertical arrow pointing downwards, starting from the top and ending with a curved arrowhead at the bottom.

LOG

A hand-drawn rectangular box with a horizontal line near the top, representing a log structure.

# Database Tuning

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DB Modeling

Queries +  
Programming

Indexing +  
System  
Optimization