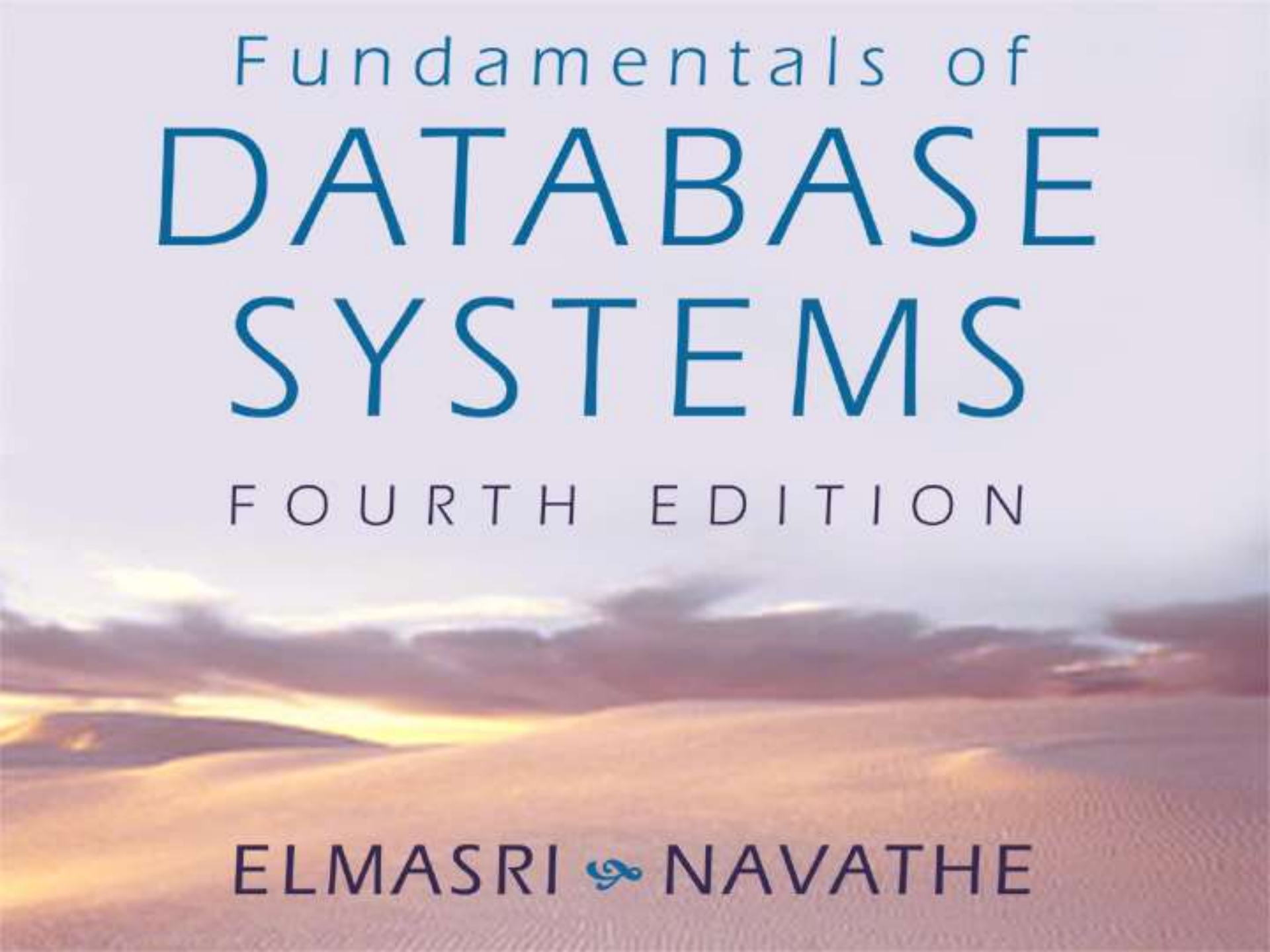
Fundamentals of DATABASE SYSTEMS

FOURTH EDITION



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Chapter 19

Database Recovery Techniques

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FIGURE 19.1
Illustrating cascading rollback (a process that never occurs in strict or cascadeless schedules). (a) The read and write operations of three transactions.
(b) System log at point of crash.

(a)

T_1	T_2	T_3
read_item(A)	read_item(B)	read_item(C)
read_item(D)	write_item(B)	write_item(B)
write_item(D)	read_item(D)	read_item(A)
	write_item(D)	write_item(A)

(b)

		A	B	C	D
		30	15	40	20
	[start-transaction, T_3]				
	[read_item, T_3, C]				
*	[write_item, T_3, B, 15, 12]		12		
	[start-transaction, T_2]				
	[read_item, T_2, B]				
**	[write_item, T_2, B, 12, 18]		18		
	[start-transaction, T_1]				
	[read_item, T_1, A]				
	[read_item, T_1, D]				
	[write_item, T_1, D, 20, 25]				25
	[read_item, T_2, D]				
**	[write_item, T_2, B, 25, 26]				26
	[read_item, T_3, A]				
	← system crash				

* T_3 is rolled back because it did not reach its commit point.
** T_2 is rolled back because it reads the value of item B written by T_3.

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FIGURE 19.1 (continued)

Illustrating cascading rollback (a process that never occurs in strict or cascadeless schedules).
(c) Operations before the crash.

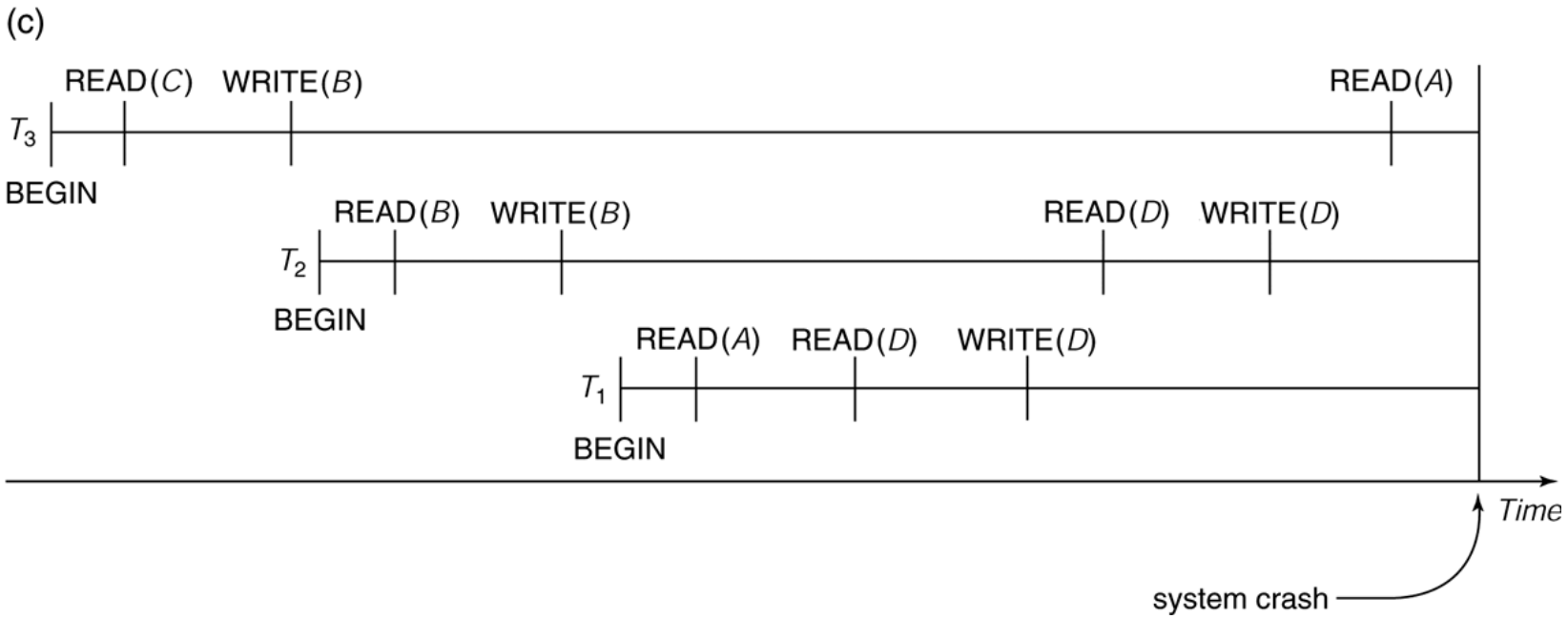

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FIGURE 19.2

An example of recovery using deferred update in a single-user environment. (a) The READ and WRITE operations of two transactions. (b) The system log at the point of crash.

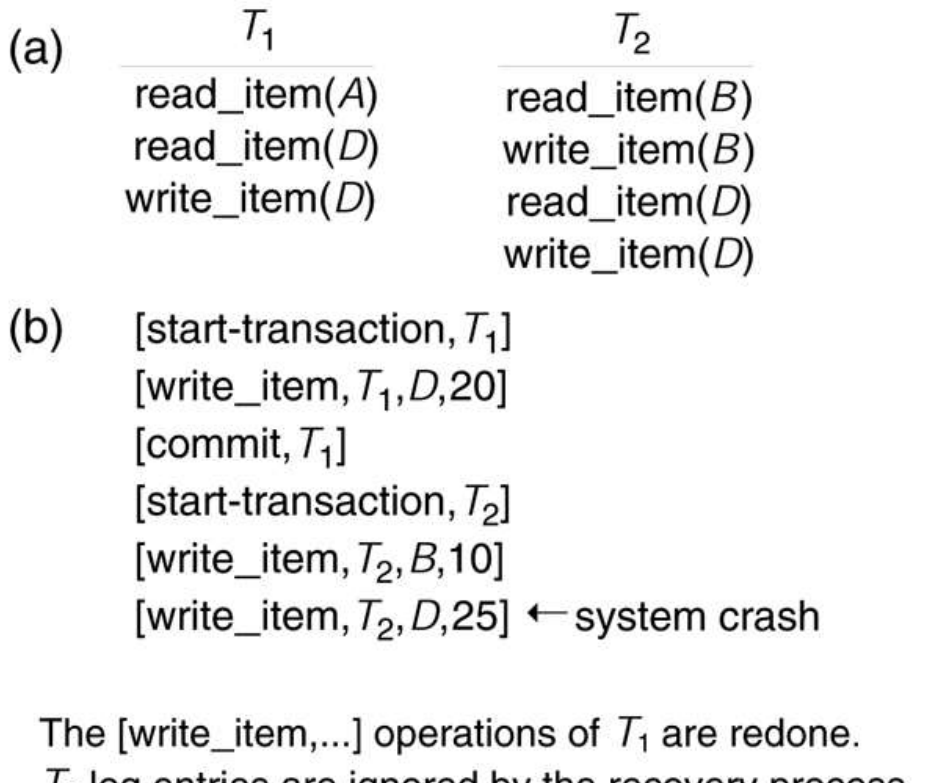

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FIGURE 19.3

An example of recovery in a multiuser environment.

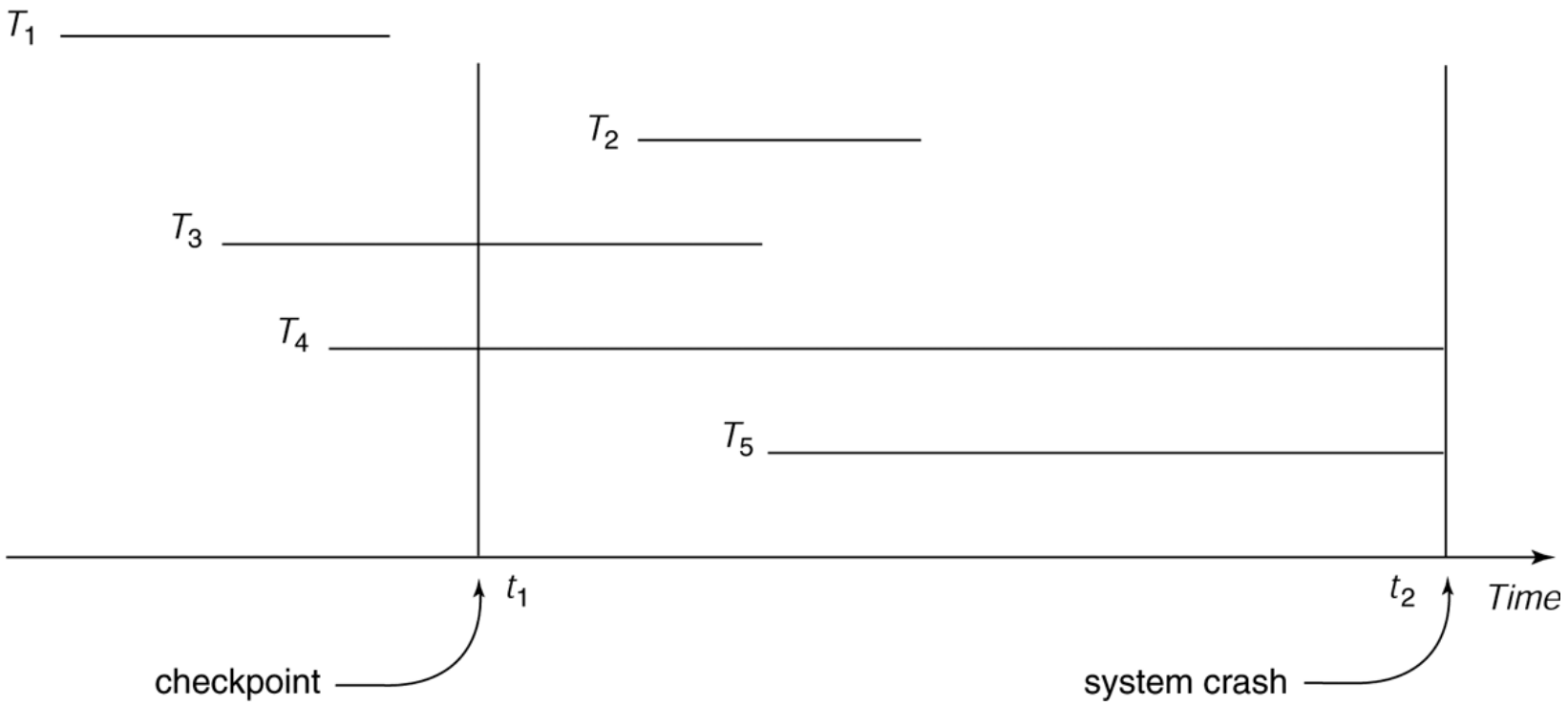

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FIGURE 19.4

An example of recovery using deferred update with concurrent transactions.

(a) The READ and WRITE operations of four transactions. (b) System log at the point of crash.

(a)

T_1	T_2	T_3	T_4
read_item(A)	read_item(B)	read_item(A)	read_item(B)
read_item(D)	write_item(B)	write_item(A)	write_item(B)
write_item(D)	read_item(D)	read_item(C)	read_item(A)
	write_item(D)	write_item(C)	write_item(A)

(b)

[start_transaction, T_1]
[write_item, T_1, D, 20]
[commit, T_1]
[checkpoint]
[start_transaction, T_4]
[write_item, T_4, B, 15]
[write_item, T_4, A, 20]
[commit, T_4]
[start_transaction, T_2]
[write_item, T_2, B, 12]
[start_transaction, T_3]
[write_item, T_3, A, 30]
[write_item, T_2, D, 25] ← system crash

T_2 and T_3 are ignored because they did not reach their commit points.
T_4 is redone because its commit point is after the last system checkpoint.

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FIGURE 19.5

An example of shadow paging.

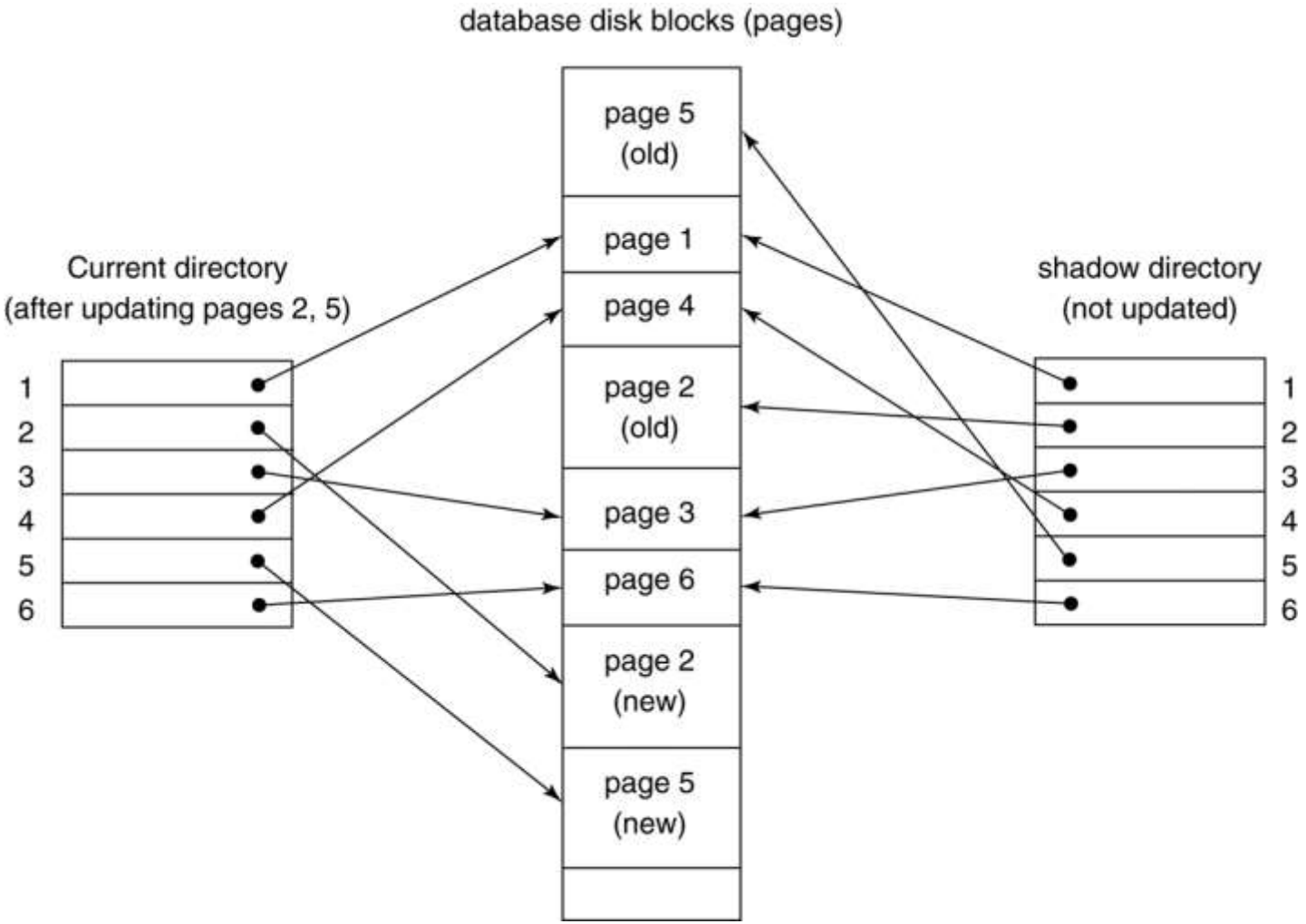

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FIGURE 19.6
An example of recovery in ARIES. (a) The log at point of crash. (b) Transaction and Dirty Page Tables at time of checkpoint. (c) The Transaction and Dirty Page Tables after the analysis phase.

(a)

LSN	LAST_LSN	TRAN_ID	TYPE	PAGE_ID	OTHER INFORMATION
1	0	T1	update	C	...
2	0	T2	update	B	...
3	1	T1	commit		...
4	begin checkpoint				
5	end checkpoint				
6	0	T3	update	A	...
7	2	T2	update	C	...
8	7	T2	commit		...

(b)

TRANSACTION TABLE			DIRTY PAGE TABLE	
TRANSACTION ID	LAST LSN	STATUS	PAGE ID	LSN
T1	3	commit	C	1
T2	2	in progress	B	2

(c)

TRANSACTION TABLE			DIRTY PAGE TABLE	
TRANSACTION ID	LAST LSN	STATUS	PAGE ID	LSN
T1	3	commit	C	1
T2	7	commit	B	2
T3	6	in progress	A	6

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FIGURE 19.7
An example schedule and its corresponding log.

[start_transaction, T_1]
[read_item, T_1, A]
[read_item, T_1, D]
[write_item, T_1, D,20]
[commit, T_1]
[checkpoint]
[start_transaction, T_2]
[read_item, T_2, B]
[write_item, T_2, B,12]
[start_transaction, T_4]
[read_item, T_4, D]
[write_item, T_4, D,15]
[start_transaction, T_3]
[write_item, T_3, C,30]
[read_item, T_4, A]
[write_item, T_4, A,20]
[commit, T_4]
[read_item, T_2, D]
[write_item, T_2, D,25] ← system crash

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