Lecture 29: Recovery

Monday, December 2, 2000

Overview

- Finish undo logging
- Redo logging (8.3)
- Undo/Redo logging (8.4)

Undo Logging

Log records

- <START T> = transaction T has begun
- <COMMIT T> = T has committed
- <ABORT T>= T has aborted
- <T,X,v>= T has updated element X, and its *old* value was v

Undo-Logging Rules

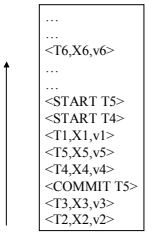
U1: If T modifies X, then <T,X,v> must be written to disk before X is written to disk

U2: If T commits, then <COMMIT T> must be written to disk only after all changes by T are written to disk

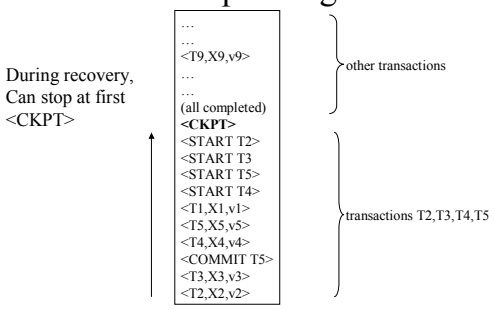
- Hence: OUTPUTs are done *early*

Action	T	Mem A	Mem B	Disk A	Disk B	Log
						<START T>
REAT(A,t)	8	8		8	8	
t:=t*2	16	8		8	8	
WRITE(A,t)	16	16		8	8	<T,A,8>
READ(B,t)	8	16	8	8	8	
t:=t*2	16	16	8	8	8	
WRITE(B,t)	16	16	16	8	8	<T,B,8>
OUTPUT(A)	16	16	16	16	8	
OUTPUT(B)	16	16	16	16	16	
						<COMMIT T>

Recovery with Undo Log



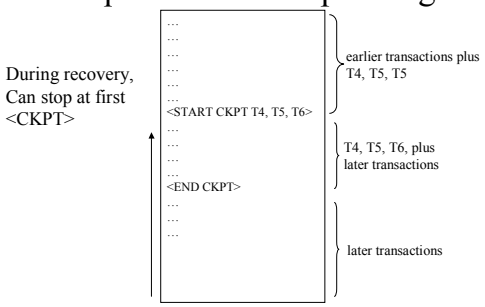
Undo Recovery with Checkpointing



Nonquiescent Checkpointing

- Motivation: don't freeze database during checkpointing
- Write a <START CKPT(T1,…,Tk)> where T1,…,Tk are all active transactions
- Continue normal operation
- When all of T1,…,Tk have completed, write <END CKPT>

Undo Recovery with Nonquiescent Checkpointing



Redo Logging

Log records

- <START T> = transaction T has begun
- <COMMIT T> = T has committed
- <ABORT T>= T has aborted
- <T,X,v>= T has updated element X, and its *new* value is v

Redo-Logging Rules

R1: If T modifies X, then both <T,X,v> and <COMMIT T> must be written to disk before X is written to disk

- Hence: OUTPUTs are done *late*

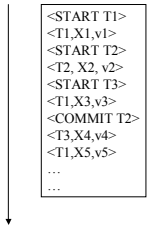
Action	T	Mem A	Mem B	Disk A	Disk B	Log
						<START T>
REAT(A,t)	8	8		8	8	
t:=t*2	16	8		8	8	
WRITE(A,t)	16	16		8	8	<T,A,16>
READ(B,t)	8	16	8	8	8	
t:=t*2	16	16	8	8	8	
WRITE(B,t)	16	16	16	8	8	<T,B,16>
						<COMMIT T>
OUTPUT(A)	16	16	16	16	8	
OUTPUT(B)	16	16	16	16	16	

Recovery with Redo Log

After system's crash, run recovery manager

- Step 1. Decide for each transaction T whether it is completed or not
  - <START T>….<COMMIT T>…. = yes
  - <START T>….<ABORT T>……. = yes
  - <START T>…… = no
- Step 2. Read log from the beginning, redo all updates of *committed* transactions

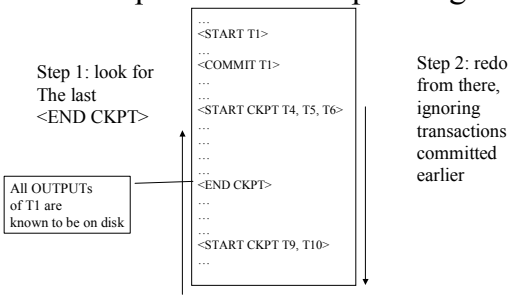
Recovery with Redo Log



Nonquiescent Checkpointing

- Write a <START CKPT(T1,…,Tk)> where T1,…,Tk are all active transactions
- Flush to disk all blocks of committed transactions (*dirty blocks*), while continuing normal operation
- When all blocks have been written, write <END CKPT>

Redo Recovery with Nonquiescent Checkpointing



Comparison Undo/Redo

- Undo logging:
  - OUTPUT must be done early
  - If <COMMIT T> is seen, T definitely has written all its data to disk
- Redo logging
  - OUTPUT must be done late
  - If <COMMIT T> is not seen, T definitely has not written any of its data to disk

Undo/Redo Logging

Log records, only one change

- <T,X,u,v>= T has updated element X, its *old* value was u, and its *new* value is v

Undo/Redo-Logging Rule

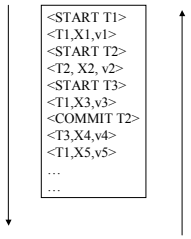
UR1: If T modifies X, then <T,X,u,v> must be written to disk before X is written to disk

Note: we are free to OUTPUT early or late (I.e. before or after <COMMIT T>)

Action	T	Mem A	Mem B	Disk A	Disk B	Log
						<START T>
REAT(A,t)	8	8		8	8	
t:=t*2	16	8		8	8	
WRITE(A,t)	16	16		8	8	<T,A,8,16>
READ(B,t)	8	16	8	8	8	
t:=t*2	16	16	8	8	8	
WRITE(B,t)	16	16	16	8	8	<T,B,8,16>
OUTPUT(A)	16	16	16	16	8	
						<COMMIT T>
OUTPUT(B)	16	16	16	16	16	

Recovery with Undo/Redo Log

After system's crash, run recovery manager

- Redo all committed transaction, top-down
- Undo all uncommitted transactions, bottom-up

Recovery with Redo Log