Lecture 10: TM Implementations

- Topics: wrap-up of eager implementation (LogTM), scalable lazy implementation

Eager Overview

Topics:
- Logs
- Log optimization
- Conflict examples
- Handling deadlocks
- Sticky scenarios
- Aborts/commits/parallelism

“Eager” Implementation (Based Primarily on LogTM)

- A write is made permanent immediately (we do not wait until the end of the transaction)
- This means that if some other transaction attempts a read, the latest value is returned and the memory may also be updated with this latest value
- Can’t lose the old value (in case this transaction is aborted) – hence, before the write, we copy the old value into a log (the log is some space in virtual memory -- the log itself may be in cache, so not too expensive)
  This is eager versioning

Versioning

- Every write first requires a read and a write to log the old value – the log is maintained in virtual memory and will likely be found in cache
- Aborts are uncommon – typically only when the contention manager kicks in on a potential deadlock; the logs are walked through in reverse order
- If a block is already marked as being logged (wr-set), the next write by that transaction can avoid the re-log
- Log writes can be placed in a write buffer to reduce contention for L1 cache ports

Conflict Detection and Resolution

- Since Transaction-A's writes are made permanent rightaway, it is possible that another Transaction-B's rd/wr miss is re-directed to Tr-A

- At this point, we detect a conflict (neither transaction has reached its end, hence, *eager conflict detection)*: two transactions handling the same cache line and at least one of them does a write

- One solution: requester stalls: Tr-A sends a NACK to Tr-B; Tr-B waits and re-tries again; hopefully, Tr-A has committed and can hand off the latest cache line to B → neither transaction needs to abort

Deadlocks

- Can lead to deadlocks: each transaction is waiting for the other to finish

- Need a separate (hw/sw) contention manager to detect such deadlocks and force one of them to abort

Tr-A	Tr-B
write X	write Y
…	…
read Y	read X

- Alternatively, every transaction maintains an “age” and a young transaction aborts and re-starts if it is keeping an older transaction waiting and itself receives a nack from an older transaction

Block Replacement

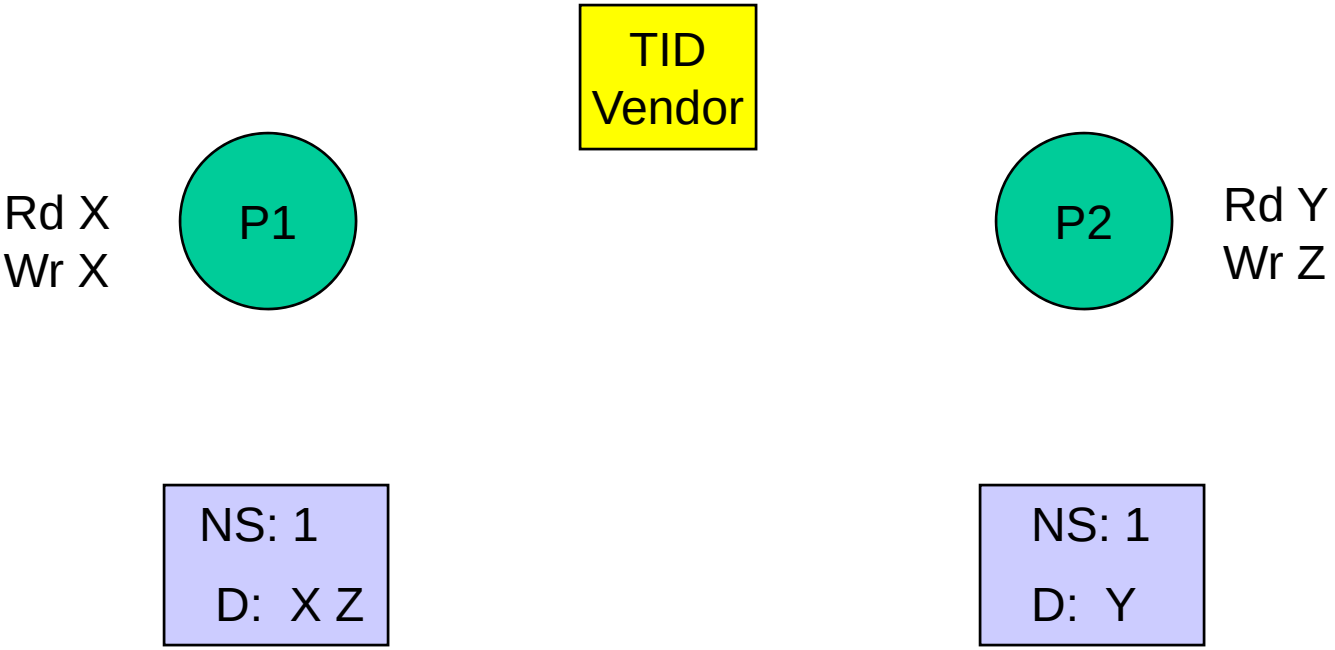
- If a block in a transaction's rd/wr-set is evicted, the data is written back to memory if necessary, but the directory continues to maintain a "sticky" pointer to that node (subsequent requests have to confirm that the transaction has committed before proceeding)

- The sticky pointers are lazily removed over time (commits continue to be fast)

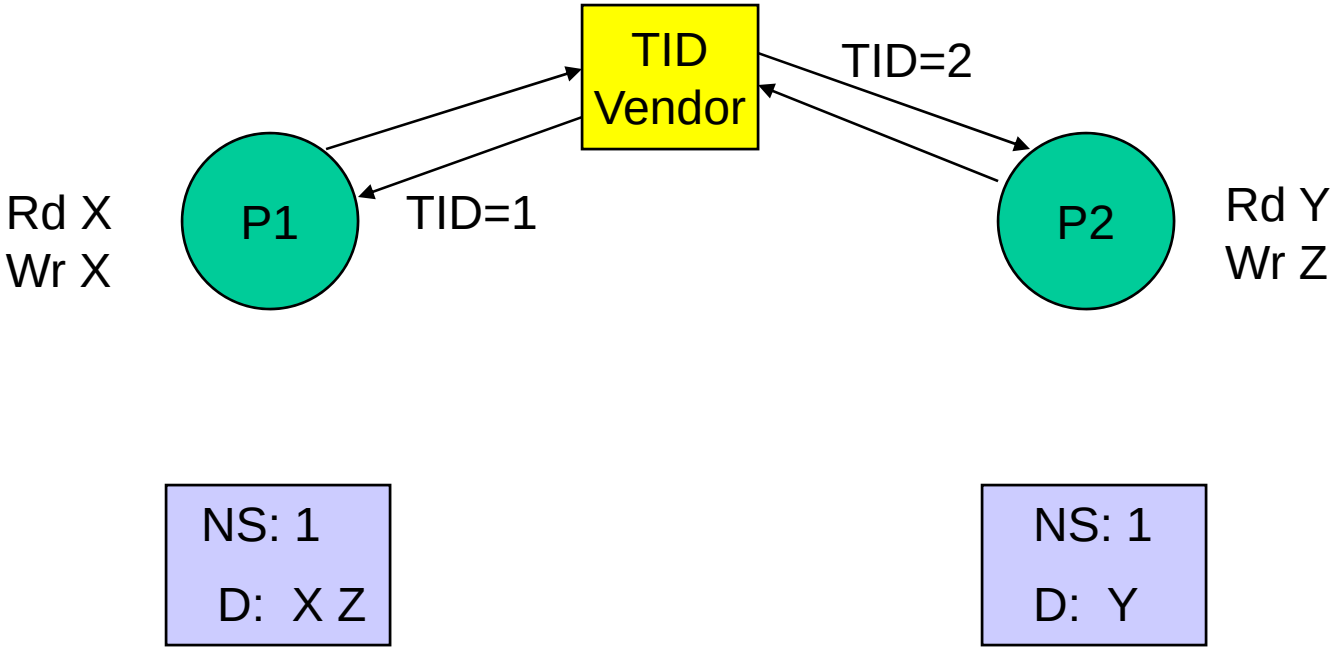
Scalable Algorithm – Lazy Implementation

- Probe your write-set to see if it is your turn to write (helps serialize writes)
- Let others know that you don't plan to write (thereby allowing parallel commits to unrelated directories)
- Mark your write-set (helps hide latency)
- Probe your read-set to see if previous writes have completed
- Validation is now complete – send the actual commit message to the write set

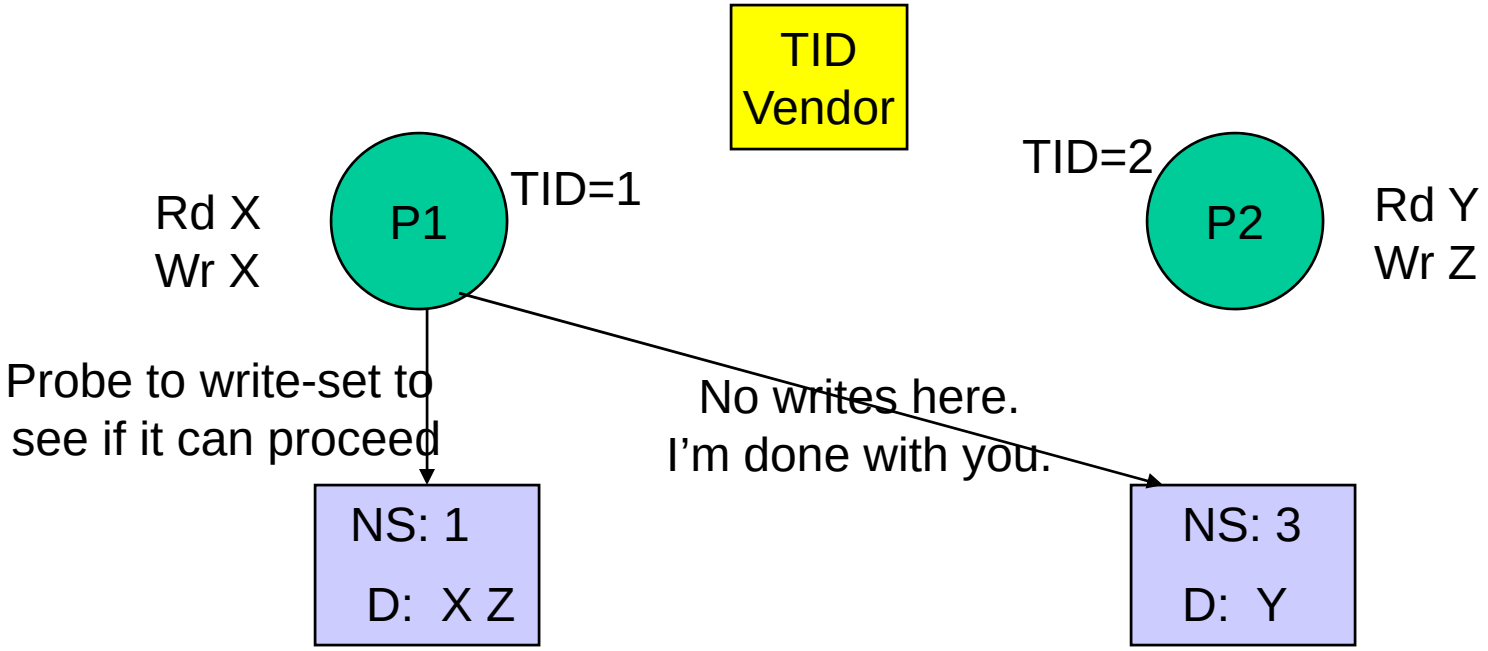
Example



Example

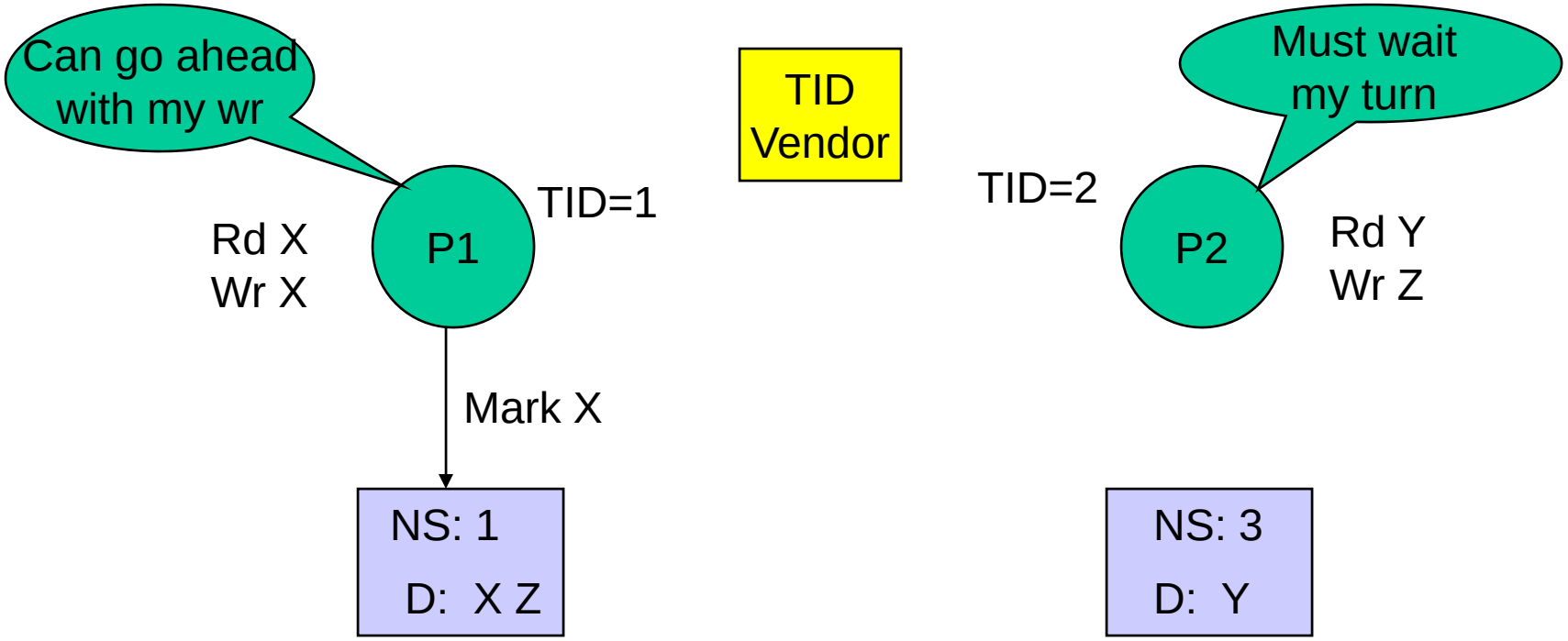


Example



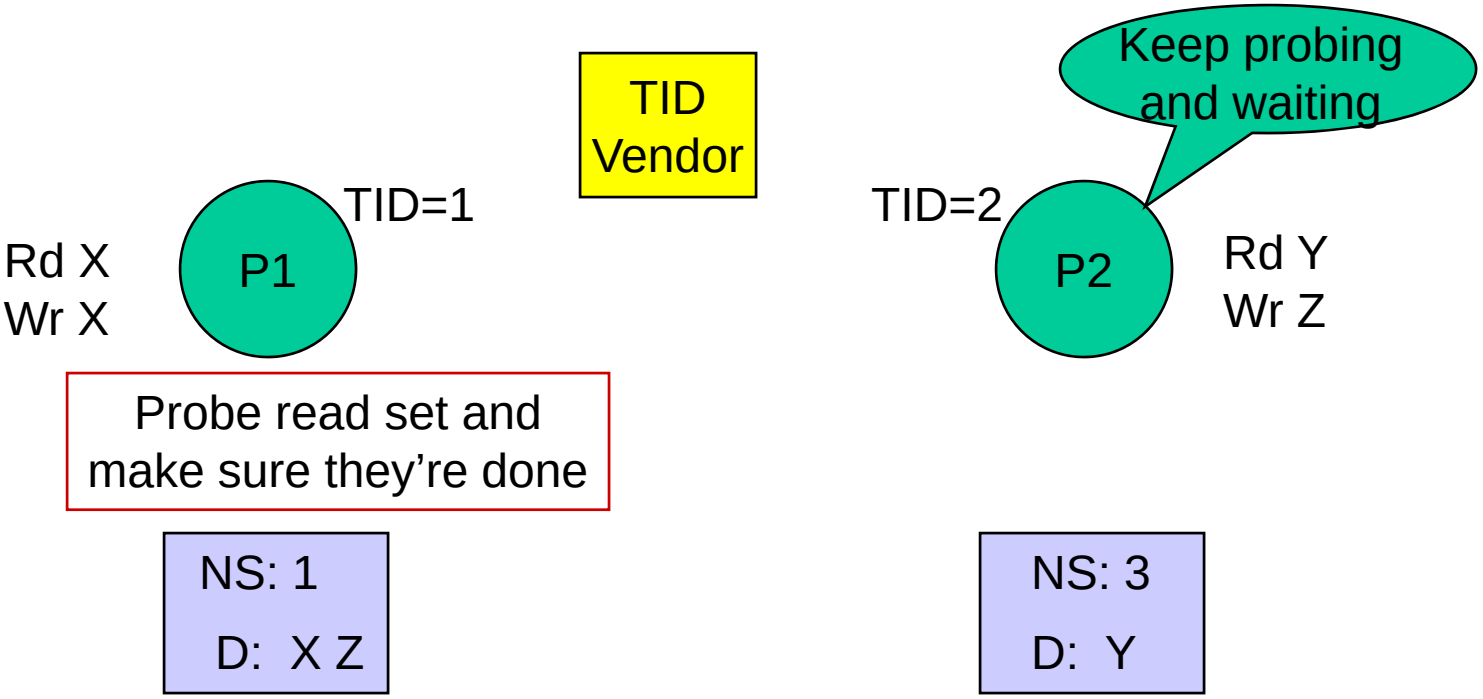
P2 sends the same set of probes/notifications

Example

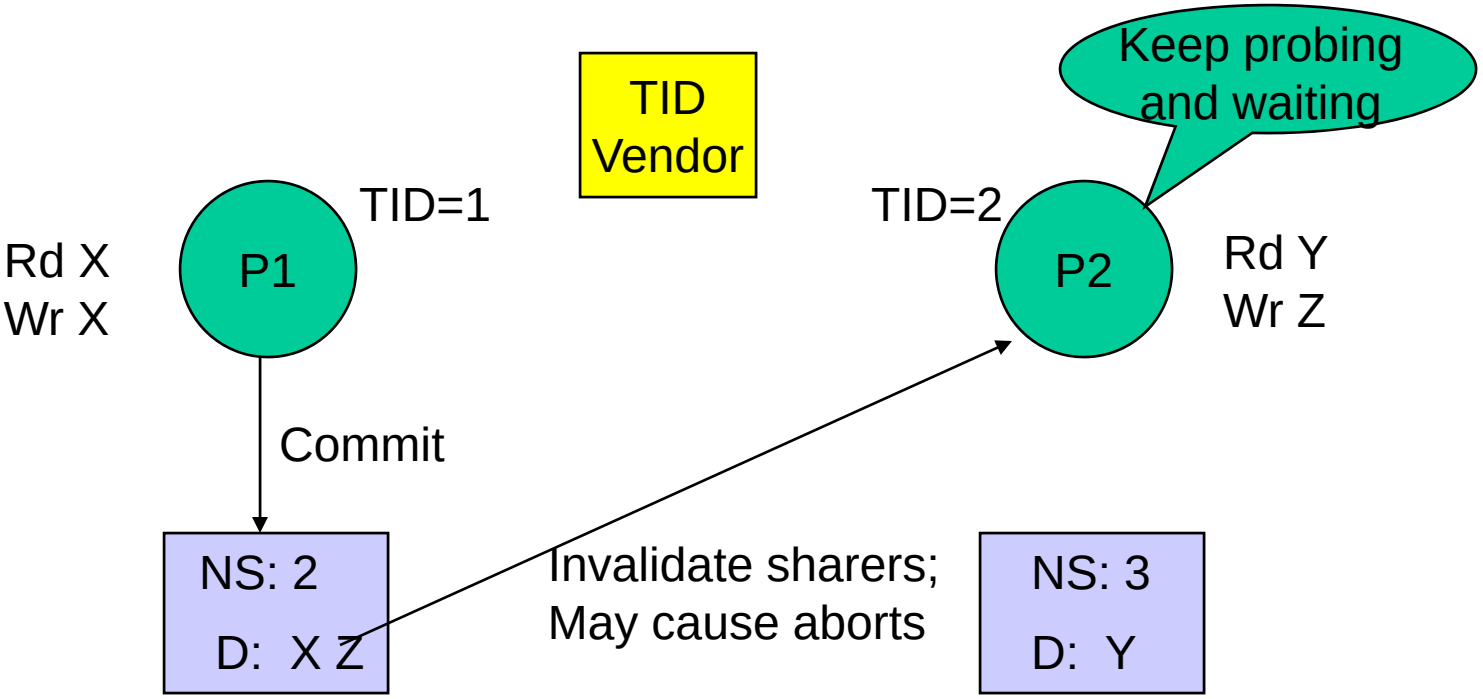


Mark messages are hiding the latency for the subsequent commit

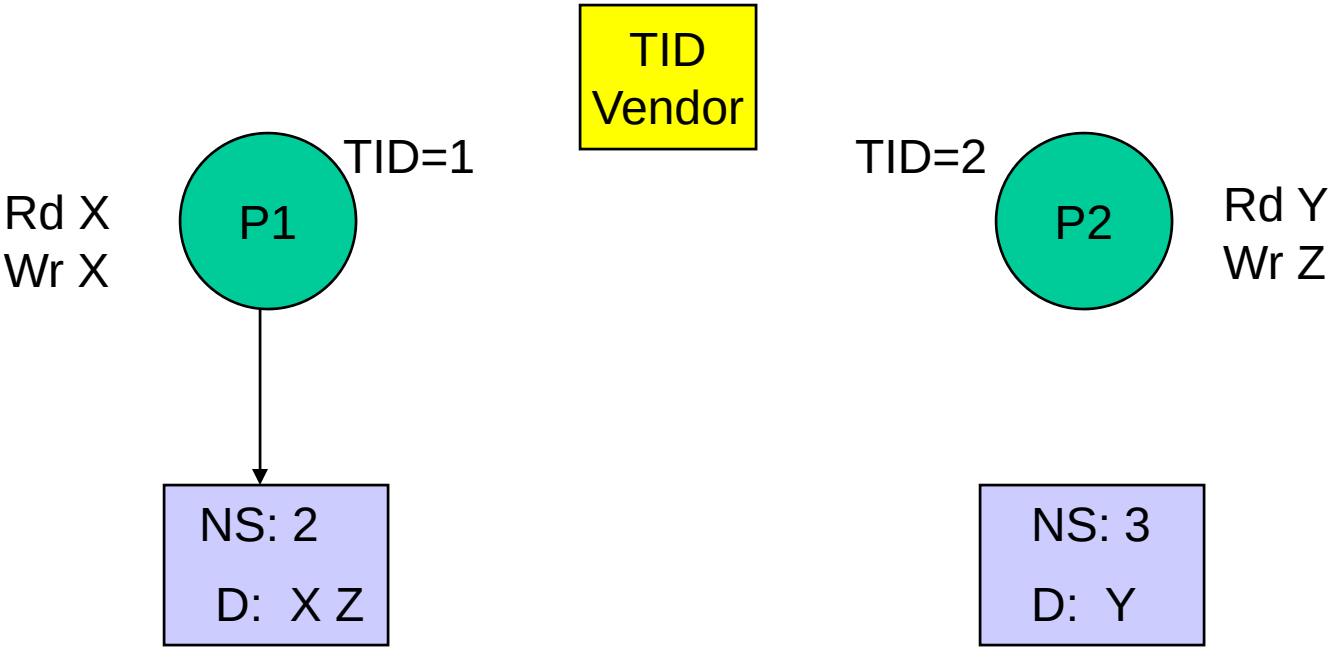
Example


TID
Vendor
Keep probing
and waiting
TID=1
TID=2
P1
P2
Rd X
Wr X
Rd Y
Wr Z
Probe read set and
make sure they're done
NS: 1
D: X Z
NS: 3
D: Y

Example


TID
Vendor
Keep probing
and waiting
TID=1
TID=2
Rd X
Wr X
P1
P2
Rd Y
Wr Z
Commit
NS: 2
D: X Z
Invalidate sharers;
May cause aborts
NS: 3
D: Y

Example



P2: Probe finally successful.
Can mark Z.
Will then check read-set.
Then proceed with commit

Title

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