Database Management Systems (CSN-351)
Concurrency Control (contd.)

BTech 3rd Year (CS) + Minor

Instructor: **R**anita **B**iswas
Department of Computer Science and Engineering
Indian Institute of Technology Roorkee
Roorkee, Uttarakhand - 247 667, India

Locking Protocols

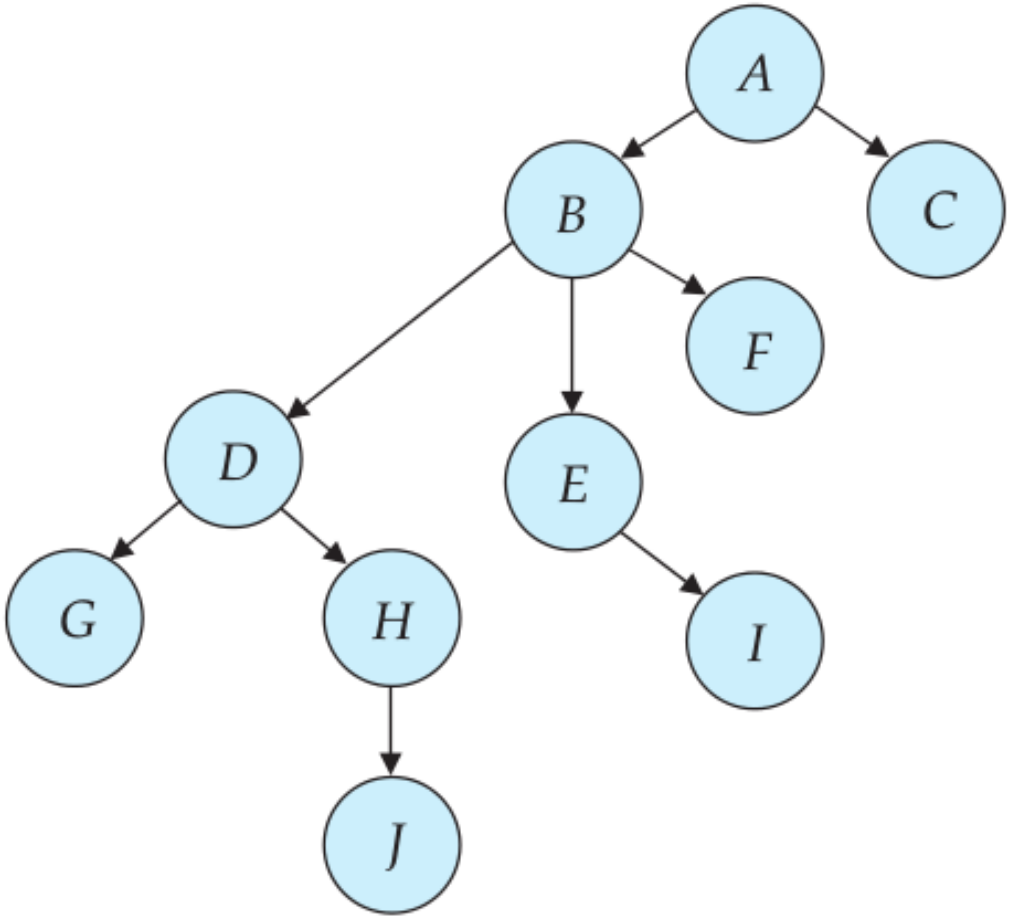
Graph-Based Protocols → Tree protocol

Locking Protocols

Graph-Based Protocols → Tree protocol

Multiple Granularity → Multiple-granularity locking protocol

Database Graph



Tree Protocol

- The first lock by T_i may be on any data item.

Tree Protocol

- The first lock by T_i may be on any data item.
- Subsequently, a data item Q can be locked by T_i only if the parent of Q is currently locked by T_i .

Tree Protocol

- The first lock by T_i may be on any data item.
- Subsequently, a data item Q can be locked by T_i only if the parent of Q is currently locked by T_i .
- Data items may be unlocked at any time.

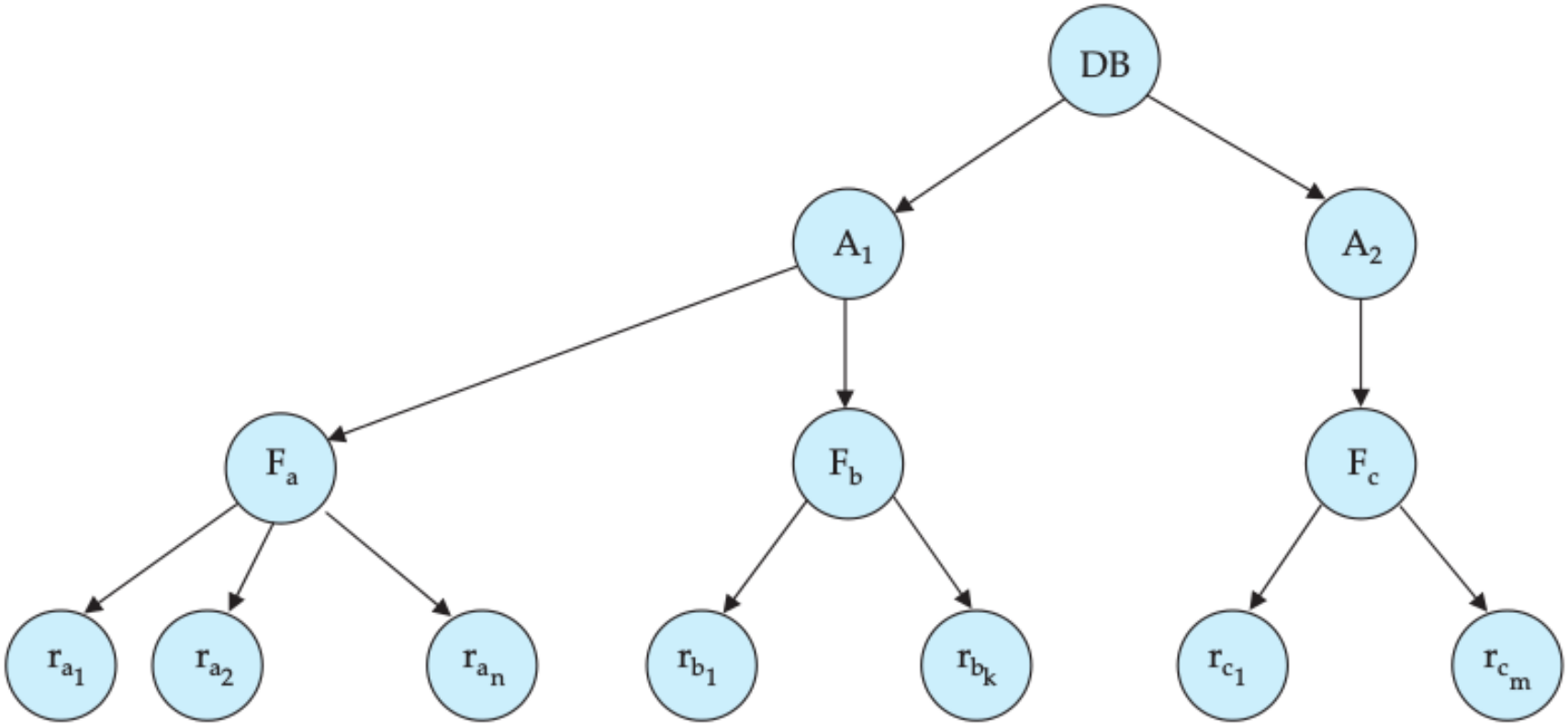
Tree Protocol

- The first lock by T_i may be on any data item.
- Subsequently, a data item Q can be locked by T_i only if the parent of Q is currently locked by T_i .
- Data items may be unlocked at any time.
- A data item that has been locked and unlocked by T_i cannot subsequently be relocked by T_i .

Schedule

T_{10}	T_{11}	T_{12}	T_{13}
lock-X(B)			
	lock-X(D)		
	lock-X(H)		
	unlock(D)		
lock-X(E)			
lock-X(D)			
unlock(B)			
unlock(E)			
		lock-X(B)	
		lock-X(E)	
	unlock(H)		
lock-X(G)			
unlock(D)			
			lock-X(D)
			lock-X(H)
			unlock(D)
			unlock(H)
		unlock(E)	
		unlock(B)	
unlock(G)			

Granularity Hierarchy



New Lock Modes

- **Intention-shared (IS):** explicit locking is being done at a lower level of the tree, but with only shared-mode locks.

New Lock Modes

- **Intention-shared (IS):** explicit locking is being done at a lower level of the tree, but with only shared-mode locks.
- **Intention-exclusive (IX):** explicit locking is being done at a lower level, with exclusive-mode or shared-mode locks.

New Lock Modes

- **Intention-shared (IS):** explicit locking is being done at a lower level of the tree, but with only shared-mode locks.
- **Intention-exclusive (IX):** explicit locking is being done at a lower level, with exclusive-mode or shared-mode locks.
- **Shared and intention-exclusive (SIX):** the subtree rooted by that node is locked explicitly in shared mode, and that explicit locking is being done at a lower level with exclusive-mode locks.

Compatibility Matrix

	IS	IX	S	SIX	X
IS	true	true	true	true	false
IX	true	true	false	false	false
S	true	false	true	false	false
SIX	true	false	false	false	false
X	false	false	false	false	false

Multiple-granularity locking protocol

- Transaction T_i must observe the lock-compatibility function.

Multiple-granularity locking protocol

- Transaction T_i must observe the lock-compatibility function.
- Transaction T_i must lock the root of the tree first, and can lock it in any mode.

Multiple-granularity locking protocol

- Transaction T_i must observe the lock-compatibility function.
- Transaction T_i must lock the root of the tree first, and can lock it in any mode.
- Transaction T_i can lock a node Q in S or IS mode only if T_i currently has the parent of Q locked in either IX or IS mode.

Multiple-granularity locking protocol

- Transaction T_i must observe the lock-compatibility function.
- Transaction T_i must lock the root of the tree first, and can lock it in any mode.
- Transaction T_i can lock a node Q in S or IS mode only if T_i currently has the parent of Q locked in either IX or IS mode.
- Transaction T_i can lock a node Q in X, SIX , or IX mode only if T_i currently has the parent of Q locked in either IX or SIX mode.

Multiple-granularity locking protocol

- Transaction T_i must observe the lock-compatibility function.
- Transaction T_i must lock the root of the tree first, and can lock it in any mode.
- Transaction T_i can lock a node Q in S or IS mode only if T_i currently has the parent of Q locked in either IX or IS mode.
- Transaction T_i can lock a node Q in X, SIX , or IX mode only if T_i currently has the parent of Q locked in either IX or SIX mode.
- Transaction T_i can lock a node only if T_i has not previously unlocked any node (that is, T_i is two phase).

Multiple-granularity locking protocol

- Transaction T_i must observe the lock-compatibility function.
- Transaction T_i must lock the root of the tree first, and can lock it in any mode.
- Transaction T_i can lock a node Q in S or IS mode only if T_i currently has the parent of Q locked in either IX or IS mode.
- Transaction T_i can lock a node Q in X, SIX , or IX mode only if T_i currently has the parent of Q locked in either IX or SIX mode.
- Transaction T_i can lock a node only if T_i has not previously unlocked any node (that is, T_i is two phase).
- Transaction T_i can unlock a node Q only if T_i currently has none of the children of Q locked.