Outline

- Introduction
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- Distributed DBMS Architecture
- Distributed Database Design
- Distributed Query Processing
- Distributed Transaction Management
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  - Distributed Concurrency Control
  - Distributed Reliability
- Building Distributed Database Systems (RAID)
- Mobile Database Systems
- Privacy, Trust, and Authentication
- Peer to Peer Systems

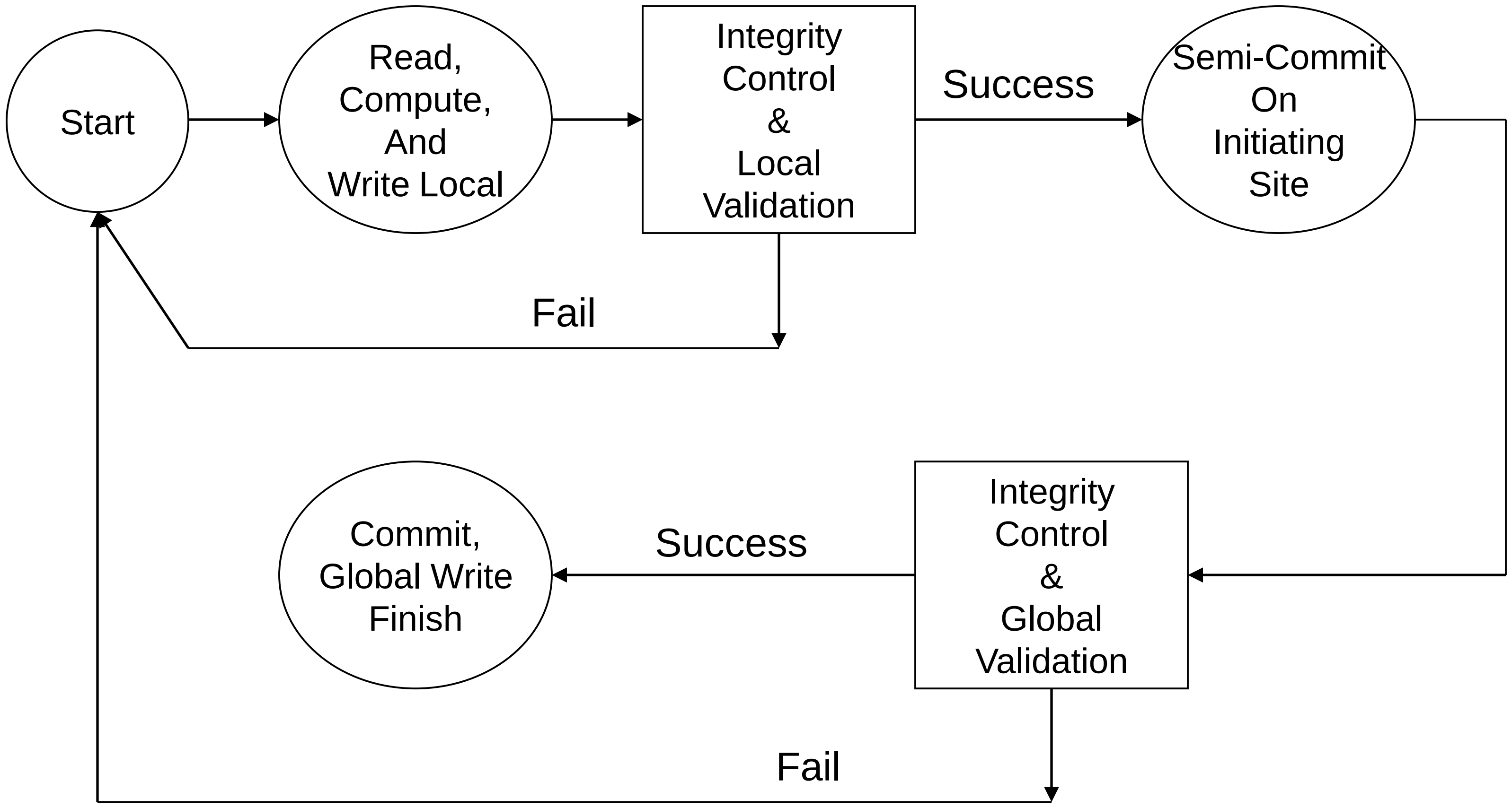
Useful References

- H.T. Kung and John T. Robinson, *On Optimistic Methods for Concurrency Control*, ACM Trans. Database Systems, 6(2), 1981.
- B. Bhargava, *Concurrency Control in Database Systems*, IEEE Trans on Knowledge and Data Engineering,11(1), Jan.-Feb. 1999

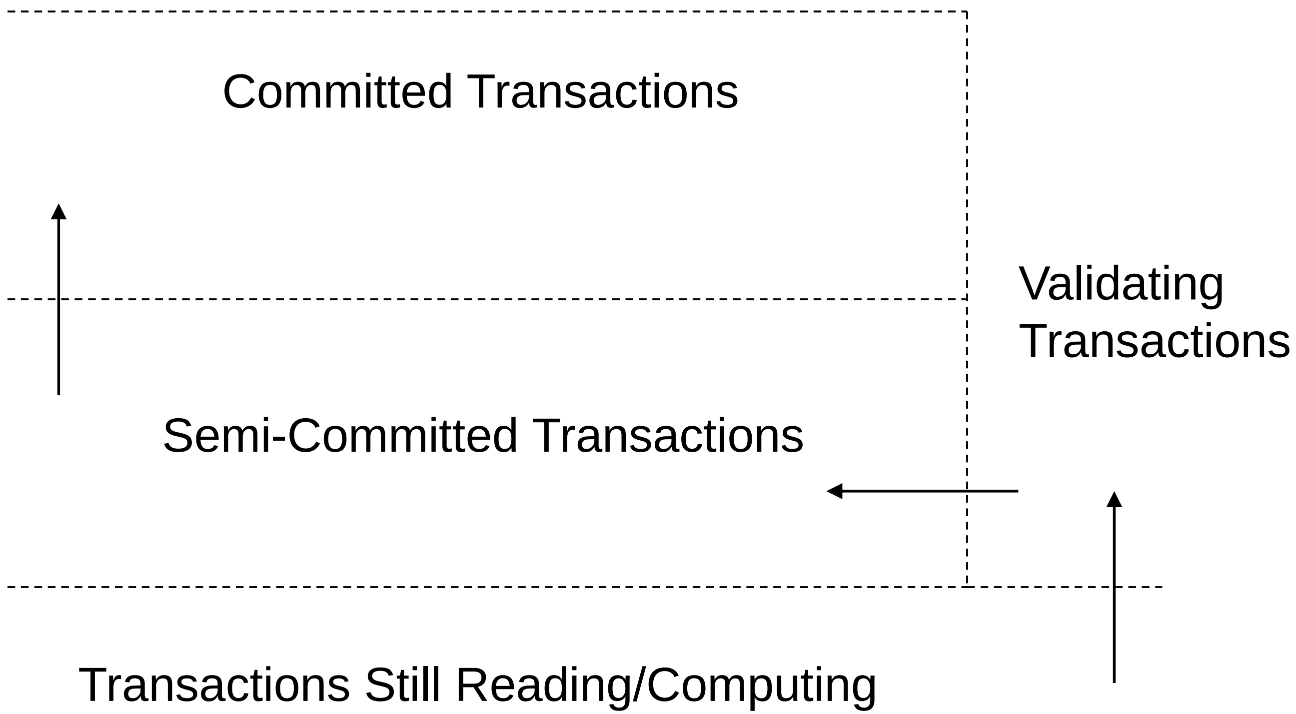
Optimistic Concurrency Control Algorithms

- Transaction execution model: divide into subtransactions each of which execute at a site
  - T_{ij}: transaction T_i that executes at site j
- Transactions run independently at each site until they reach the end of their read phases
- All subtransactions are assigned a timestamp at the end of their read phase
- Validation test performed during validation phase. If one fails, all rejected.

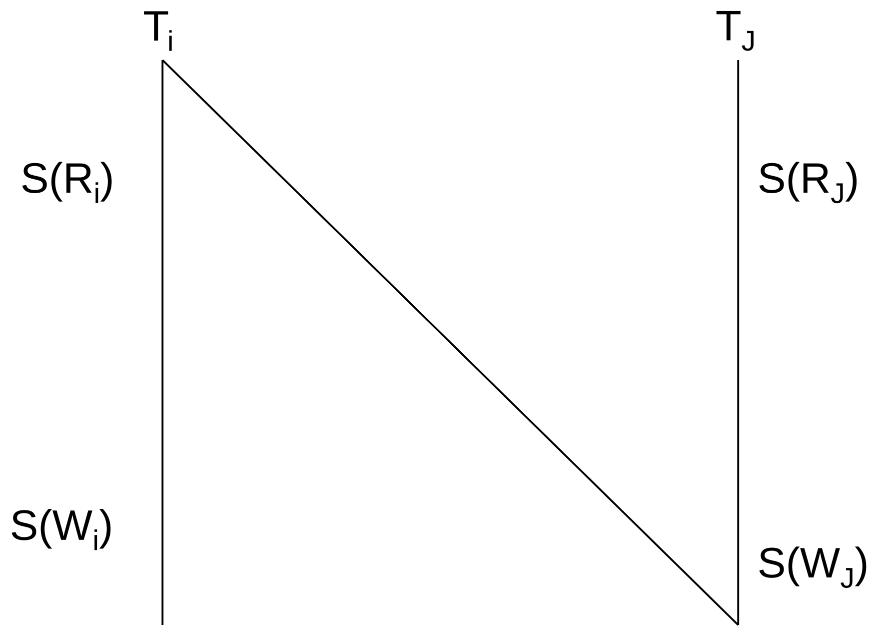
Optimistic Concurrency Control Processing



Transaction Types on a Site



Exmaple of Locking vs Optimistic



$S(R_i) \cap S(W_J) \neq \emptyset$ AND

$\Pi(R_i) < \Pi(W_J)$

$\Rightarrow T_i \rightarrow T_J$

Locking

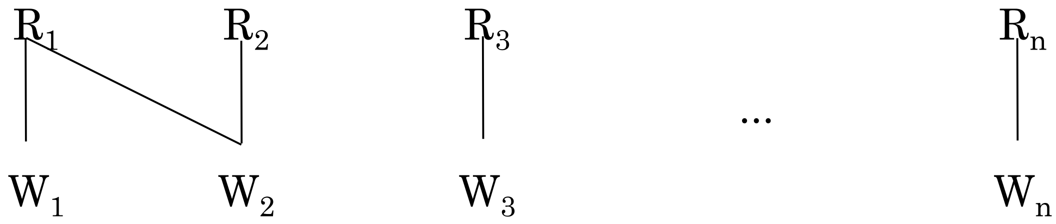
$R_i \; R_J \; W_i \; W_J$

Optimistic

$R_i \; R_J \; W_i \; W_J$

$R_i \; R_J \; W_J \; W_i$

Example: $h = R_1 R_2 W_2 R_3 W_3 \ldots R_n W_n W_1$



Locking: This history not allowed

W_2 is blocked by R_1

T_2 cannot finish before T_1

What if T_1 is a log trans. and T_2 is a small trans.?

T_1 blocks T_2; can block T_3 … T_n if $(R_2 \cap W_3 \neq \emptyset)$

Optimistic [Kung]

T_i (i = 2,…,n) commit. W_i saved for valid_n

R_1 validated with W_i, T_1 aborted

$$h = R_1 R_2 W_2 \ldots R_n W_n W_1$$

switch to

Optimistic Validation (first modification)

$$h = R_1\ R_2 W_2 R_3 W_3 \ldots R_n W_n\ W_1$$

Try this or this switch

T_i's can commit, W_i and R_i saved from validation

W_1 validates with W_i and R_i

T_1 aborted if validation fails (second modification)

$$h = R_1\ R_2 W_2 R_3 W_3 \ldots R_n W_n\ W_1$$

- Switch R_1 to the right after W_2, $W_3 \ldots W_n$
- Switch W_1 to the left before R_n, $R_{n-1} \ldots R_2$
- If R_1 and W_1 are adjacent, T_1 is successful

$$h \equiv R_1 R_2 W_2 \ldots R_k W_k \ldots R_n W_n W_1$$

$$\equiv R_2 W_2 \ldots R_1 W_1 R_k W_k \ldots R_n W_n$$

Probability that two transactions do not share an object

$$= \frac{{}^{M}C_{B_S} * {}^{M-B_S}C_{B_S}}{{}^{M}C_{B_S} * {}^{M}C_{B_S}}$$

$$= \left(\frac{M - B_S}{M}\right) * \left(\frac{M - B_S - 1}{M - 1}\right) * \left(\frac{M - 2B_S + 1}{M - B_S + 1}\right)$$

Lower bound on this problem $= \left(\frac{M - 2B_S + 1}{M - B_S + 1}\right)^{B_S}$

Maximum problem that two transactions will share an object

$$= 1 - \left(\frac{M - 2B_S + 1}{M - B_S + 1}\right)^{B_S}$$

BS	M	Probability of conflict
5	100	.0576
10	500	.0025
20	1000	.113

Probability of cycle
= $0(PC^2)$
≅ small

Concurrency/Multiprogramming level is low

Example:

I/O	=	.005 seconds
CPU	=	.0001 seconds
Trans size	=	5
Time to execute trans.	=	.0255 seconds

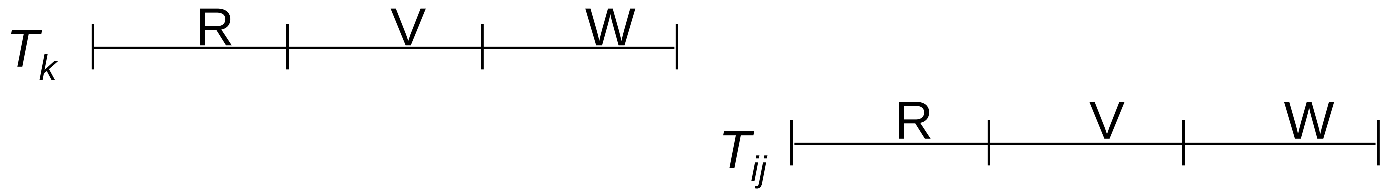
For another trans. to meet this trans. in the system

$$\text{Arrival rate} > \frac{1}{.0255} \text{ or } > 40 \text{ per second}$$

Optimistic CC Validation Test

If all transactions T_k where $ts(T_k) < ts(T_{ij})$ have completed their write phase before T_{ij} has started its read phase, then validation succeeds

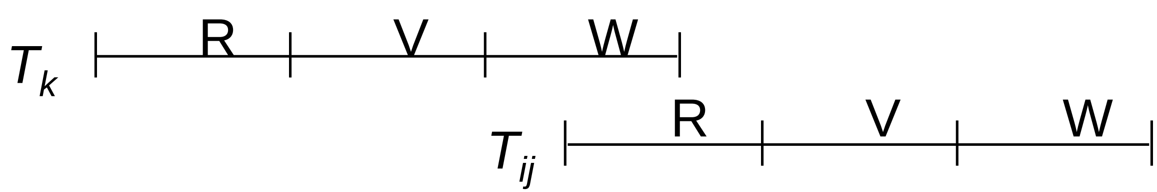
- Transaction executions in serial order



Optimistic CC Validation Test

If there is any transaction T_k such that $ts(T_k) < ts(T_{ij})$ and which completes its write phase while T_{ij} is in its read phase, then validation succeeds if $WS(T_k) \cap RS(T_{ij}) = \emptyset$

- Read and write phases overlap, but T_{ij} does not read data items written by T_k



Optimistic CC Validation Test

If there is any transaction T_k such that $ts(T_k) < ts(T_{ij})$ and which completes its read phase before T_{ij} completes its read phase, then validation succeeds if $WS(T_k) \cap RS(T_{ij}) = \emptyset$ and $WS(T_k) \cap WS(T_{ij}) = \emptyset$

- They overlap, but don't access any common data items.