

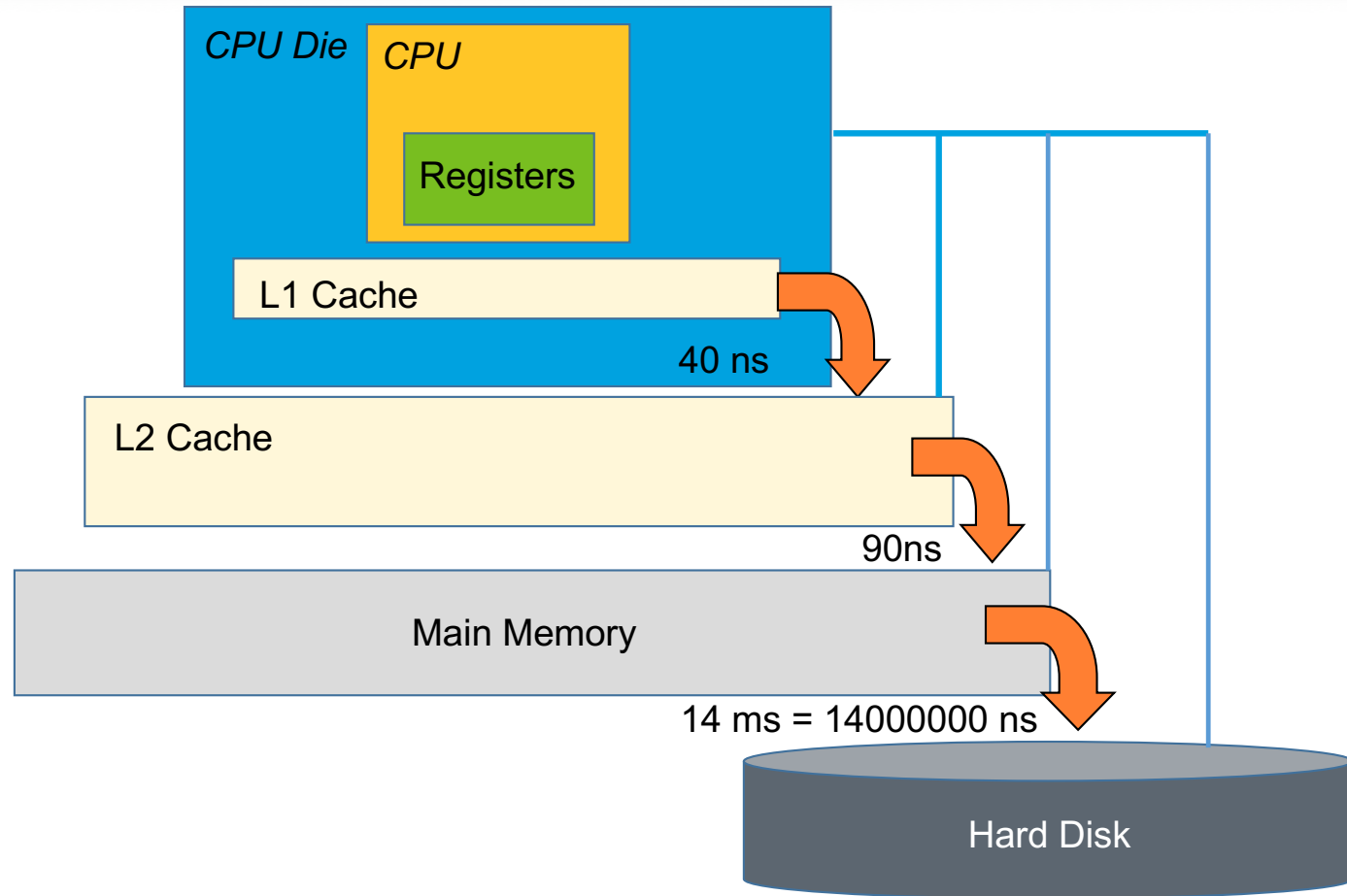
Fundamental Operators

Let **r** and **s** be relations with **schemas R and S**

union	$r \cup s = \{ t \mid t \in r \vee t \in s \}$
difference	$r - s = \{ t \mid t \in r \wedge t \notin s \}$
cartesian_product	$r \times s = \{ t \mid t = t_r t_s \text{ where } t_r \in r \wedge t_s \in s \}$
selection	$\sigma_p(r)$
projection	$\pi_A(r)$

The Memory Hierarchy

Example:
Intel PIII
CPU: 450MHz
Memory: 512MB



Internal Data Storage

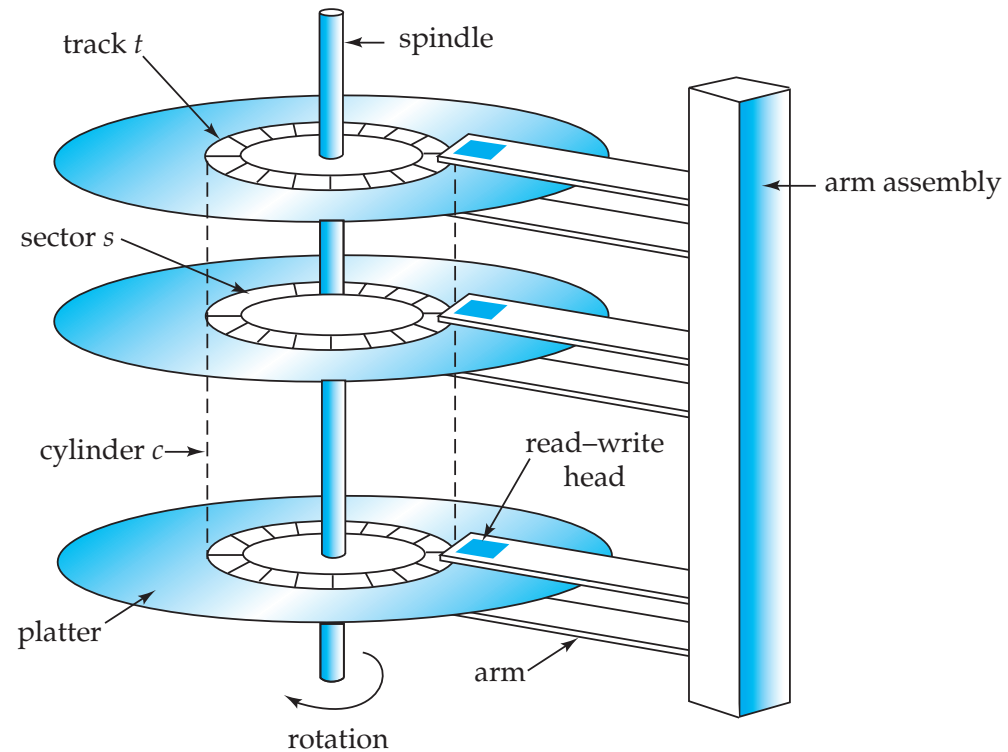
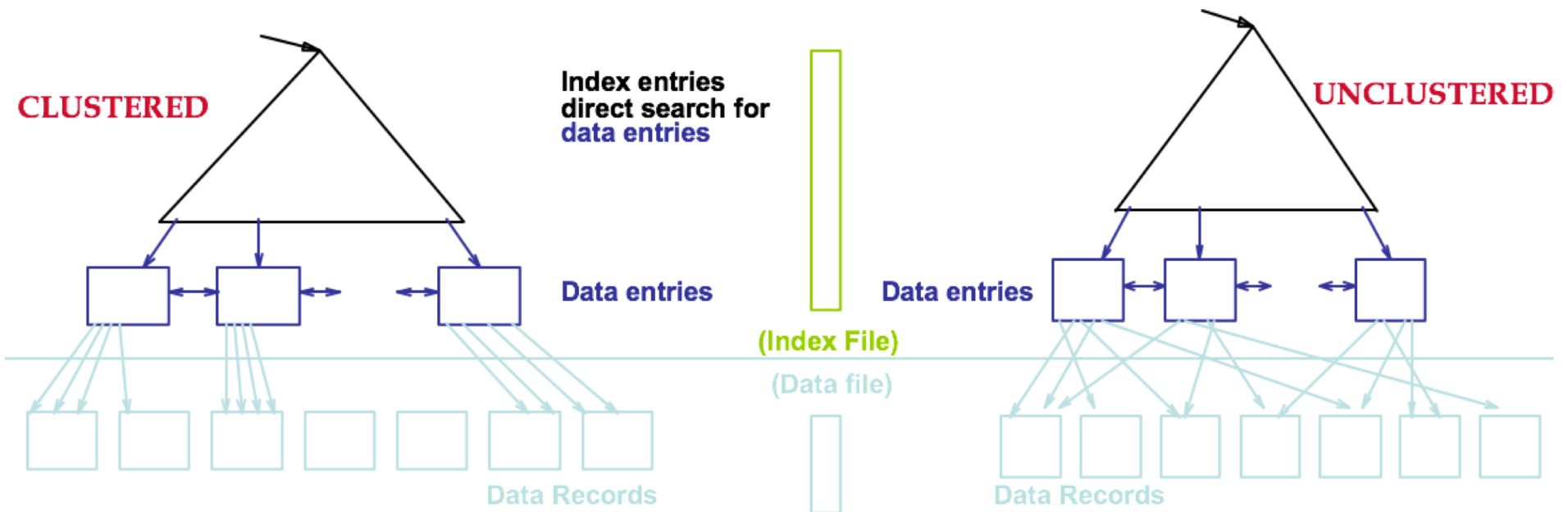


Image source: <https://www.snia.org>

Clustered vs. Unclustered Index



Transaction ACID Properties

ACID

Atomic

"ALL OR NOTHING"

Transaction cannot be subdivided

Consistent

Transaction → transform database from one consistent state to another consistent state

Isolated

Transactions execute independently of one another

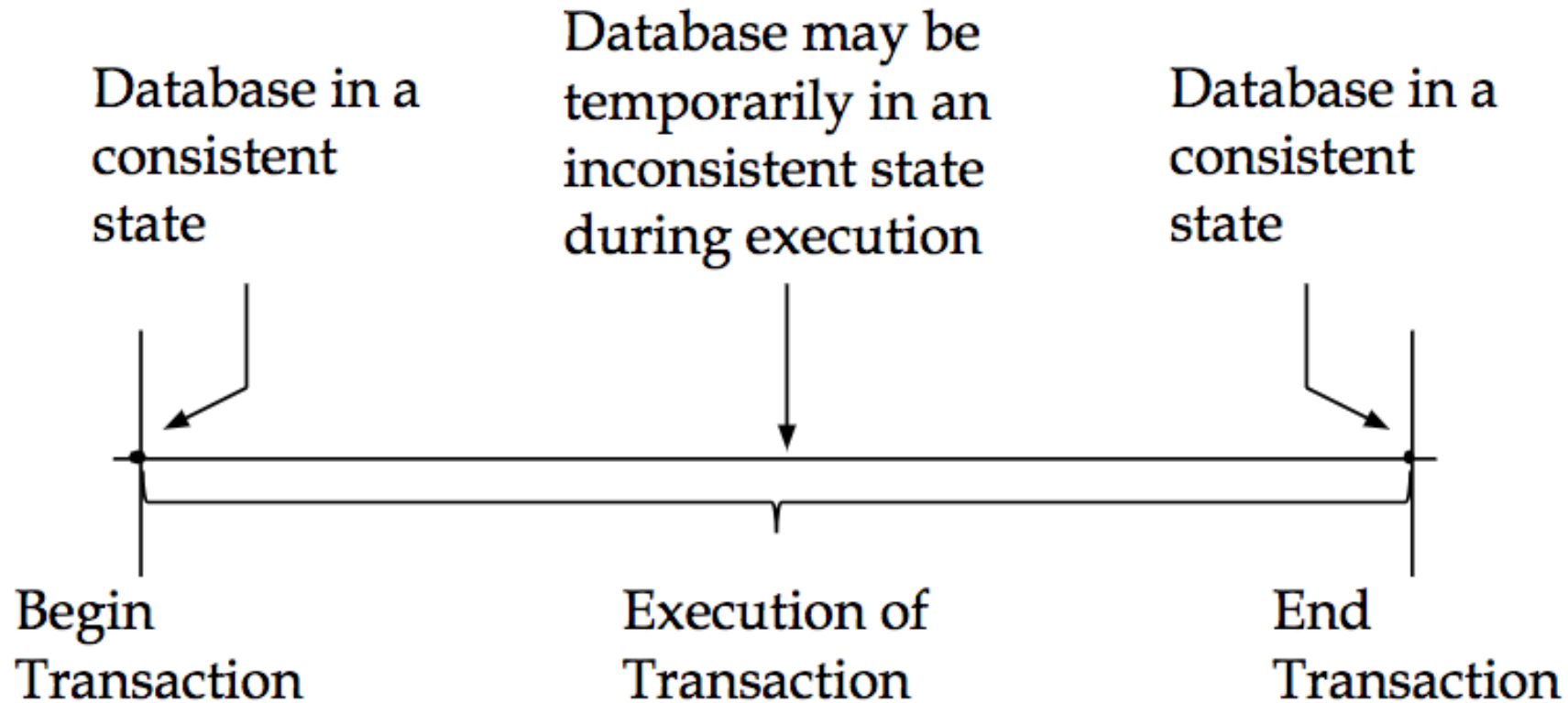
Database changes not revealed to users until after transaction has completed

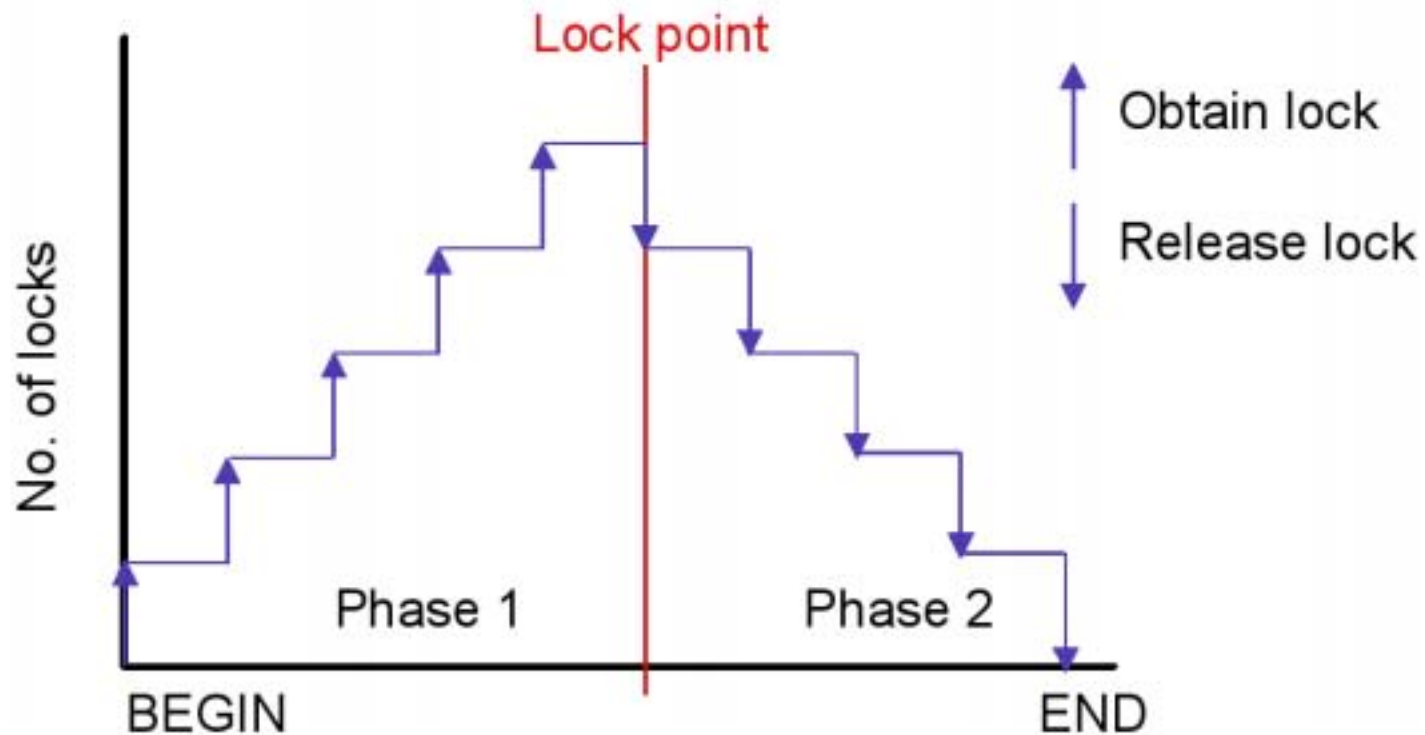
Durable

Database changes are permanent

The permanence of the database's consistent state

Transactions





Initial State



begin



Transaction

commit



roll back



**Transaction
completed**



**Transaction
failed**