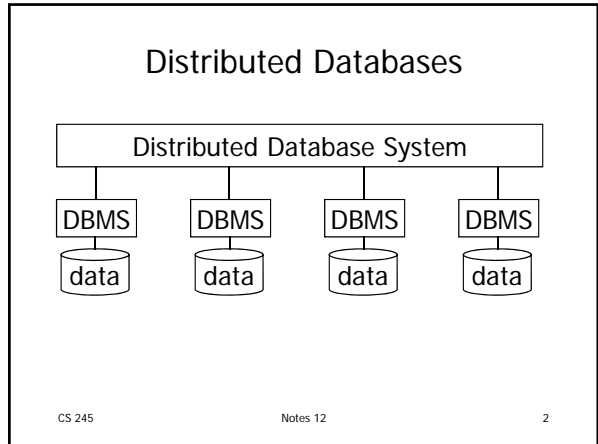


**CS 245: Database System Principles**  
**Notes 12: Distributed Databases**  
 Hector Garcia-Molina

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### Advantages of a DDBS

- Modularity
- Fault Tolerance
- High Performance
- Data Sharing
- Low Cost Components

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### Issues

- Data Distribution
- Exploiting Parallelism
- Concurrency and Recovery
- Heterogeneity

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### Parallelism: Pipelining

- Example:
  - $T_1 \leftarrow \text{SELECT } * \text{ FROM A WHERE cond}$
  - $T_2 \leftarrow \text{JOIN } T_1 \text{ and B}$

```

    graph LR
      A[(A)] --> S([select])
      S --> J([join])
      B[(B with index)] --> J
      J --> Out[ ]
  
```

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### Parallelism: Concurrent Operations

- Example:  $\text{SELECT } * \text{ FROM A WHERE cond}$

```

    graph BT
      S1([select]) --- A1[(A where A.x < 10)]
      S2([select]) --- A2[(A where 10 <= A.x < 20)]
      S3([select]) --- A3[(A where 20 <= A.x)]
      S1 --> M([merge])
      S2 --> M
      S3 --> M
  
```

data location is important...

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### Join Processing

- Example: JOIN A, B over attribute X

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### Join Processing

- Example: JOIN A, B over attribute X

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### Concurrency & Recovery

- Two Phase Commit

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### 2PC: ATM Withdrawl

- Mainframe is coordinator
- Phase 1: ATM checks if money available; mainframe checks if account has funds (money and funds are "reserved")
- Phase 2: ATM releases funds; mainframe debits account

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### Replicated Data Mangement

- Key to fault-tolerance, durability
- Illustrates transaction processing issues
- Various concurrency control/recovery algorithms available

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### Primary Copy Algorithm

- Updates run at primary site
- Backups repeat writes; backups allow "out-of-date" reads

Primary Site		Backup Site 1		Backup Site 2	
A	5	A	5	A	5
B	9	B	9	B	8
C	7	C	7	C	6
D	25	D	25	D	25

T1: A:5; C:6  
T2: B:9; C:7

propagate in order

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### To be covered in CS347

- More replicated data algorithms
- More commit protocols
- Distributed query processing
- And many, many more fun topics!!