Chapter 9: The Client/Server Database Environment

Modern Database Management

6th Edition

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Client/Server Systems

- Networked computing model
- Processes distributed between clients and servers
- Client – Workstation (usually a PC) that requests and uses a service
- Server – Computer (PC/mini/mainframe) that provides a service
- For DBMS, server is a database server

Application Logic in C/S Systems

- Presentation Logic
  - Input – keyboard/mouse
  - Output – monitor/printer
- Processing Logic
  - I/O processing
  - Business rules
  - Data management
- Storage Logic
  - Data storage/retrieval

GUI Interface

Procedures, functions, programs

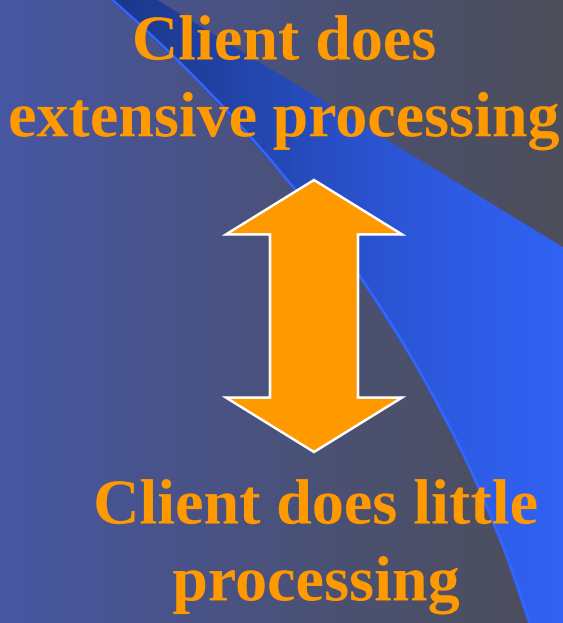
DBMS activities

Client/Server Architectures

File Server Architecture

Database Server Architecture

Three-tier Architecture



File Server Architecture

All processing is done at the PC that requested the data

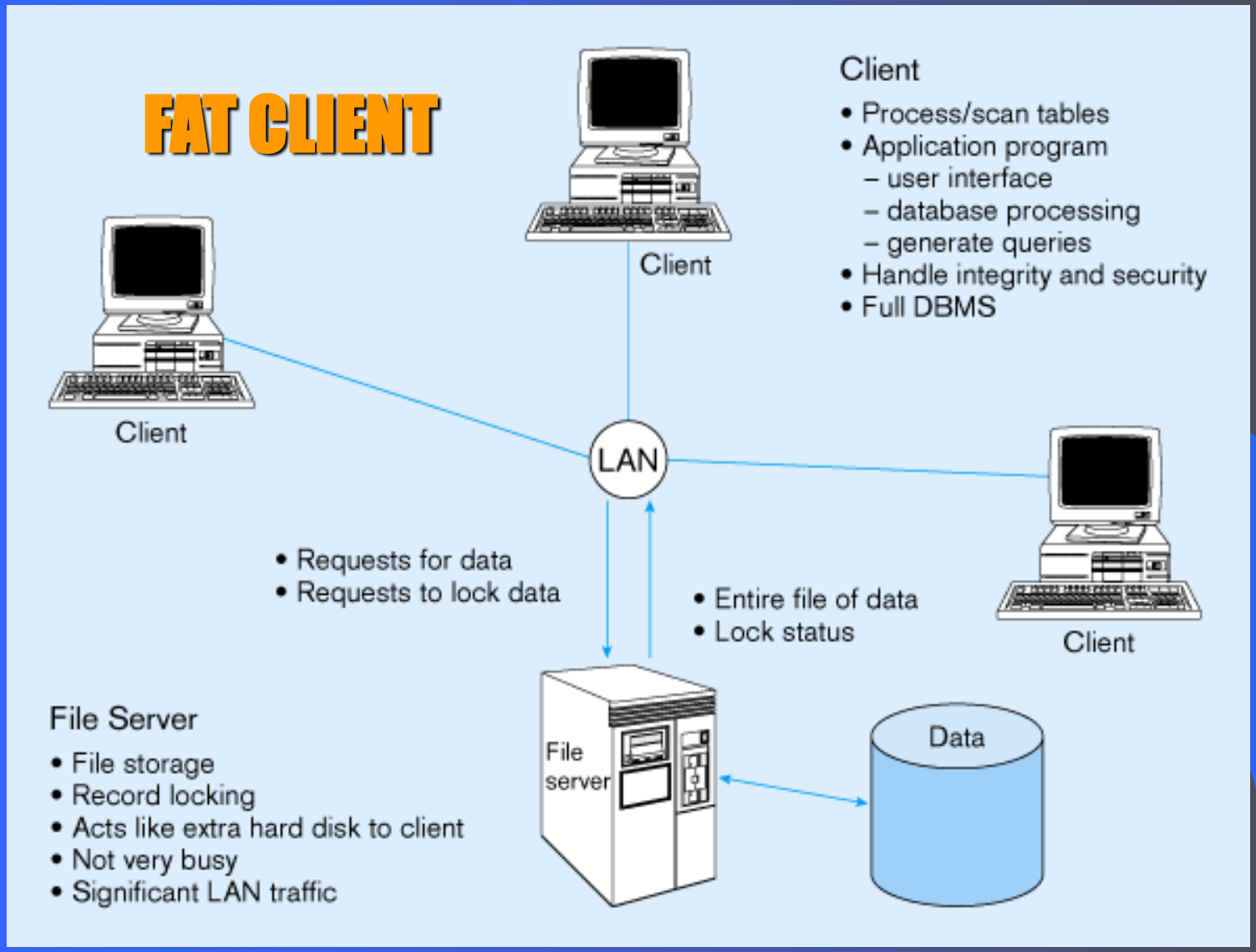
FAT CLIENT

Entire files are transferred from the server to the client for processing.

Problems:

- Huge amount of data transfer on the network
- Each client must contain full DBMS
  - Heavy resource demand on clients
  - Client DBMSs must recognize shared locks, integrity checks, etc.

Figure 9-2 – File Server Architecture



Database Server Architectures

2-tiered approach

Client is responsible for

- I/O processing logic
- Some business rules logic

Server performs all data storage and access processing

➔ **DBMS is only on server**

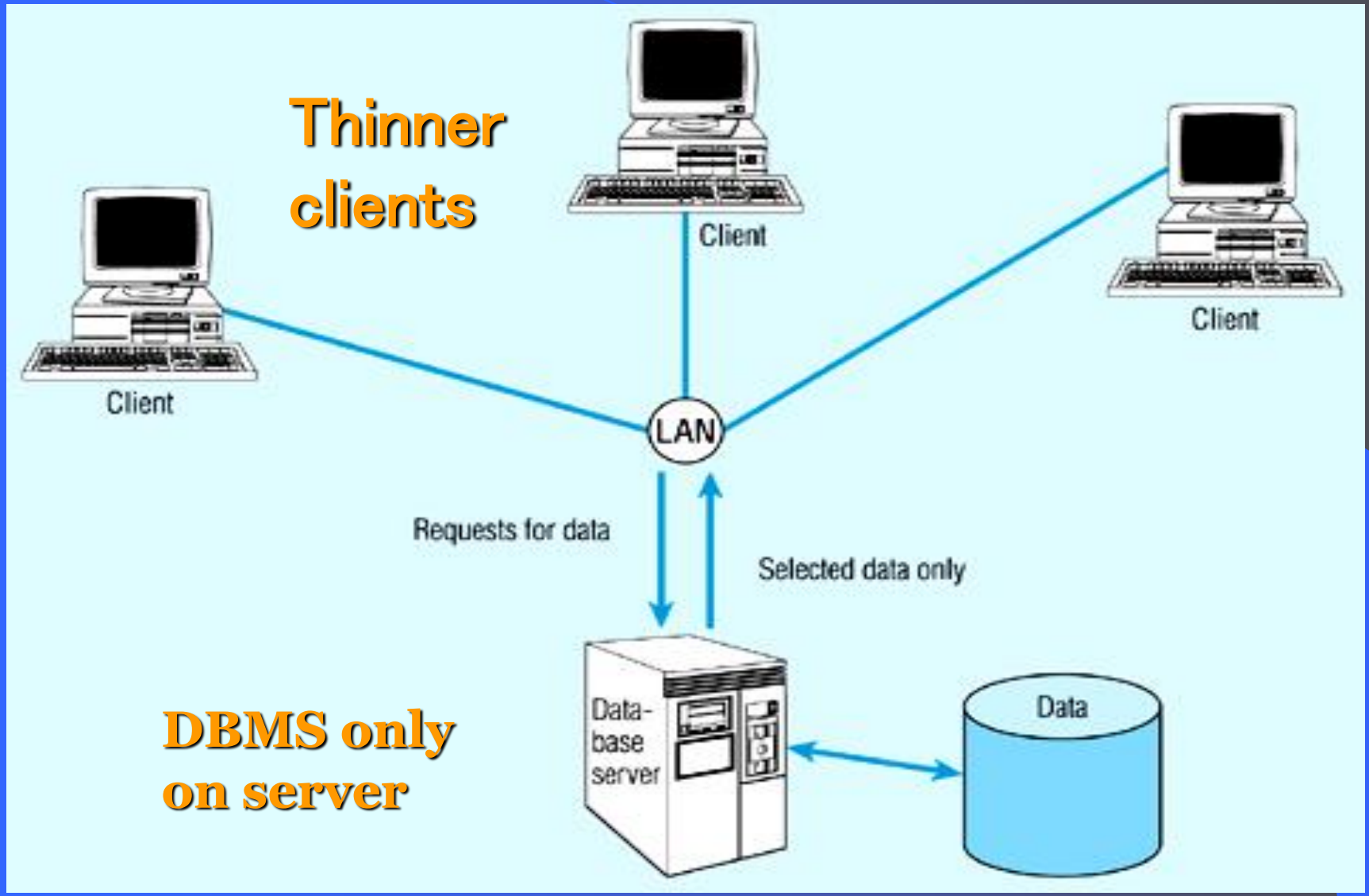
Advantages

- Clients do not have to be as powerful
- Greatly reduces data traffic on the network
- Improved data integrity since it is all processed centrally
- **Stored procedures** ➔ some business rules done on server

Advantages of Stored Procedures

- Compiled SQL statements
- Reduced network traffic
- Improved security
- Improved data integrity
- Thinner clients

Figure 9-3 – Database server architecture



Three-Tier Architectures

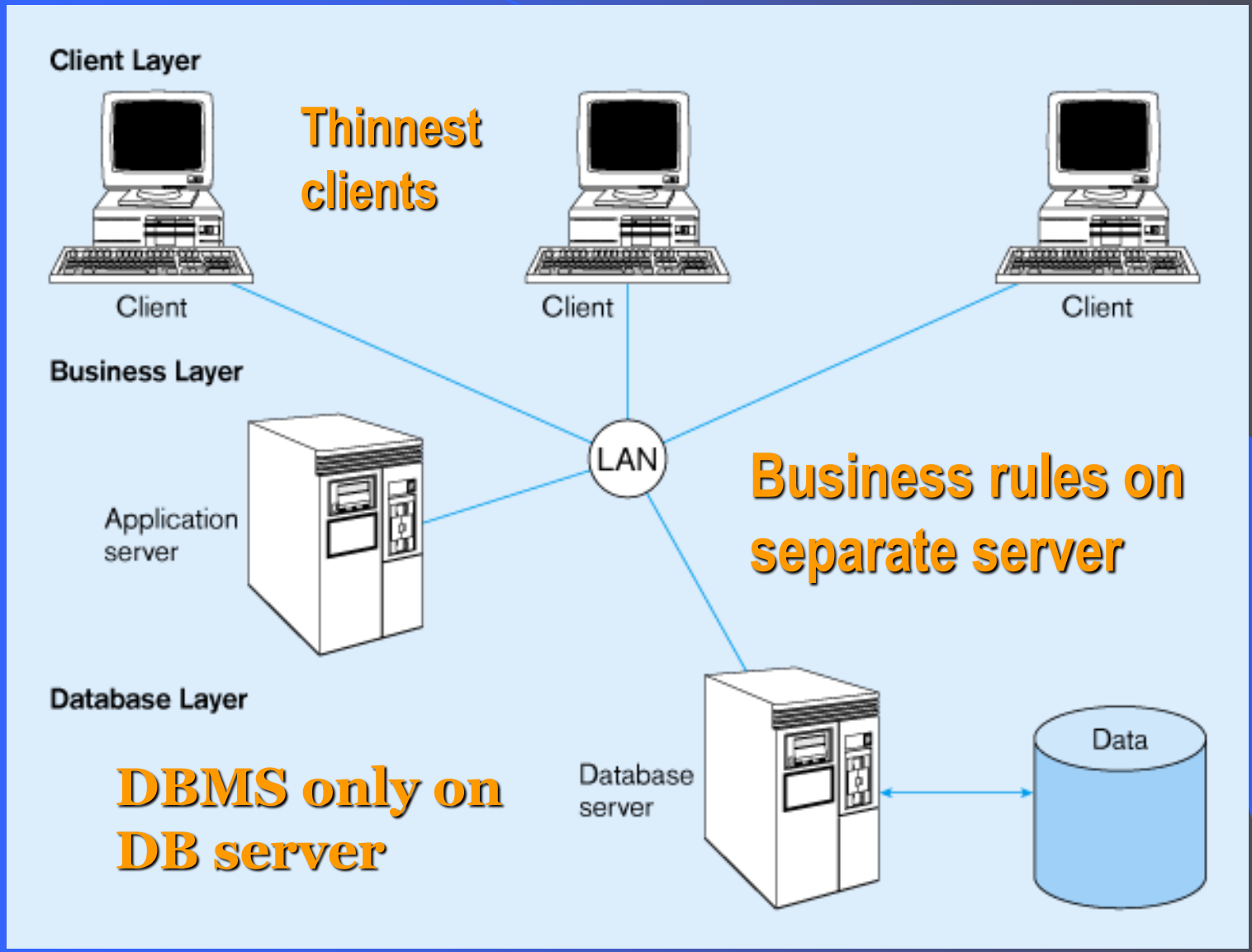
Three layers:

- Client — **GUI interface (I/O processing)** — ***Browser***
- Application server — **Business rules** — ***Web Server***
- Database server — **Data storage** — ***DBMS***

Thin Client

PC just for user interface and a little application processing. Limited or no data storage (sometimes no hard drive)

Figure 9-4 -- Three-tier architecture



Advantages of Three-Tier Architectures

- Scalability
- Technological flexibility
- Long-term cost reduction
- Better match of systems to business needs
- Improved customer service
- Competitive advantage
- Reduced risk

Challenges of Three-tier Architectures

- High short-term costs
- Tools and training
- Experience
- Incompatible standards
- Lack of compatible end-user tools

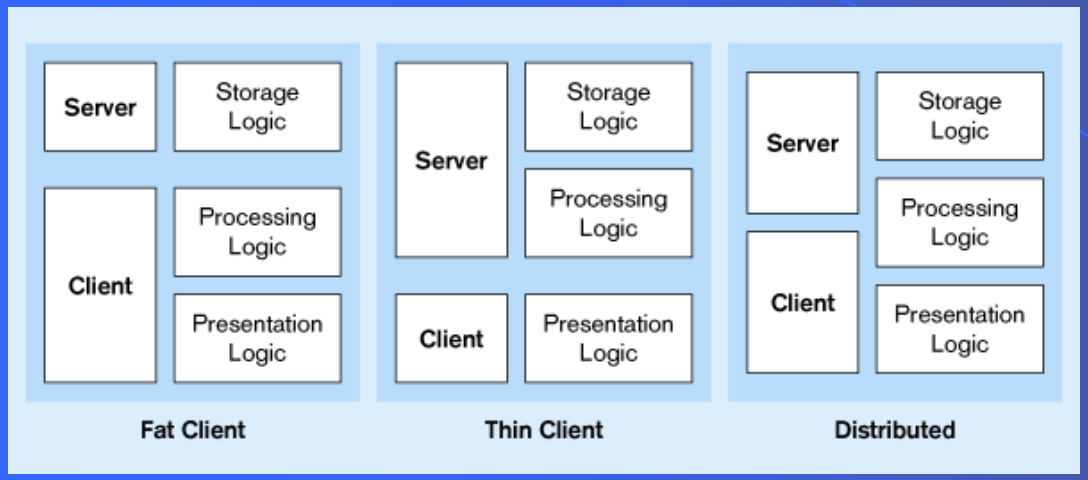
Application Partitioning

Placing portions of the application code in different locations (client vs. server) AFTER it is written

Advantages

- Improve performance
- Improve interoperability
- Balanced workloads

Processing Logic Distributions

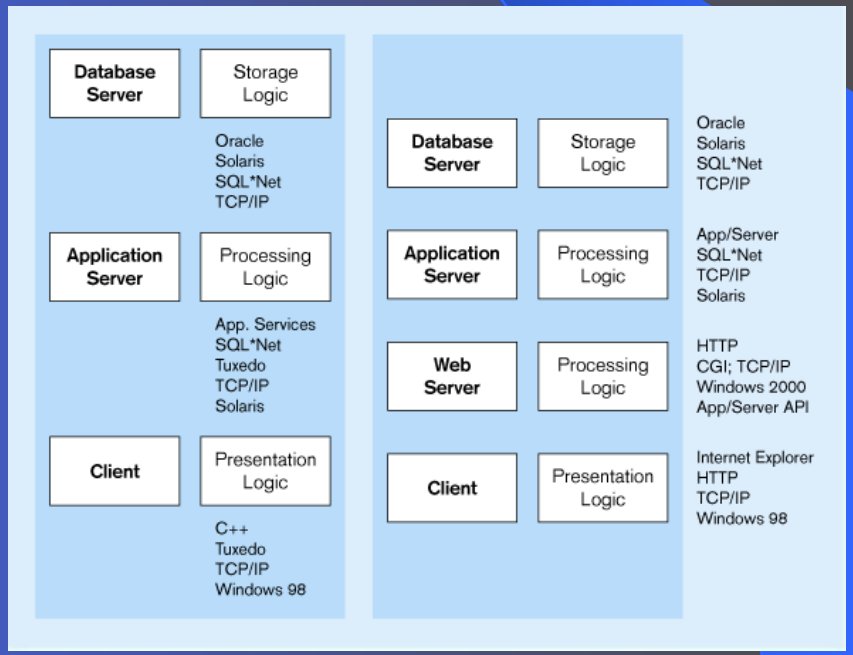


2-tier distributions

Processing logic could be at client, server, or both

Processing logic will be at application server or Web server

n-tier distributions



Parallel Computer Architectures

Tightly Coupled

- Symmetric Multiprocessing (SMP)
- Multiple CPUs
- Shared RAM

Loosely Coupled

- Massively Parallel Processing (MPP)
- Multiple CPUs
- Each CPU has its own RAM space

Parallel Computer Architectures

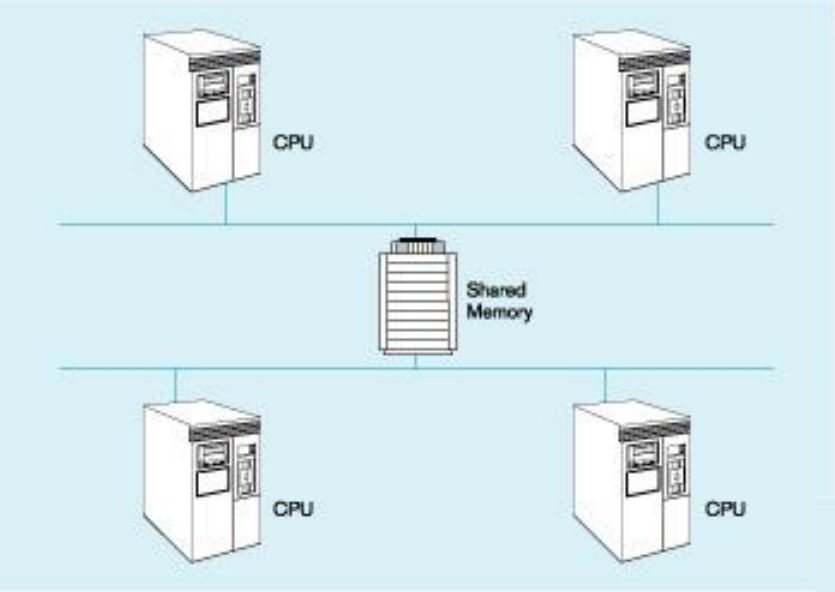


Figure 9-6 – Tightly-coupled – CPUs share common memory space

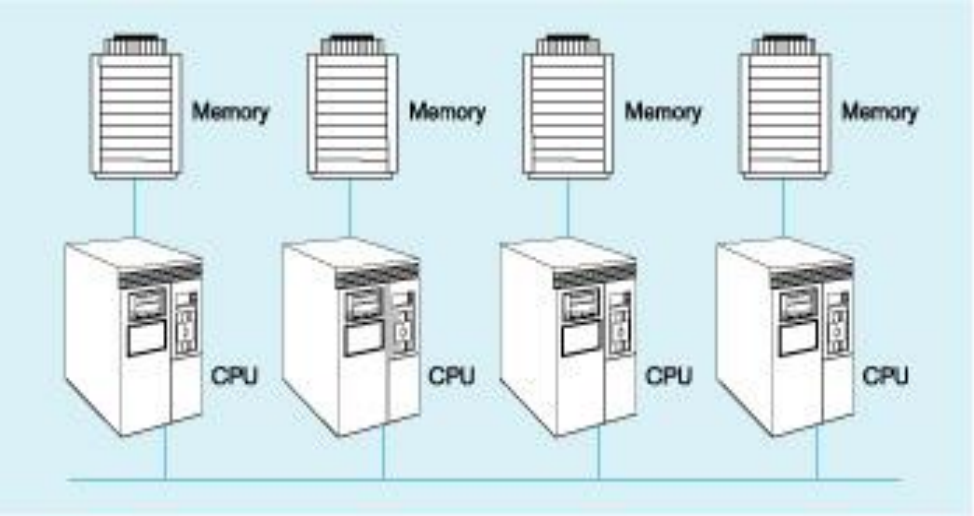


Figure 9-7 – Loosely-coupled – CPUs each have their own memory space

Query Processing with Parallel Processors

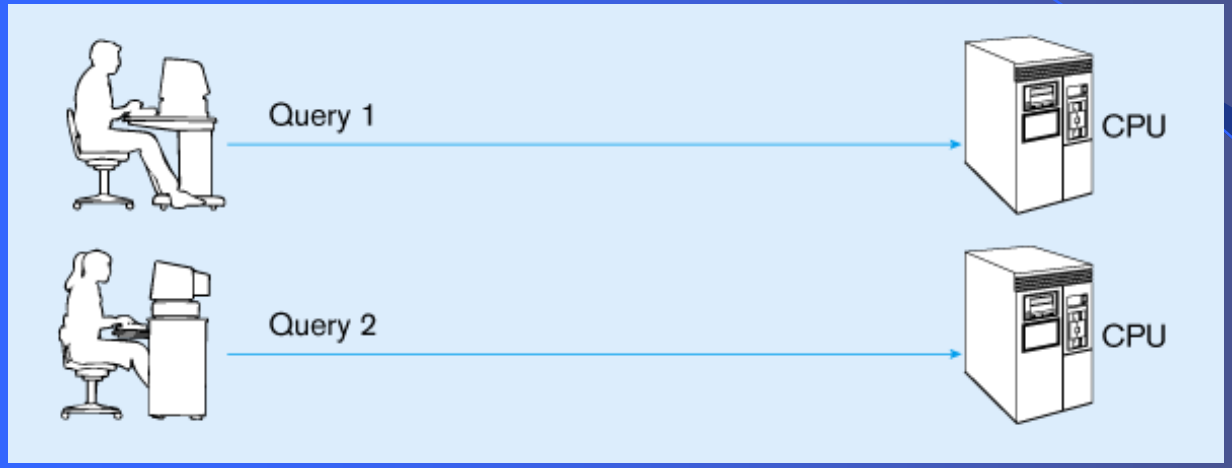


Figure 9-5(a) – Parallel transactions

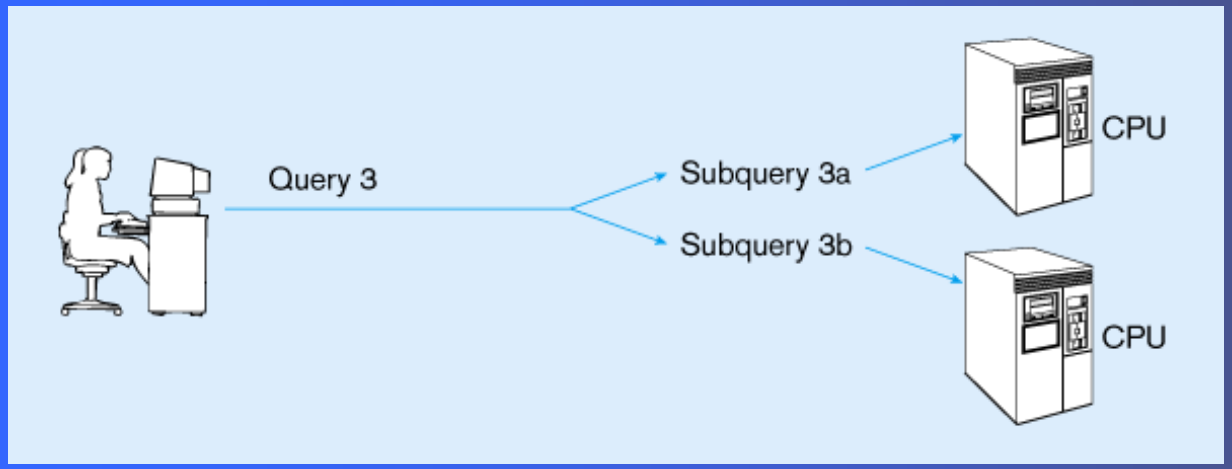


Figure 9-5(b) – Parallel query

Middleware

Software which allows an application to ***interoperate*** with other software

No need for programmer/user to understand internal processing

Accomplished via ***Application Program Interface*** (API)

The *"glue"* that holds client/server applications together

Types of Middleware

RPC – Remote Procedure Calls (RPC)

- client makes calls to procedures running on remote computers
- synchronous and asynchronous

Message-Oriented Middleware (MOM)

- asynchronous calls between the client via message queues

Publish/Subscribe

- push technology → server sends information to client when available

Object Request Broker (ORB)

- Object-oriented management of communications between clients and servers

SQL-oriented Data Access

- Middleware between applications and database servers

Database Middleware

ODBC – Open Database Connectivity

- Most DB vendors support this

OLE-DB

- Microsoft enhancement of ODBC

JDBC – Java Database Connectivity

- Special Java classes that allow Java applications/applets to connect to databases

Client/Server Security

Network environment → complex security issues

Security levels:

- System-level password security
  - for allowing access to the system
- Database-level password security
  - for determining access privileges to tables; read/update/insert/delete privileges
- Secure client/server communication
  - via encryption

Query-by-Example (QBE)

- Direct-manipulation database language
- Graphical approach
- Available in MS Access
- MS Access translates QBE to SQL and vice versa
- Useful for end-user database programming
- Good for ad hoc processing and prototyping

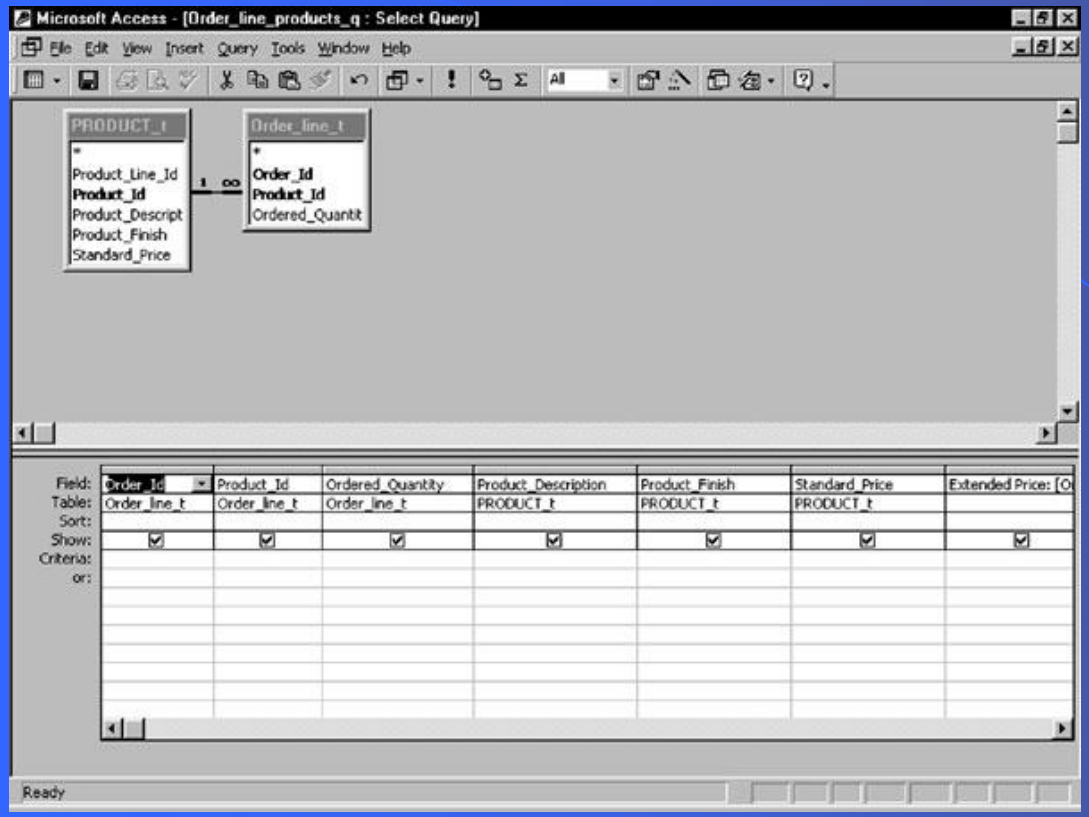


Figure 9-10: QBE view of a 2-table join query

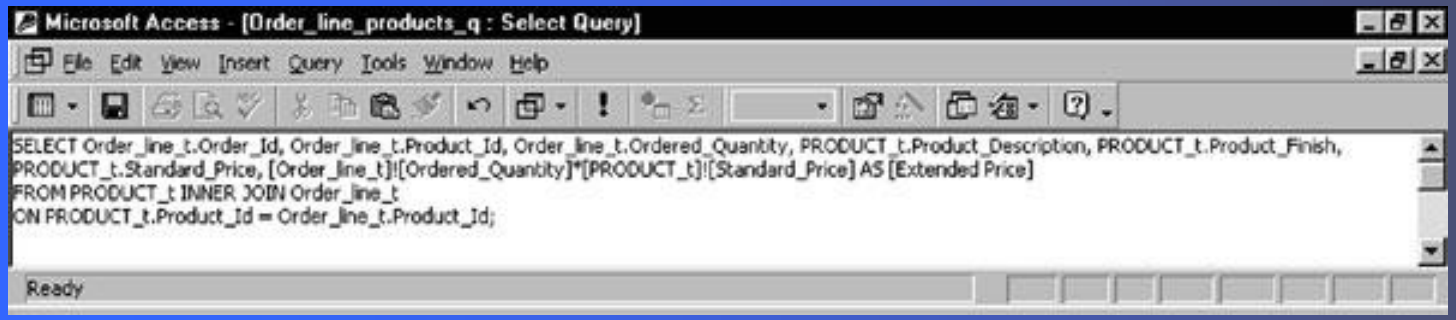
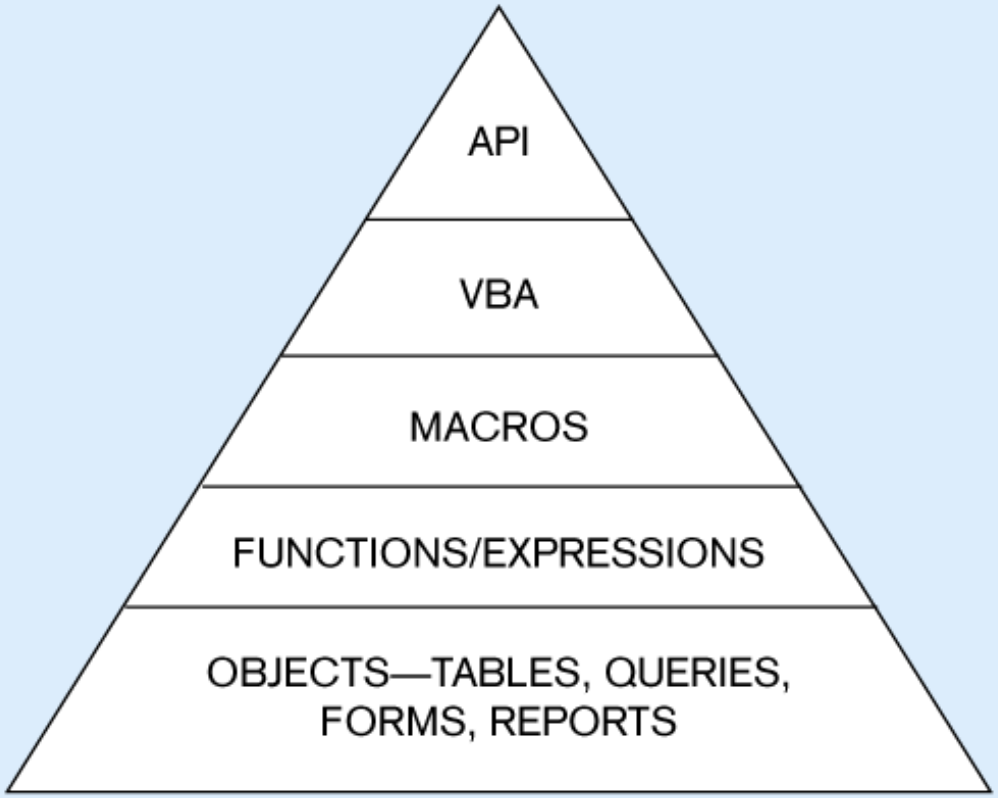


Figure 9-12: Equivalent query in SQL

Figure 9-9: Access usability hierarchy



API to call functions in DLLs external to MS Access

Visual Basic for Applications…language for customizing the application

Stored modules of pre-existing VBA code

Simple processes

Foundation of MS Access

Using ODBC to Link External Databases Stored on a Database Server

Open Database Connectivity (ODBC)

- API that provides a common language for application programs to access and process SQL databases independent of the particular RDBMS that is accessed

Required parameters:

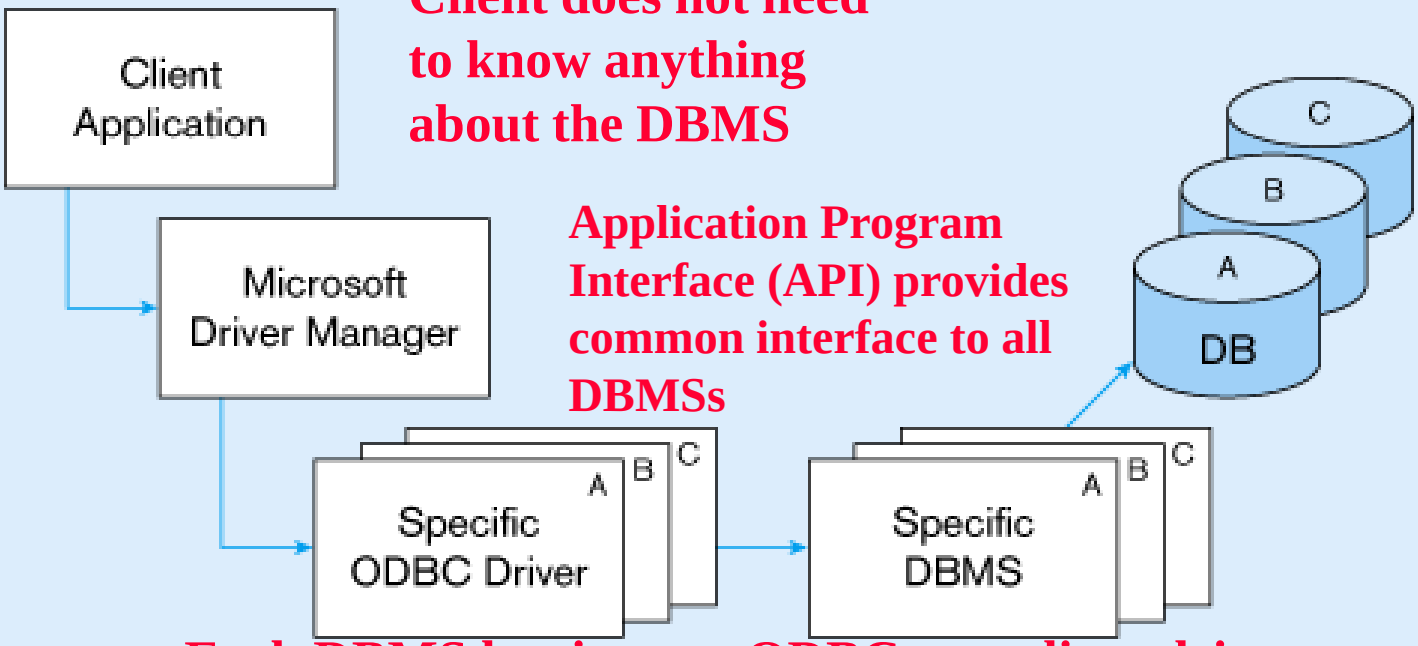
- ODBC driver
- Back-end server name
- Database name
- User id and password

Additional information:

- Data source name (DSN)
- Windows client computer name
- Client application program's executable name

Java Database Connectivity (JDBC) is similar to ODBC – built specifically for Java applications

ODBC Architecture
(Figure 9-18)



Visual Basic for Applications

VBA is the programming language that accompanies Access 2000

VBA provides these features:

- Ability to perform complex functionality
- Error handling
- Faster execution than macros
- Easier maintenance
- OLE automation
- Programmatic control
- Ease of reading for programmers

Event-driven – nonprocedural programming that detects events and generates appropriate responses