Enterprise Application Outline

- Evolusi enterprise application
- Design of an enterprise application
  - Bottom up design
  - Top down design
- Architecture of an enterprise application
  - One tier
  - Two tier (client/server)
  - Three tier (middleware)
  - N-tier architectures
- Middleware: RPC, TP-Monitor, CORBA, MOM
- Communication in an enterprise application
  - Blocking or synchronous interactions
  - Non-blocking or asynchronous interactions

Evolusi Enterprise Application

- Dahulu sistem bersifat “**Centralized Approach**”.

  Yaitu sistem bersifat stand alone dan terpusat.
  - Single system for all processing needs
  - Physical limitations of scalability, single points of failure, dan limited accessibility from remote locations

  Bersifat **single-tier**: presentasi, logic business, code, dan data menjadi satu kesatuan, tidak dipisah-pisah.
- Kekurangan **single-tier**:
  - ❑ Menyebabkan perubahan terhadap salah satu komponen diatas tidak mungkin dilakukan, karena akan mengubah semua bagian.
  - ❑ Tidak memungkinkan adanya **re-usable** component dan code.

Evolusi Enterprise Application

- Sekarang sistem bersifat “**Distributed Approach**”
  - Sistem bersifat tersebar dan multiproses.
  - Sistem ini bersifat **On Demand Software** dan **Software as Service**
  - Bersifat **multi-tier**:
    - presentasi, logic business, dan data terpisah-pisah menjadi lapisan-lapisan tersendiri.

Layering

- Layering salah satu teknik umum di mana para software designer menggunakan hal itu untuk **memecah** sebuah sistem yang rumit ke dalam bagian-bagian yang lebih sederhana.
    - Contoh pada networking: lapisan layer OSI dan TCP/IP.
- Ketika sistem dibagi dalam layer-layer:
    - bagian sistem yang principal dalam software diatur dalam layer
    - setiap **upper layer bergantung** pada **lower layer**.

Layering

- **Higher layer** menggunakan service-service yang didefinisikan oleh **lower layer**
  - lower layer tidak perlu mengetahui the higher layer.
- Setiap layer biasanya **menyembunyikan** lower layernya dari layer atasnya
  - Ex: layer 4 menggunakan services dari layer 3,
    - Layer 3 menggunakan services dari layer 2,
    - Layer 4 tidak tahu menahu tentang layer 2.

Kelebihan Layering

- User mengetahui aplikasi tersebut terdiri dari satu **single layer** saja **tanpa harus tahu** layer-layer yang lain.
  - Kita dapat memanfaatkan FTP service pada TCP tanpa harus tahu bagaimana cara kerja Ethernet Card secara fisik.
- Kita **dapat mengganti** layer-layer dengan aplikasi lain yang mengimplementasikan **servis dasar** yang sama.
  - Dapat dibuat berbagai FTP software yang berjalan tanpa harus mengganti Ethernet, atau kabel-kabel.
- Kita dapat **meminimalisasi ketergantungan** antar layer-layer.
  - Jika kita mengganti kabel jaringan, kita tidak perlu juga mengganti FTP service.

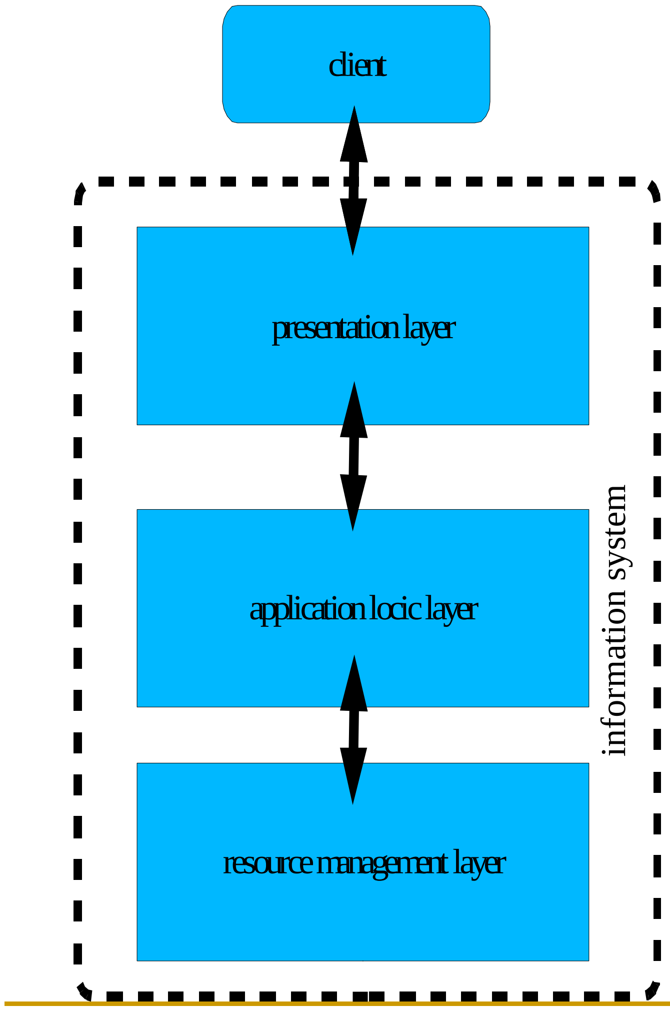
Kelebihan Layering

- Layer sangat mendukung **standarisasi**.
  - TCP / IP = standar
- Sesudah layer terbentuk, kita dapat menggunakannya untuk **bermacam-macam servis** lainnya.
  - Contoh, TCP/IP digunakan oleh FTP, telnet, SSH, dan HTTP.

Kelemahan Layering

- Penggunaan layer menyebabkan dan menambah tingkat **kompleksitas** proses.
  - Setiap layer harus memiliki fungsinya masing-masing
  - Suatu proses harus melewati masing-masing layer tersebut terlebih dahulu baru dapat menghasilkan output.
  - Jadi masing-masing layer harus **memiliki kemampuan proses yang berlainan**.
- Layer **mengenkapsulasi** fungsi-fungsinya masing-masing sehingga kita tidak dapat mengetahui **detail** fungsi suatu layer.
- Layer bekerja secara bersama-sama menjadi satu kesatuan sehingga seluruh layer harus bekerja secara **optimal**.

Layers of an IS Example



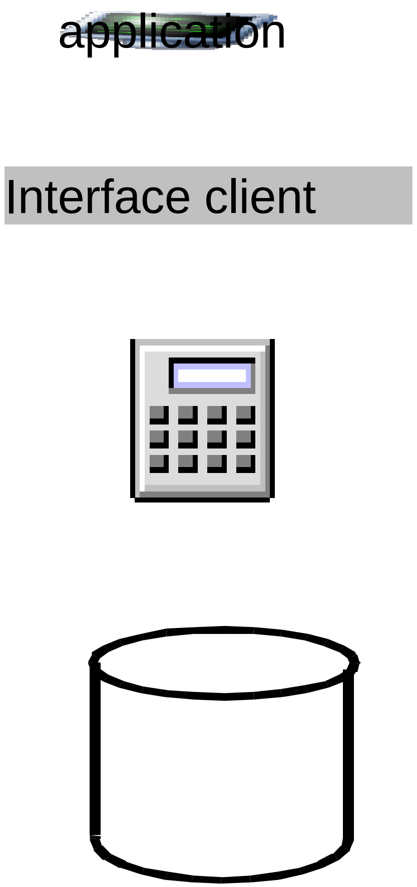
client

presentation layer

application locic layer

resource management layer

information system



application

Interface client

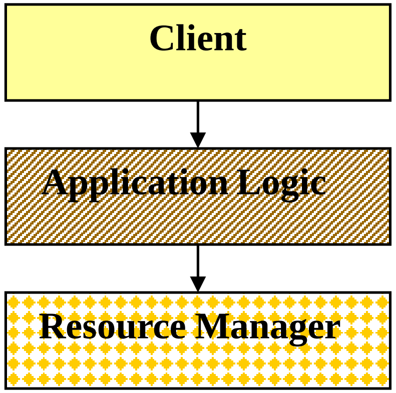
3 Principal Layers

- **Presentation logic**: mengatur bagaimana menghandle interaksi antara user dan software.
  - Bisa berupa simple command-line atau text-based menu system, tapi sekarang bisa berupa rich-client graphics UI atau HTML-based browser UI.
  - Presentation layer = menampilkan informasi ke user
  - Menginterpretasikan perintah dari user sebagai aksi terhadap business logic dan data source.

3 Principal Layers

- **Data source logic**: mengatur komunikasi dengan sistem lain dan manajemen data.
  - Bisa berupa transaction monitor dan database.
  - Ex: database / xml / text
- **Domain logic / business logic**. mengatur tindakan aturan bisnis (aturan main) suatu aplikasi.
  - Ex: melakukan kalkulasi berdasarkan input dan data yang tersimpan,
  - validasi dari data yang datang dari layer presentasi,
  - menggambarkan secara tepat mana data source logic yang dibutuhkan, tergantung dari perintah yang diterima dari layer presentasi.

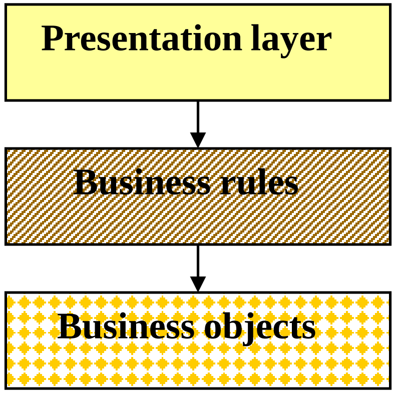
Layers and tiers



Client

Application Logic

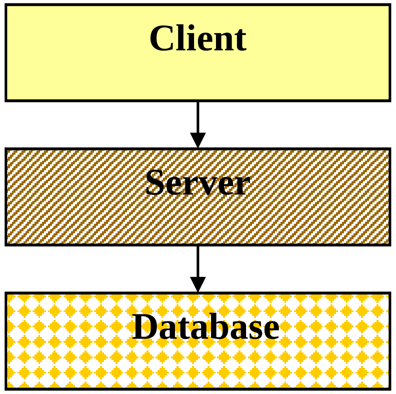
Resource Manager



Presentation layer

Business rules

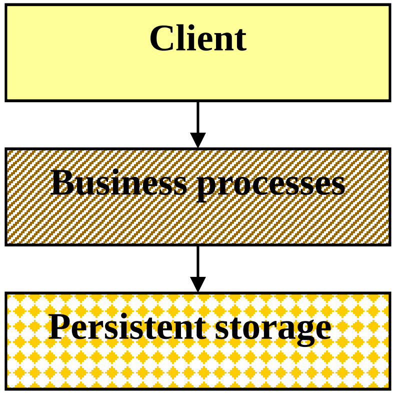
Business objects



Client

Server

Database



Client

Business processes

Persistent storage

Layers and tiers

- **Client** is any user or program that wants to perform an operation over the system.
  - Clients interact with the system through a presentation layer
- The **application logic** determines what the system actually does.
  - It takes care of enforcing the business rules and establish the business processes.
  - The application logic can take many forms: programs, constraints, business processes, etc.
- The **resource manager** deals with the organization (storage, indexing, and retrieval) of the data necessary to support the application logic.
  - This is typically a database but it can also be a text retrieval system or any other data management system providing querying capabilities and persistence.

Designs of Distributed IS

- ***top-down design***

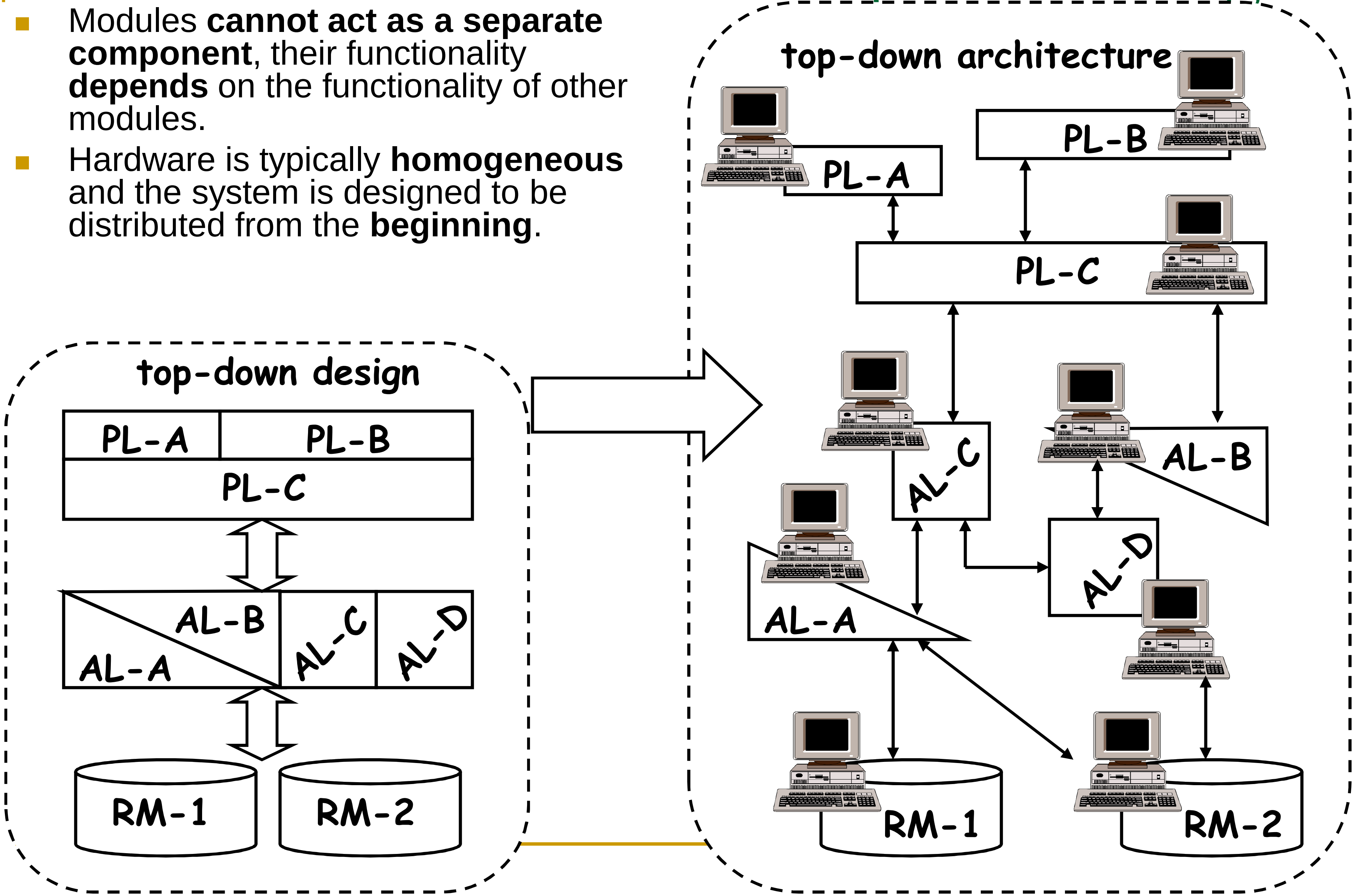
- ***bottom-up design***

top-down design

- starts with defining **functionality** desired by the client ('toplevel goals')
- **implementation** of application logic
- defining the **resources** needed by applictation logic

Top down design

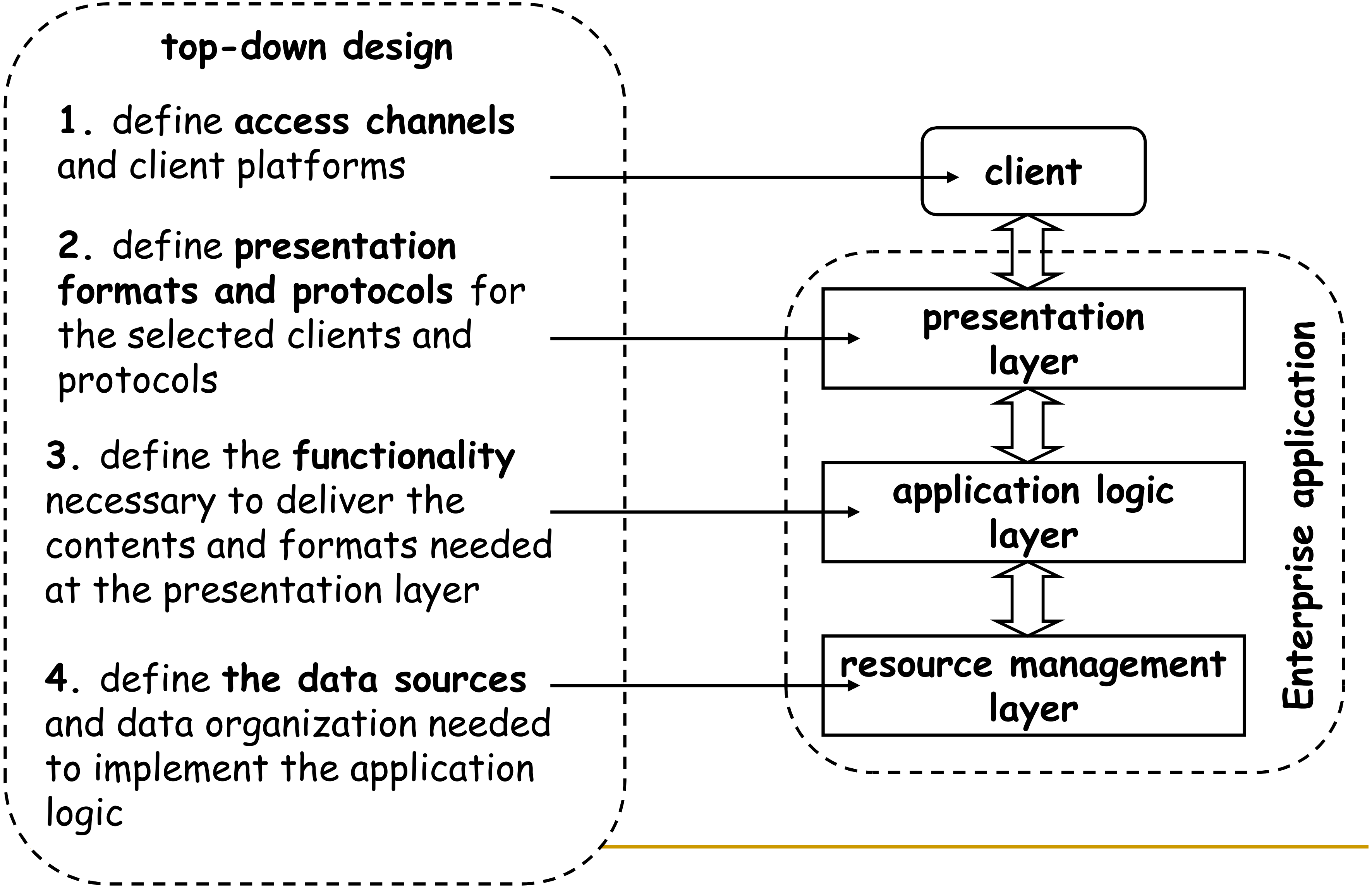
- The functionality of a system is **divided** among **several** modules.
- Modules **cannot act as a separate component**, their functionality **depends** on the functionality of other modules.
- Hardware is typically **homogeneous** and the system is designed to be distributed from the **beginning**.



top-down design

- usually created to run in **homogenous** environments
- results in **tightly coupled** components:
  - functionality of each component heavily **depends** on functionality of other components
  - *design is sometimes component based, but components are not standalone*

Top down design



top-down design

1. define **access channels** and client platforms

2. define **presentation formats and protocols** for the selected clients and protocols

3. define the **functionality** necessary to deliver the contents and formats needed at the presentation layer

4. define **the data sources** and data organization needed to implement the application logic

client

presentation layer

application logic layer

resource management layer

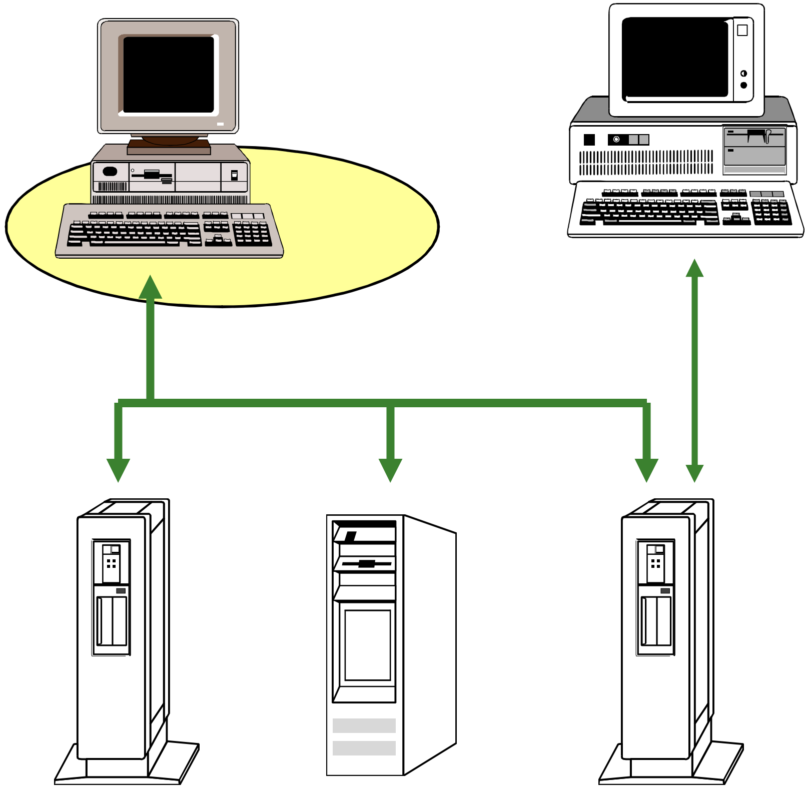
Enterprise application

advantages & disadvantages of top down

- advantages:
  - design emphasises **final goa**ls of the system
- disadvantages
  - can only be designed from **scratch**
  - legacy systems **cannot be integrated**

today **few ISs** are designed purely top-down

Bottom up design



New application

Legacy application

Legacy systems

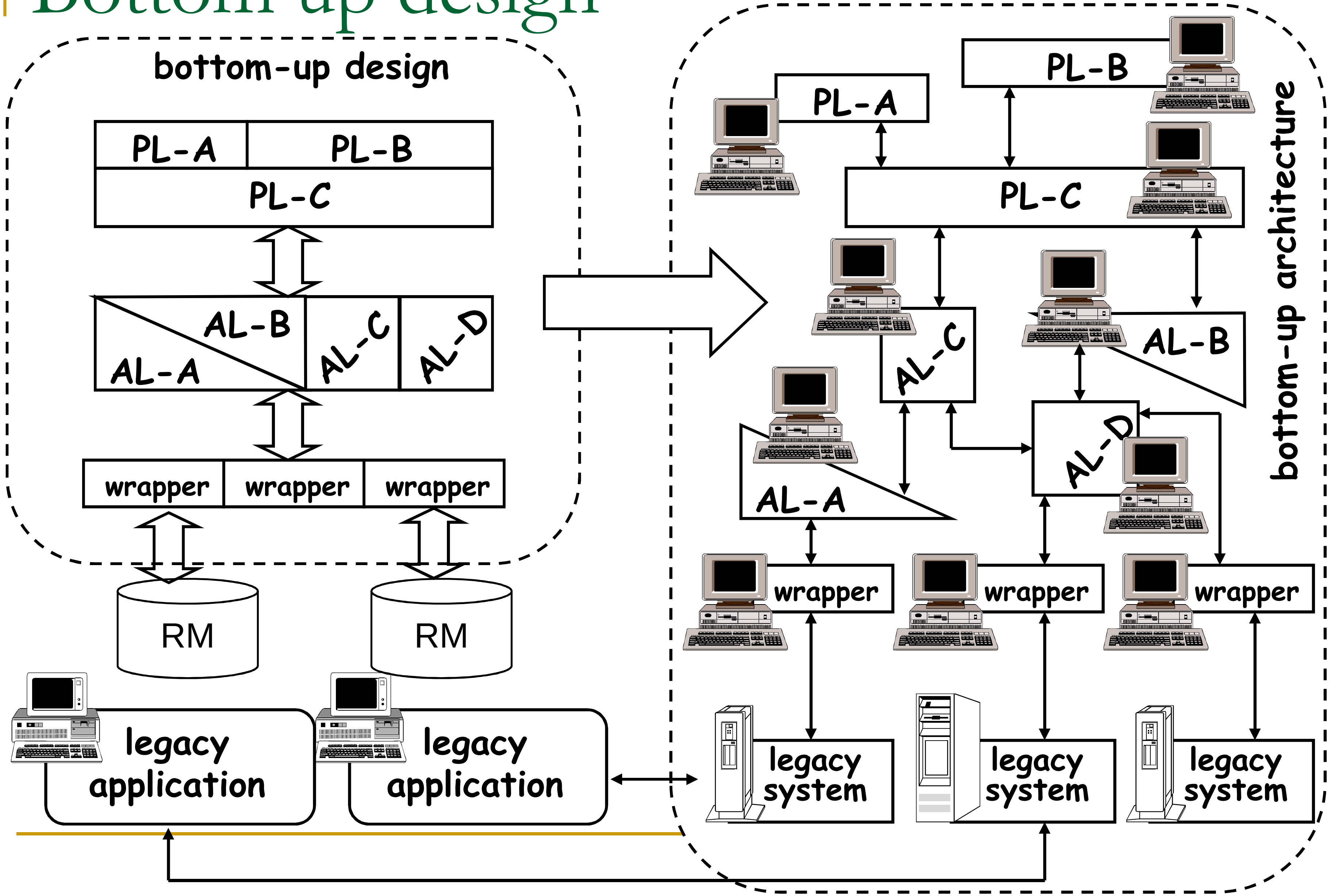
Bottom up design

- In a bottom up design, many of the basic components **already exist.**
  - These are stand alone systems which **need to be integrated** into new systems.
- The components **do not** necessarily **ease** to work as stand alone components.
  - Often old applications **continue running** at the same time as new applications.

Bottom up design

- This approach has a **wide application** because the underlying systems already **exist** and **cannot be easily replaced**.
- Much of the work and products in this area are **related to middleware**
  - **Middleware:** the intermediate layer used to *provide a common interface, bridge heterogeneity, and cope with distribution.*
- **Web services** can make those designs more efficient, cost-effective and simpler to design

Bottom up design



Bottom up design

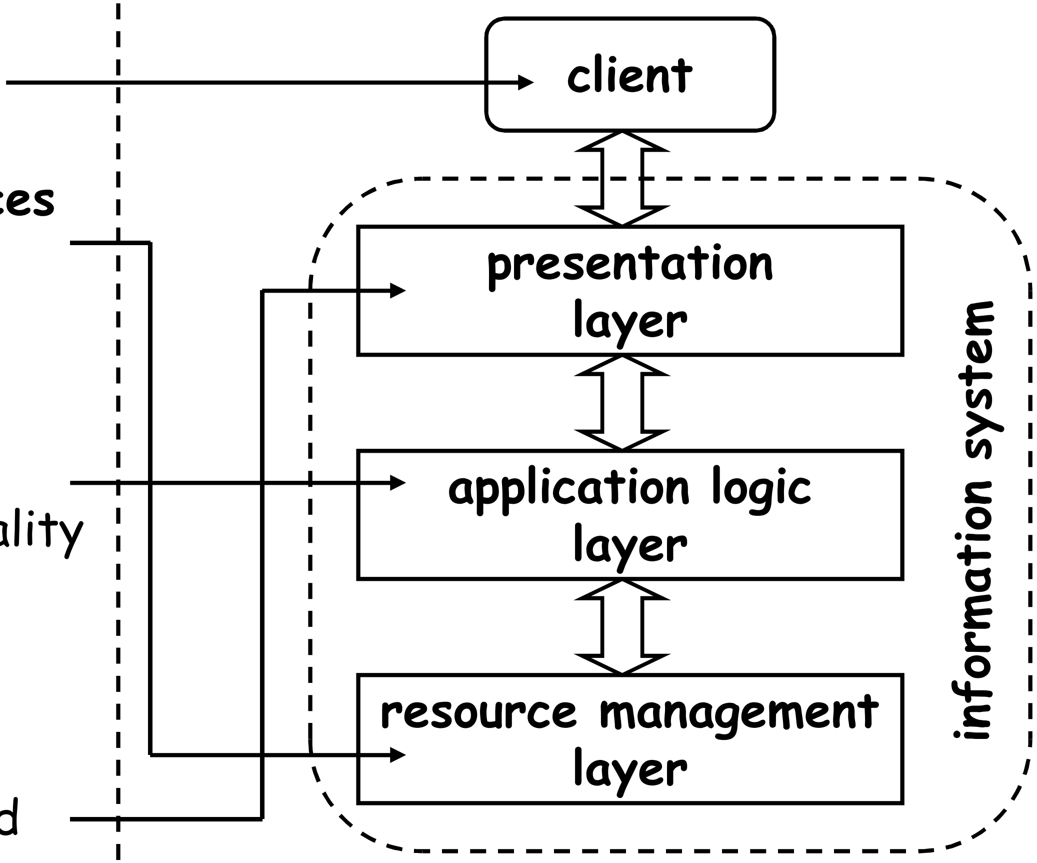
bottom-up design

1. define **access channels** and client platforms

2. examine **existing resources** and the **functionality** they offer

3. **wrap existing** resources and **integrate** their functionality into a consistent interface

4. **adapt** the output of the application logic so that it can be used with the required access channels and client protocols

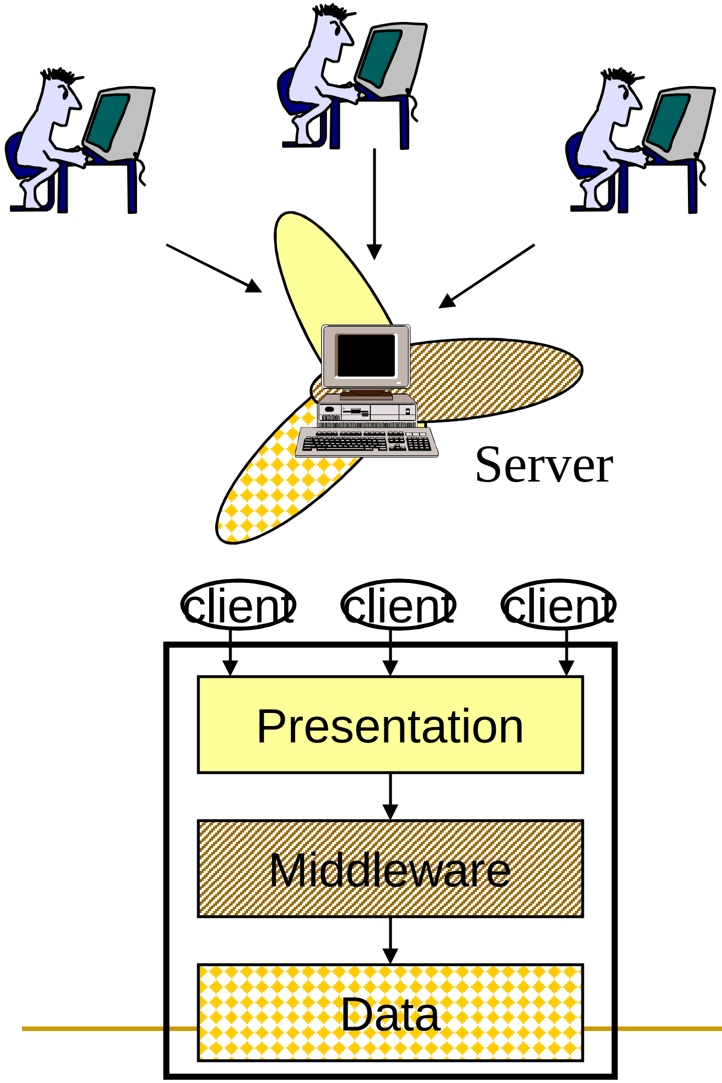


Architecture of an Information System - 4 types:

- ***1 – tier***
- ***2 – tier***
- ***3 – tier***
- ***n – tier***

One tier: fully centralized

1-tier architecture



- The presentation layer, application logic and resource manager are built as a **monolithic** entity.
- Users/programs access the system through display **terminals** but what is displayed and how it appears is controlled by the server.

  = “**dumb” terminals**
- This was the typical architecture of **mainframes**

1 – tier Architecture

advantages:

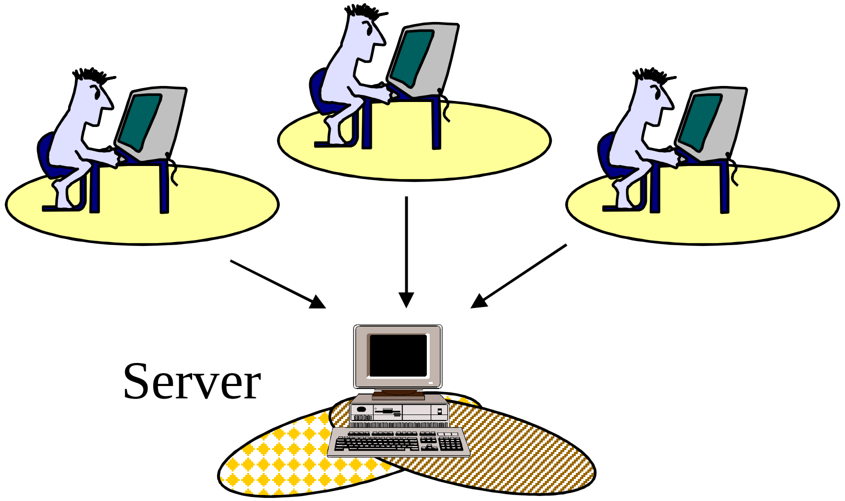
- easy to optimize performance
- no context switching
- no compatibility issues
- no client development, maintenance and deployment cost

disadvantages:

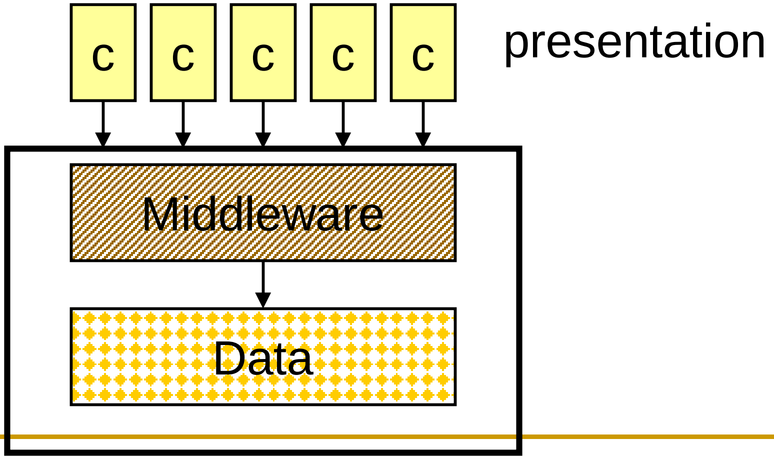
- monolithic pieces of code (high maintenance)
- hard to modify
- lack of qualified programmers for these systems

Two tier: client/server

2-tier architecture



Server



c c c c c

presentation

Middleware

Data

Two Tier Architecture Advantages

- As computers became more powerful, it was possible to **move the presentation layer to the client**. This has several advantages:
  - Clients are **independent** of each other
  - One can take advantage of the **computing power at the client machine** to have more sophisticated presentation layers. ("sophisticated client")
  - It introduces the concept of **API (Application Program Interface)**
  - The resource manager only sees **one client**: the application logic.
    - This greatly helps with performance since there are no client connections/sessions to maintain.

Disadvantages of Two Tier

- The server has to deal with **all possible** client connections.
- There are **maximum number of clients**
- Clients are “**tied**” to the system since there **is no standard presentation layer**.
  - If one wants to connect to two systems, then the *client needs two presentation layers*.
- If the server **fails**, nobody can work.
- All clientas are all **competing** for the **same** resources.

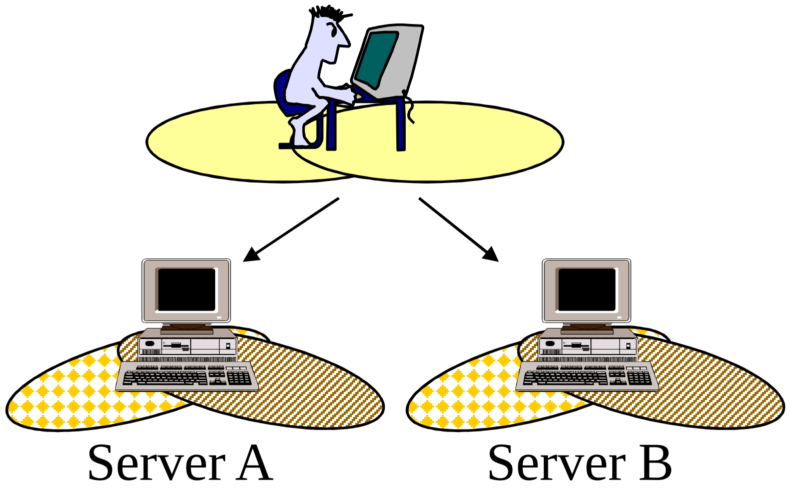
Karakteristik Client/Server

- **Service** : menyediakan layanan terpisah yang berbeda.
- **Shared resource** : server dapat melayani beberapa client pada saat yang sama dan mengatur pengaksesan resource
- **Asymmetrical Protocol** : antara client dan server merupakan hubungan one-to-many.
- **Transparency Location** : proses server dapat ditempatkan pada mesin yang sama atau terpisah dengan proses client.
  - Client/server akan menyembunyikan lokasi server dari client.

Karakteristik Client/Server

- **Mix-and-match** : tidak tergantung pada platform
- **Message-based-exchange** : antara client dan server berkomunikasi dengan mekanisme pertukaran message.
- **Encapsulation of service** : message dari client memberitahu server apa yang akan dikerjakan tanpa harus tahu detail service.
- **Integrity** : kode dan data server diatur secara terpusat, sedangkan pada client tetap pada komputer tersendiri.

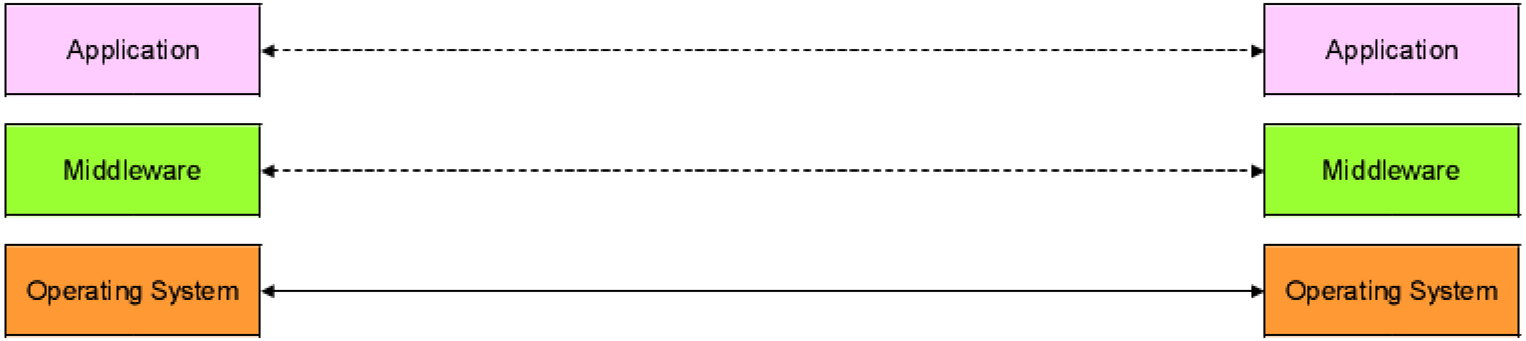
The main limitation of client/server



- the underlying systems **don’t know about each other**
- Maybe there is **no common business logic**

- the client **is the point of integration** (increasingly **fat clients**)
- The responsibility of dealing with heterogeneous systems is **shifted to the client**.
- The client **becomes responsible** for knowing where things are, how to get to them, and how to ensure consistency

Middleware (Layer perantara)



Software yang berfungsi sebagai **lapisan konversi atau penerjemah** diantara komponen aplikasi dengan tujuan untuk mengurangi kompleksitas pada aplikasi terdistribusi.

Contoh Arsitektur yang menggunakan Middleware: **Client/Server**

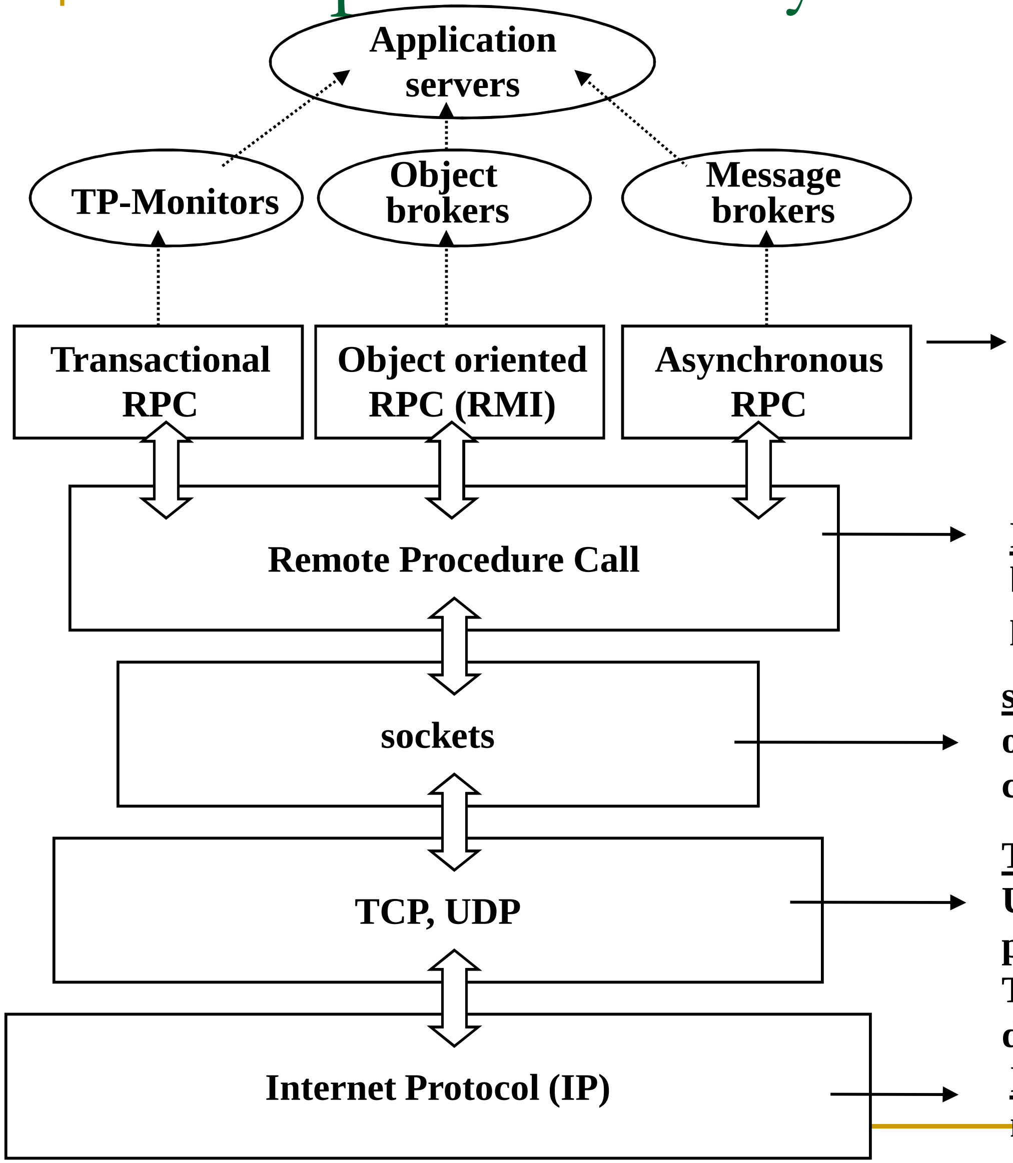
Middleware as Programming abstractions

- **Abstraction** is a key concept in making software development easier for software developers
- programming with abstractions can:
  - hide hardware/platform details
  - provide powerful building blocks
  - reduce programming errors
  - reduce development and maintenance costs

Middleware as Programming abstractions

- Middleware can be seen **as a set of programming abstractions** that make it easier to develop complex distributed systems
- Example of middleware:
  - remote communication mechanisms (Web services, CORBA, Java RMI, DCOM)
  - event notification and messaging services (Java Messaging Service etc.)
  - transaction services (TP Monitor)
  - naming services (Naming, LDAP)
  - Database connectivity (JDBC, ODBC)

Example hieararcy of middleware (RPC)



Specialized forms of RPC, typically with additional functionality or properties but almost always running on RPC platforms

Remote Procedure Call: hides communication details behind a procedure call and helps bridge heterogeneous platforms

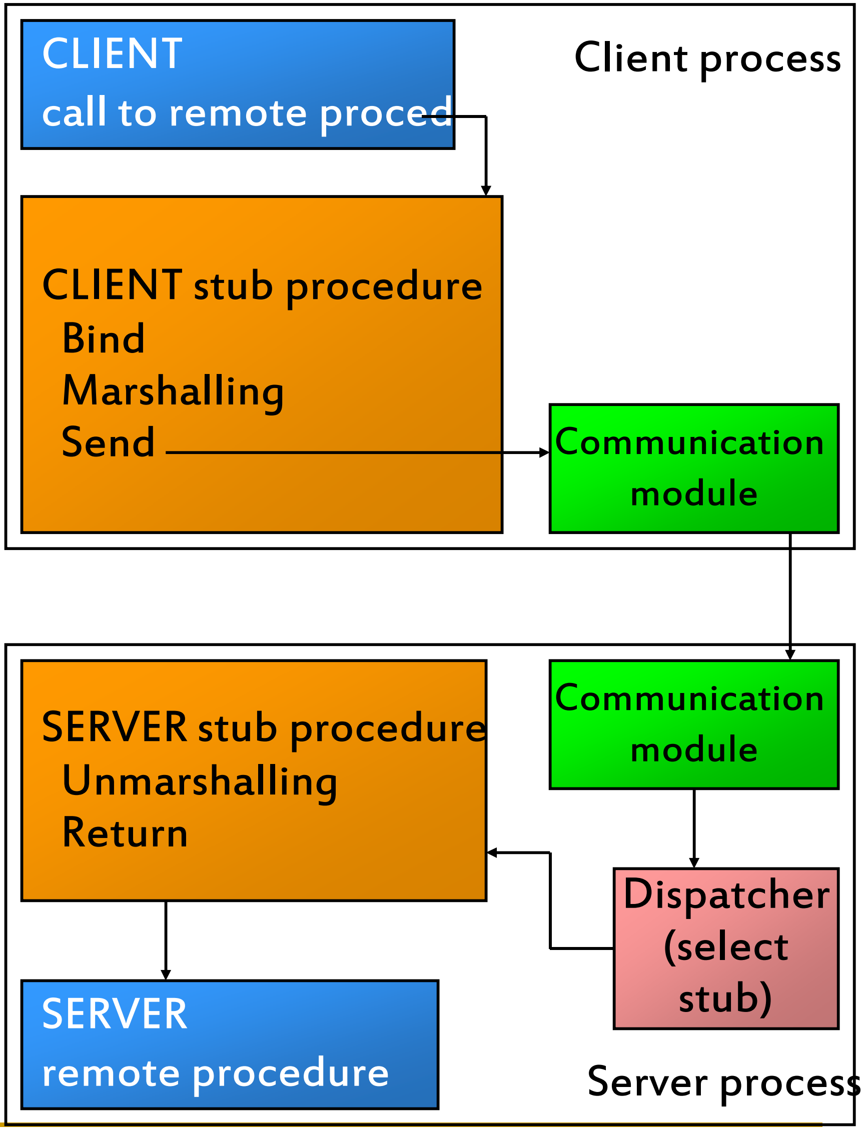
sockets:
operating system level interface to the underlying communication protocols

TCP, UDP:
User Datagram Protocol (UDP) transports data packets without guarantees
Transmission Control Protocol (TCP) verifies correct delivery of data streams

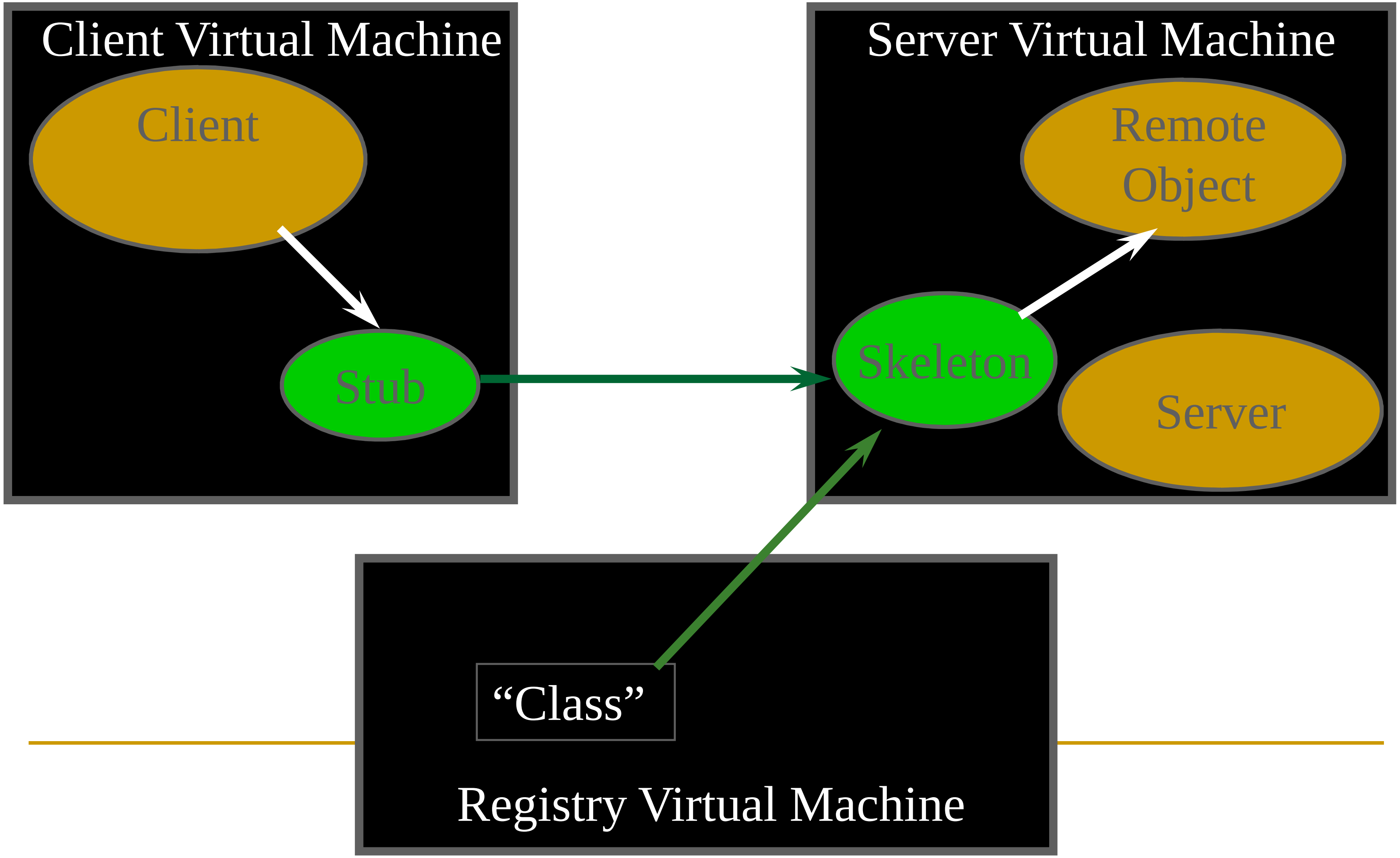
Internet Protocol (IP):
moves a packet of data from one node to another

How RPC works?

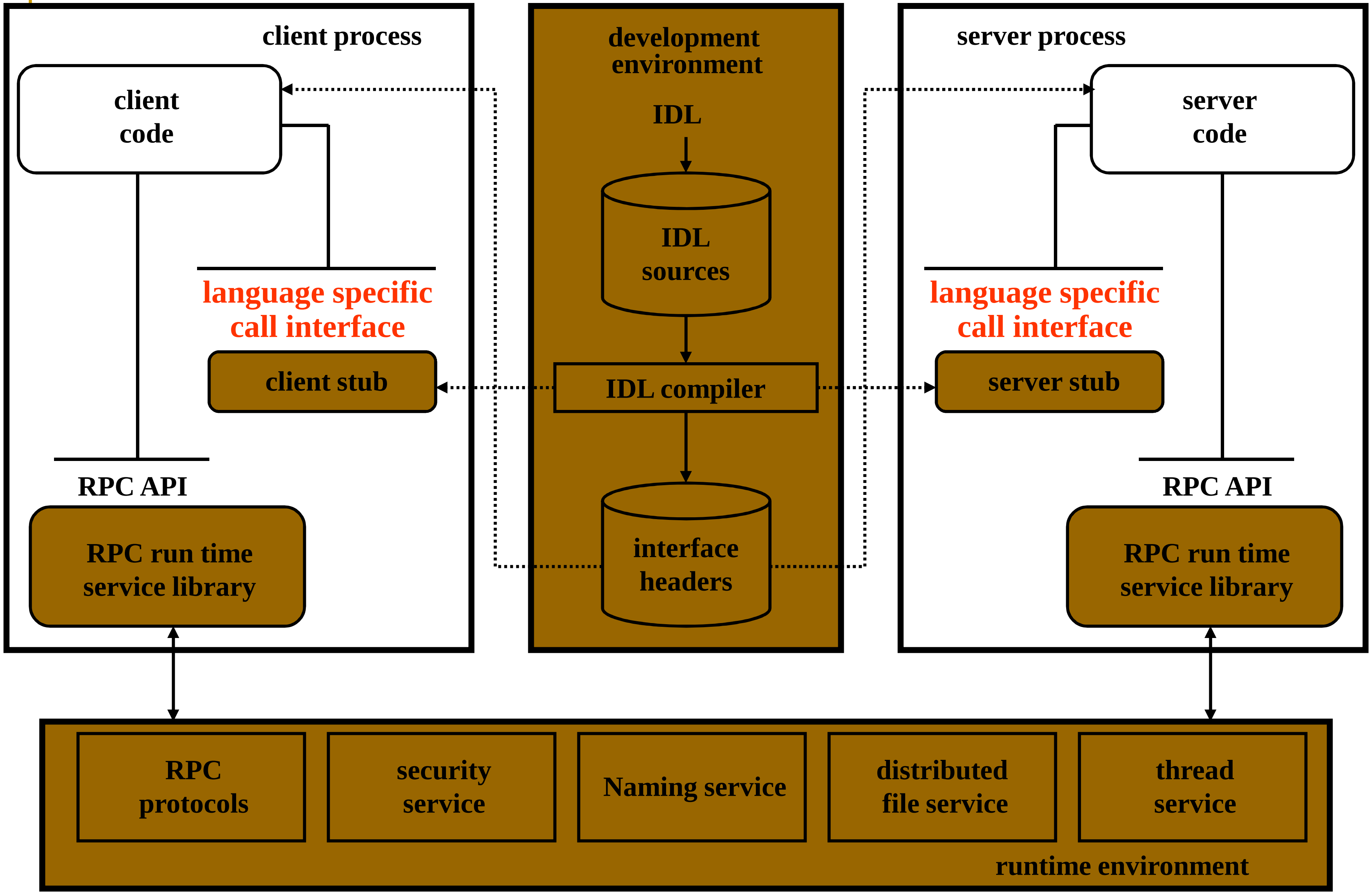
- What does an RPC system do?
  - **Hides distribution** behind procedure calls
  - Provides an **interface definition language (IDL)** to describe the services
  - **Generates** all the additional **code** necessary to make a procedure call remote and to deal with all the communication aspects
  - Provides a **binder** in case it has a **distributed name** and **directory service system**



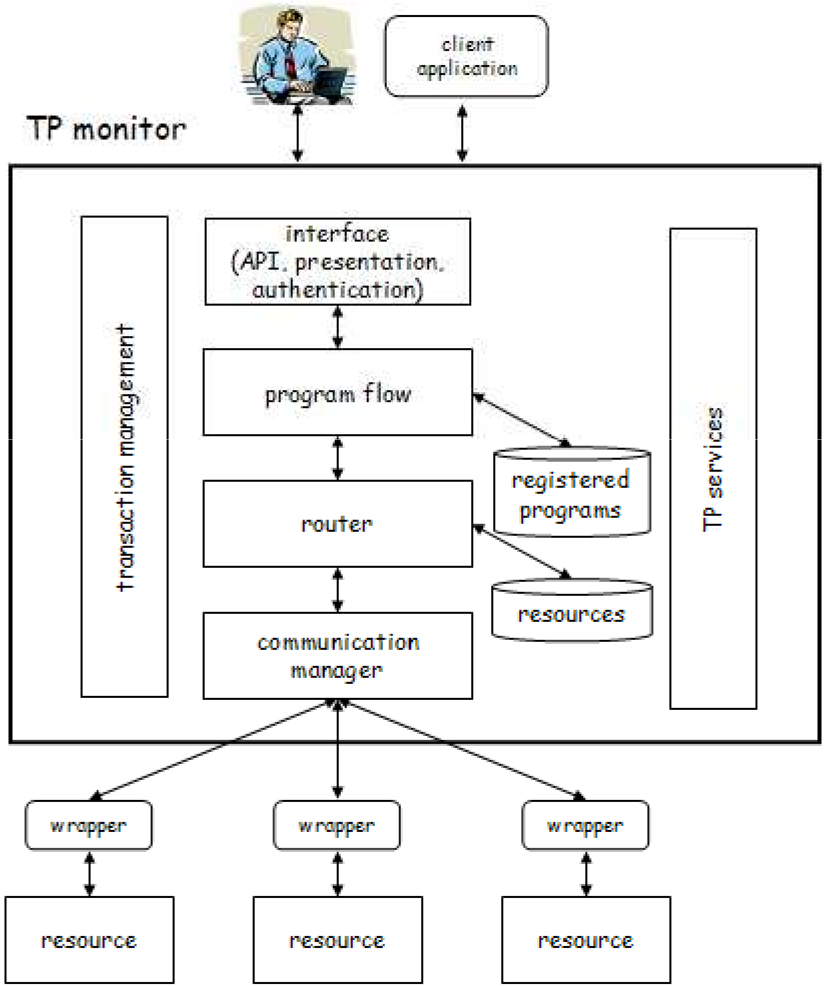
RMI System Architecture



Middleware as infrastructure (CORBA)

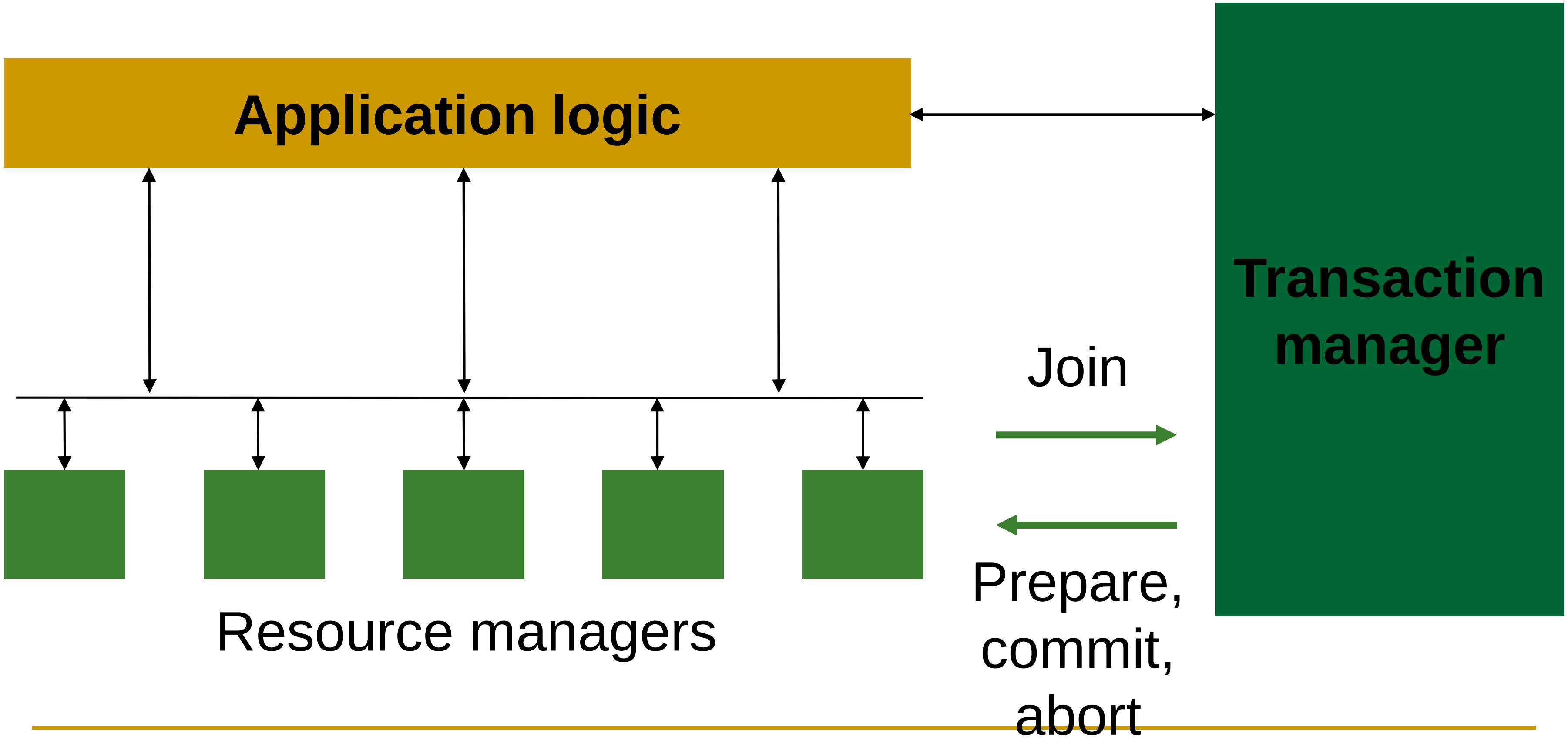


TP Monitor

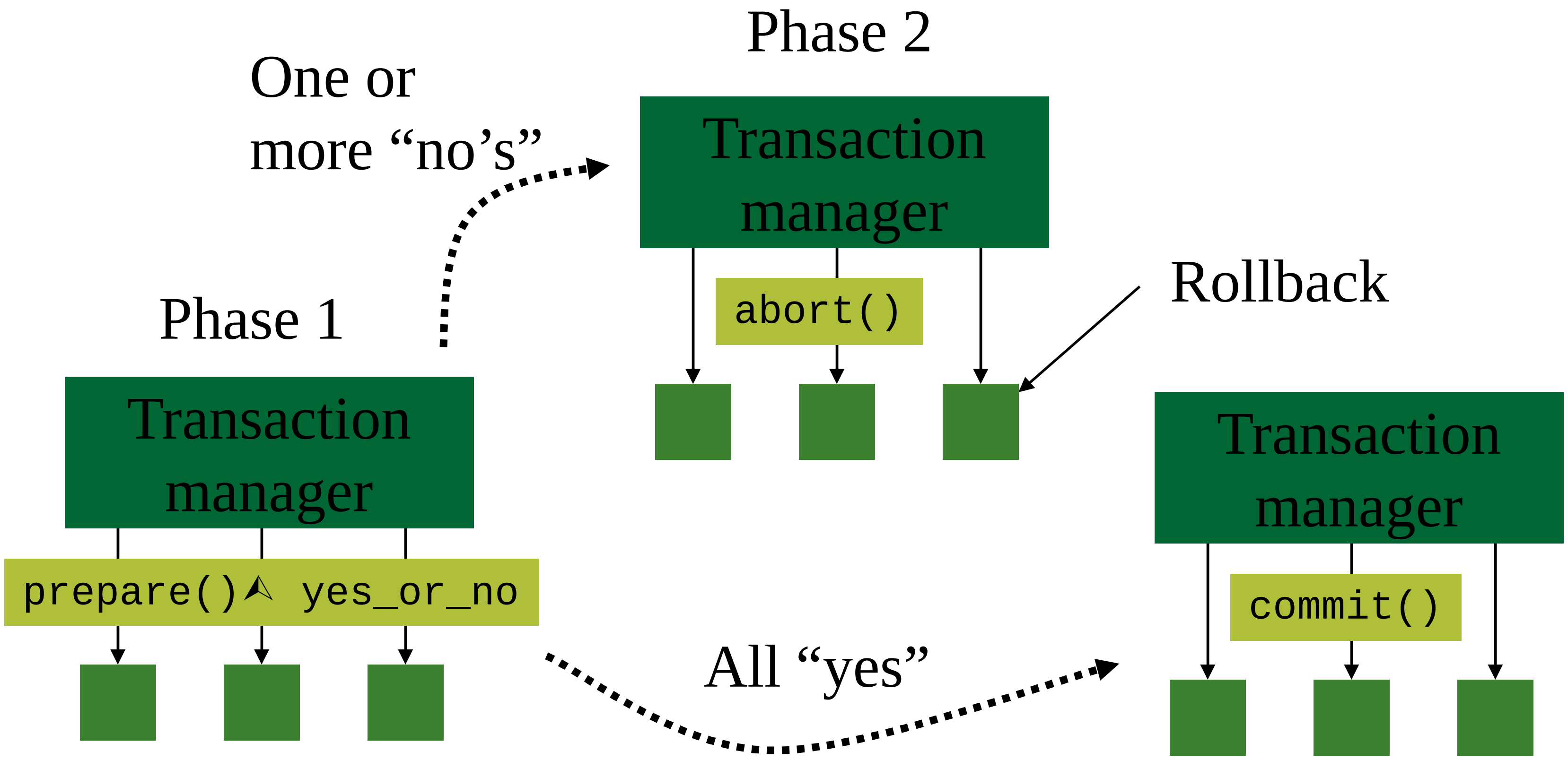


- TP Monitors are **middleware** systems that provide **transactional RPC**
- They, provide basic **RPC functionality** (IDLs, name servers, stub compilers, etc.)
- Used for banking **transactions**, purchasing plane tickets, etc
- A **TP-heavy monitor** provides
  - a full development environment
  - additional services (queues, priority scheduling, etc.)
  - support for authentication
  - its own solutions for replication, load balancing, storage management, etc.
- A **TP-lite system** is an extension to a database that
  - is implemented via threads, not processes
  - is based on stored procedures
  - does not provide a full development environment

Transaction Processing Architecture



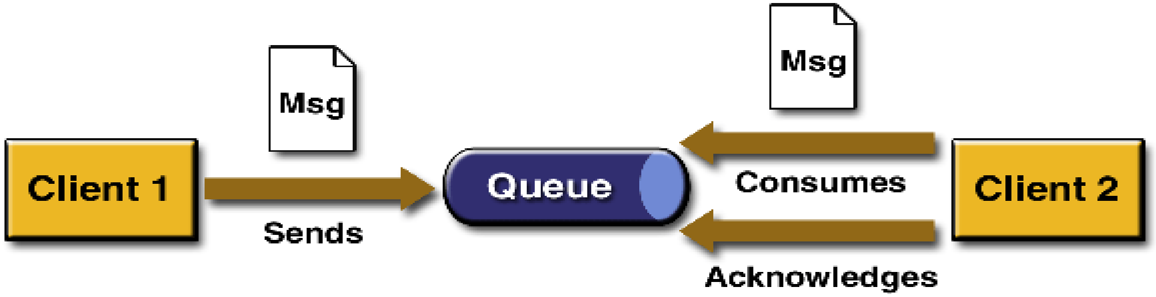
Commit or abort



Message Oriented Middleware

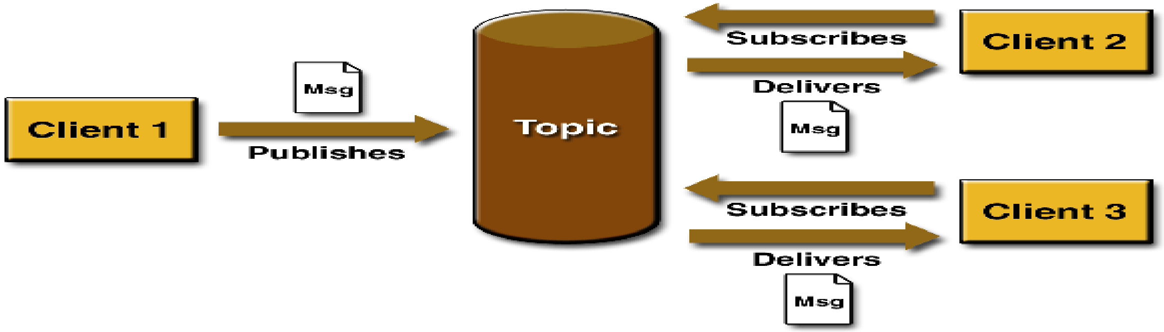
- Mendukung **asynchronous** model message berbasis protokol TCP/IP
- Menyediakan:
  - Kemampuan **message queue**
  - **Storage**: penyimpanan message
    - Ingat penyampaian pesan asynchronous
  - **Routing message**
    - Multicast / broadcast: pengiriman pesan lebih dari satu penerima
  - **Transformasi** pesan ke format standard secara otomatis (formatting message)

MOM (2)

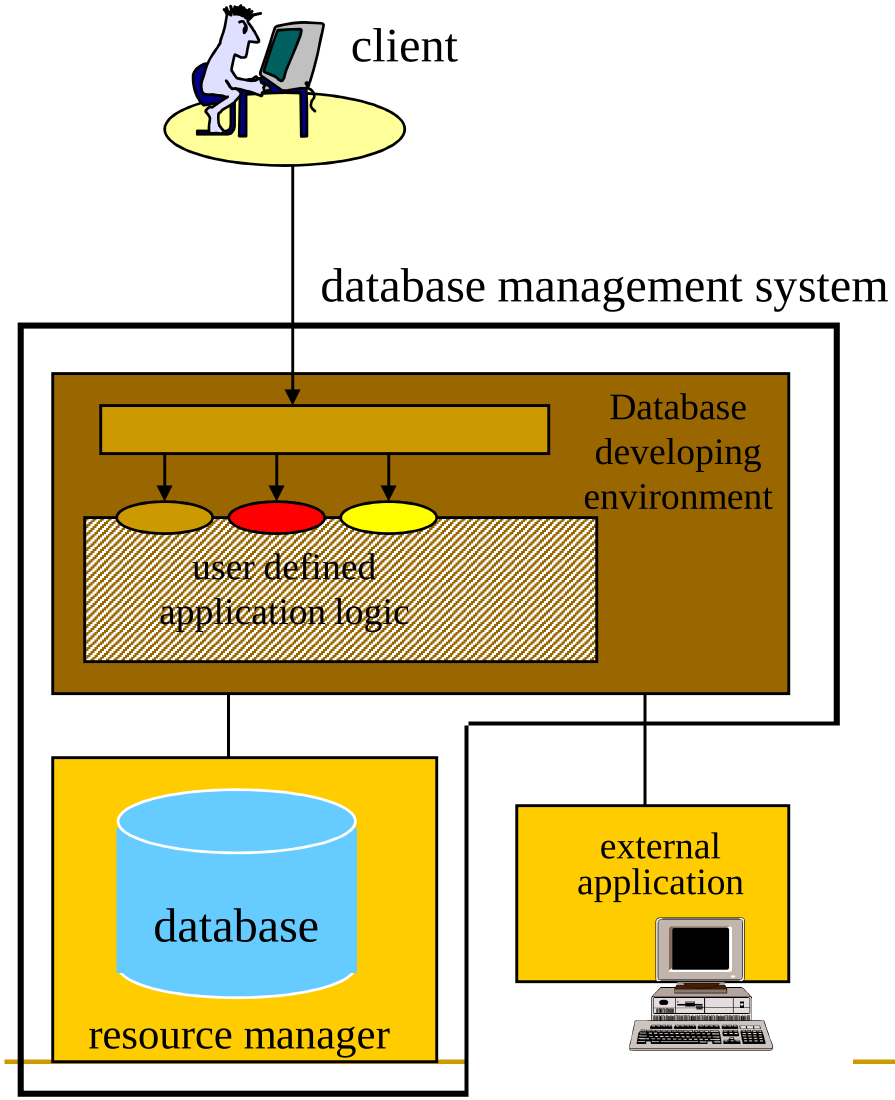


Two basic models

- **point-to-point**
  - **one component** posts a message to a server
  - **one component** (and only one) will consume a posted message
- **publish/subscribe**
  - allows a component to **publish** a message to a topic on a server
  - components interested in a particular topic can **subscribe** to that topic (messages can be consumed by a number of components)
  - when a component **publishes** a message, it subscribes to that topic and will **receive** the message

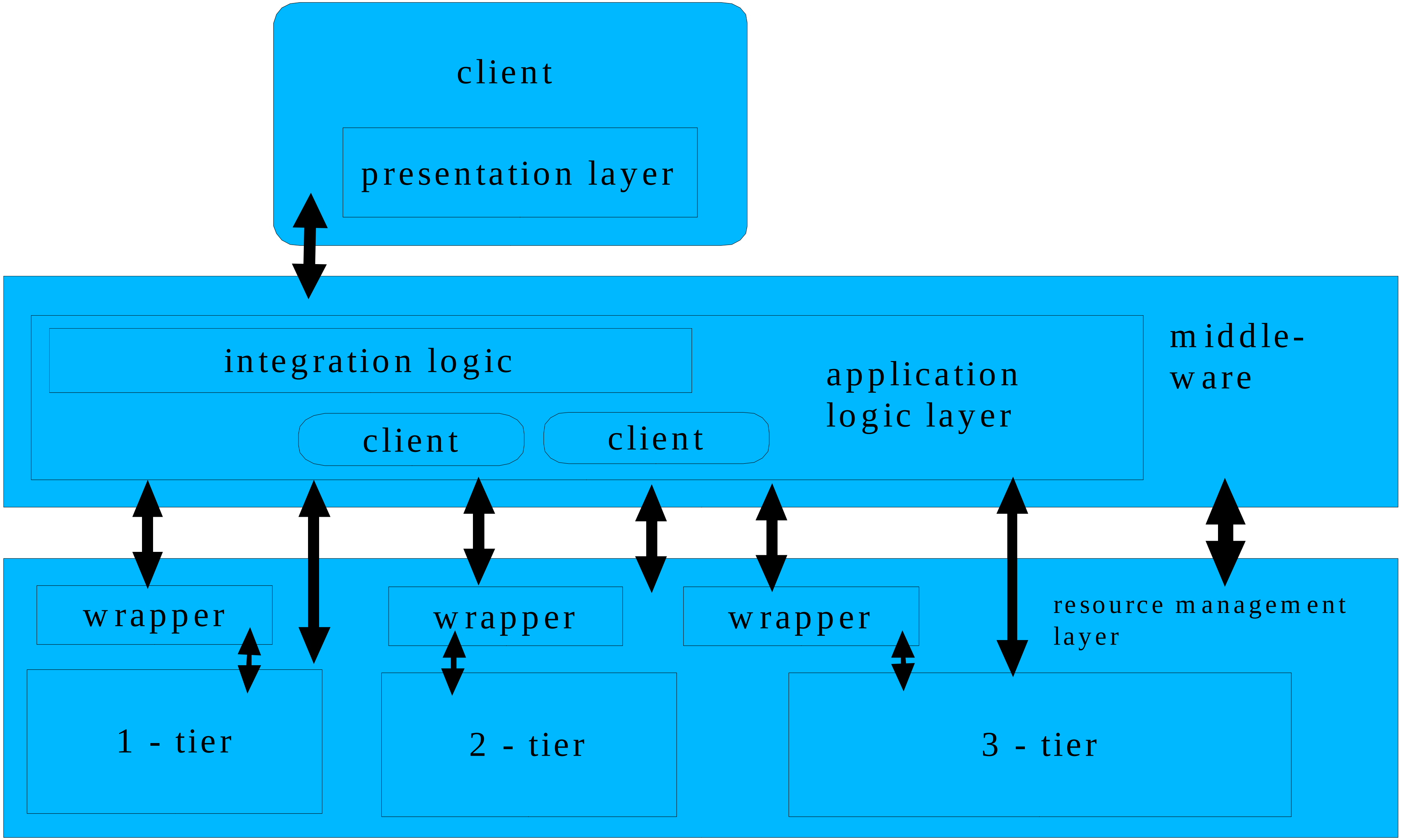


Databases and the 2 tier approach


client
database management system
Database developing environment
user defined application logic
database
resource manager
external application

- Databases are traditionally used to **manage data**.
- By doing this, **vendor** propose a 2 tier model with the **database** providing the tools necessary to implement **complex application logic**.
- These tools include: triggers, replication, stored procedures, queuing systems, standard access interfaces (**ODBC, JDBC).**

3 - tier


client
presentation layer
integration logic
client
client
application logic layer
middle-ware
wrapper
wrapper
wrapper
resource management layer
1 - tier
2 - tier
3 - tier

advantages & disadvantages

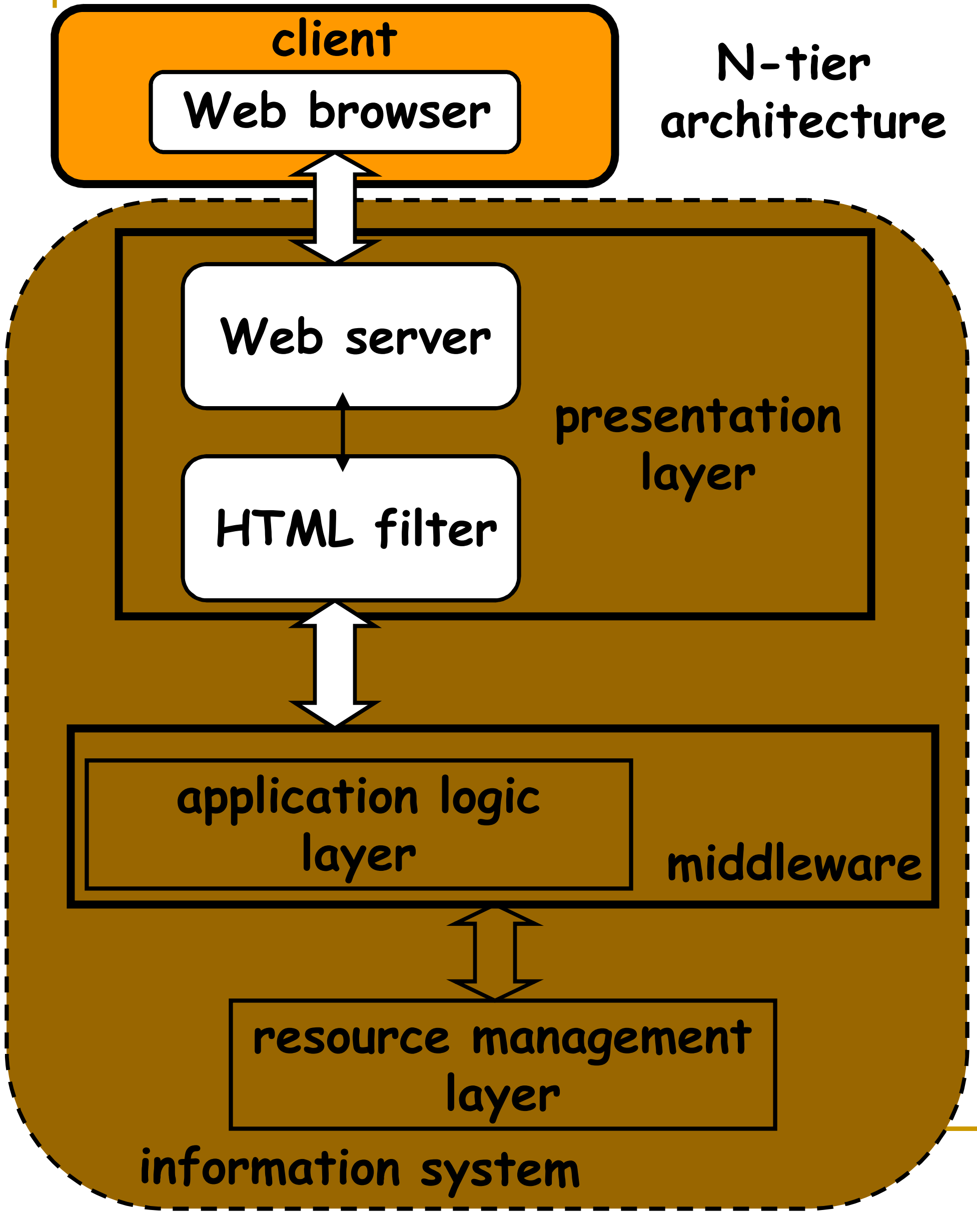
advantages

- **scalability** by running each layer on a different server
- scalability by distributing application logic layer) across many nodes
- additional tier for integration logic

disadvantages

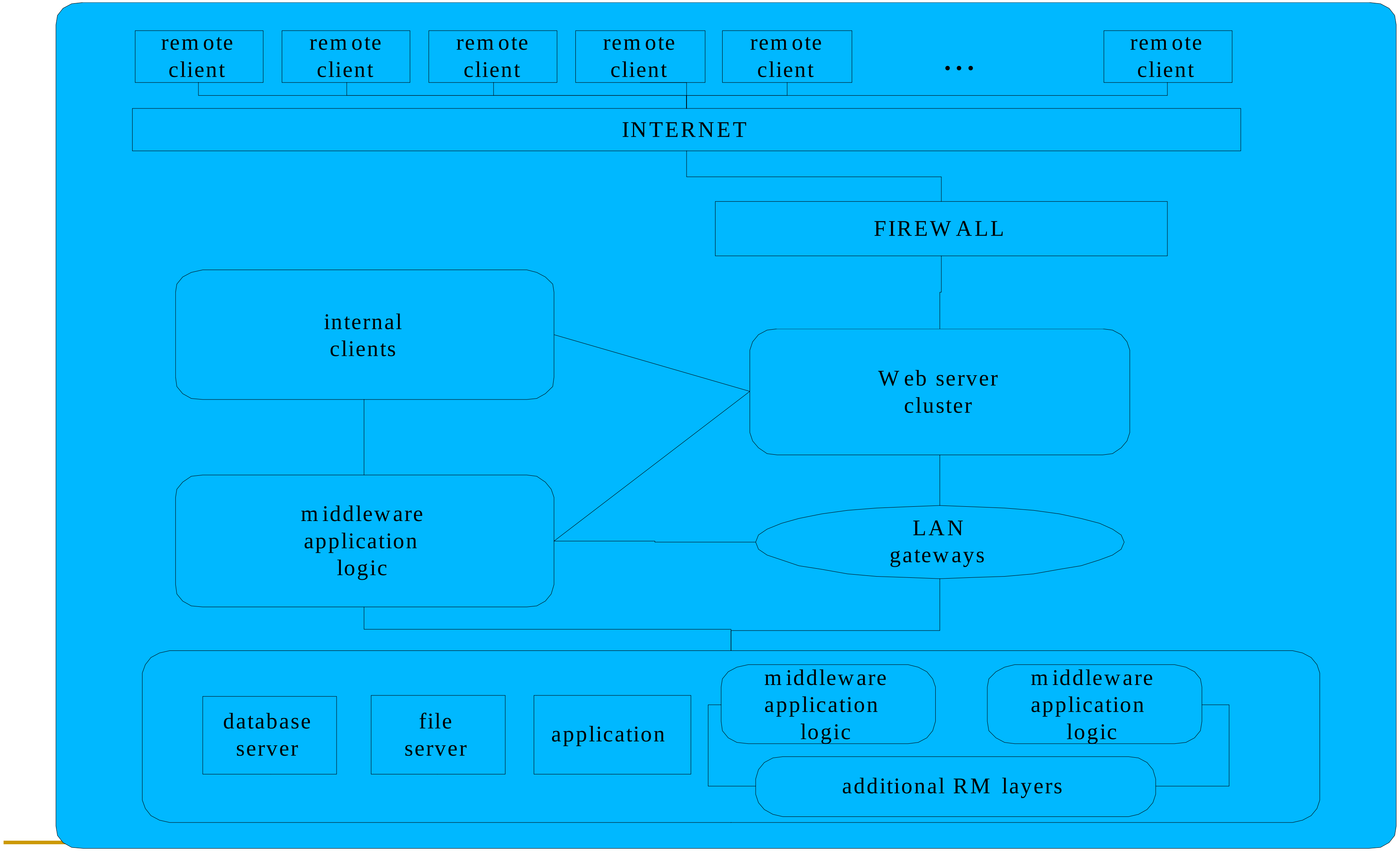
- **performance loss** if distributed over the internet
- problem when **integrating** different 3 – tier systems

N-tier: connecting to the Web



- N-tier architectures result from **connecting several three tier systems** to each other and/or **by adding an additional layer** to allow clients to **access** the system through a Web server
- The Web layer was initially **external** to the system (a true additional layer)
- The addition of the Web layer led to the notion of “**application servers**”, which was used to refer to **middleware platforms** supporting access through the Web
- Ex: glass-fish, tomcat, Oracle App

n - tier


remote client
remote client
remote client
remote client
remote client
...
remote client
INTERNET
FIREWALL
internal clients
Web server cluster
middleware application logic
LAN gateways
database server
file server
application
middleware application logic
middleware application logic
additional RM layers

advantages & disadvantages

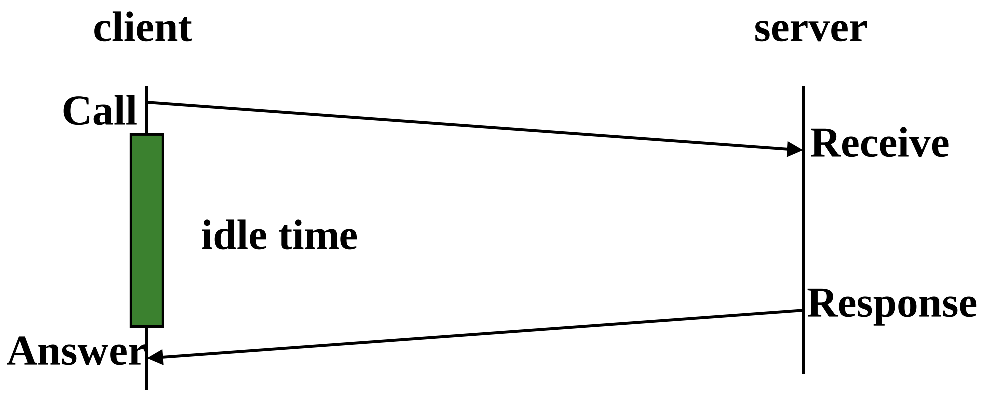
advantages

- better scalability
- higher fault tolerance
- higher throughput for less cost

disadvantages

- too much middleware involved
- redundant functionality
- difficulty and cost of developement

Blocking or synchronous interaction



- Traditionally, information systems use **blocking calls** :
  - the client **sends** a request to a service and **waits** for a response of the service to come back **before continuing** doing its work

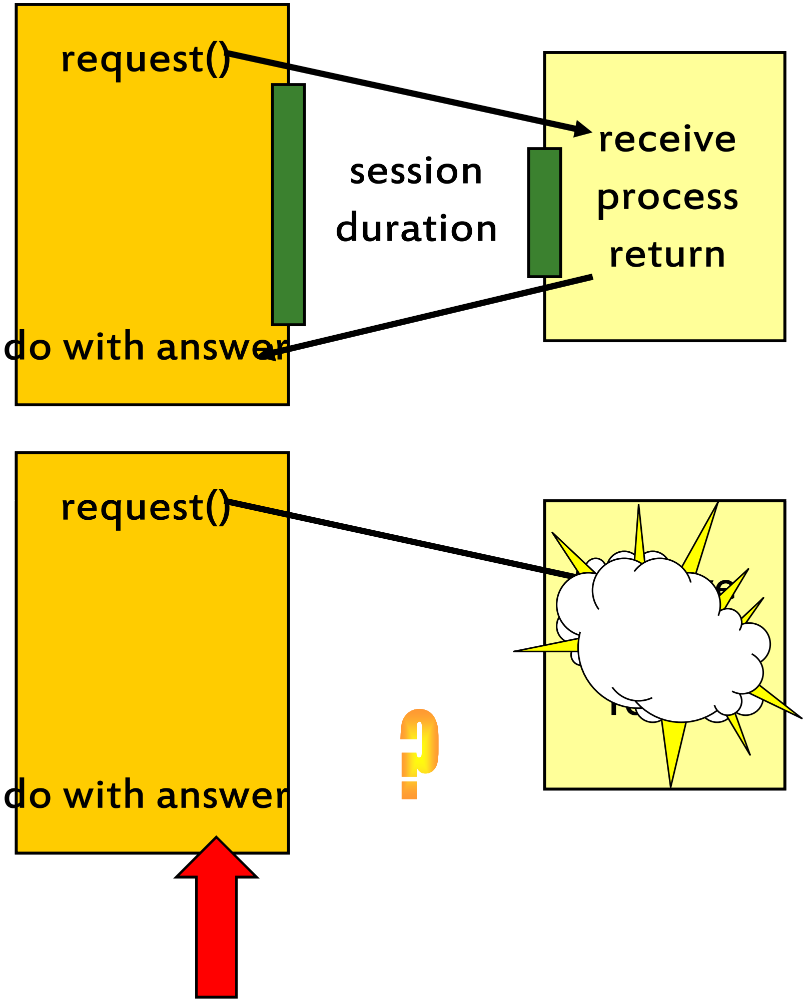
- Synchronous interaction requires both parties to be “**on-line**”:
  - the caller makes a request, the receiver gets the request, processes the request, sends a response, the caller receives the response.

Disadvantages of synchronous:

- connection **overhead**
- higher probability of **failures**
- **difficult** to identify and react to failures
- it is a **one-to-one system**; it is not really practical for nested calls and complex interactions (the problems becomes even more acute)

Overhead of synchronism

- Synchronous invocations require to maintain a **session** between the caller and the receiver.
- Maintaining sessions is **expensive** and consumes CPU resources.
- There is also a **limit** session
- For this reason, client/server systems often resort to **connection pooling** to optimize resource utilization
  - have a **pool** of open connections
  - associate a **thread** with each connection
  - **allocate** connections as needed.

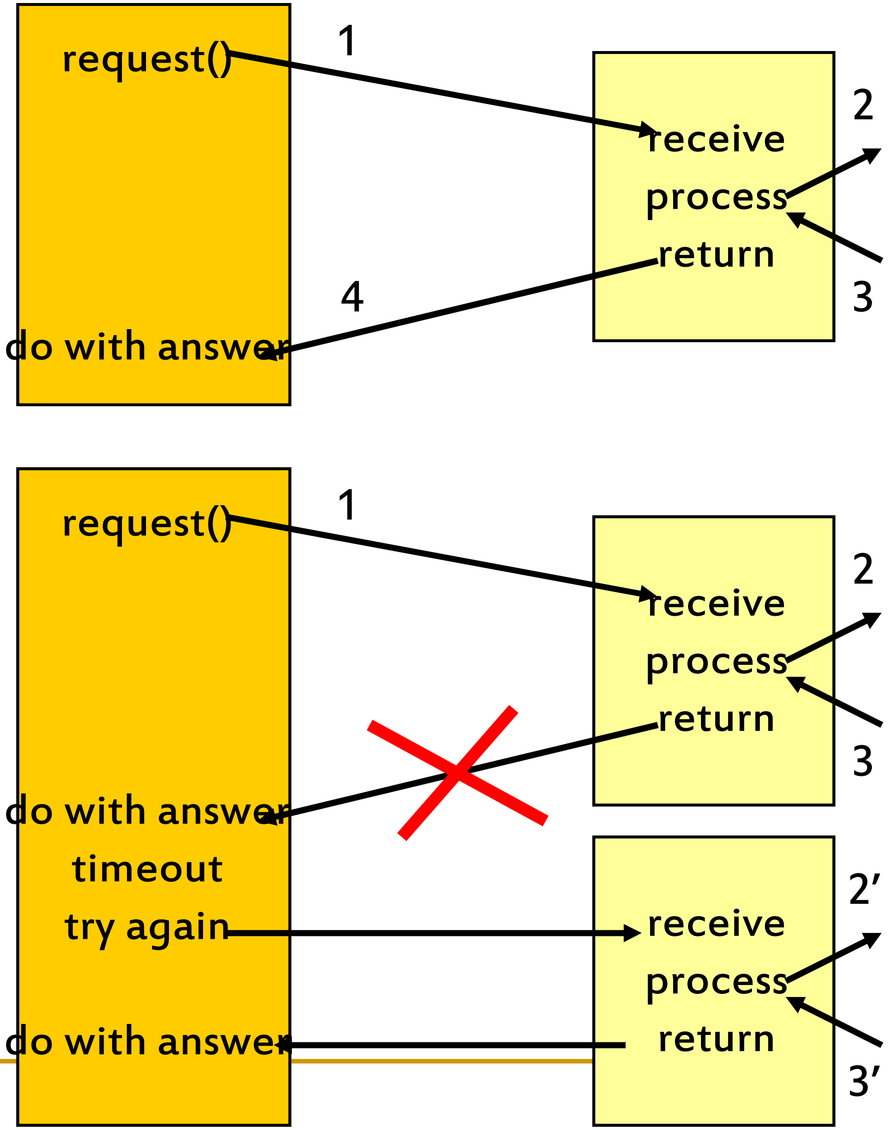


Context is lost

Needs to be restarted!!

Failures in synchronous calls

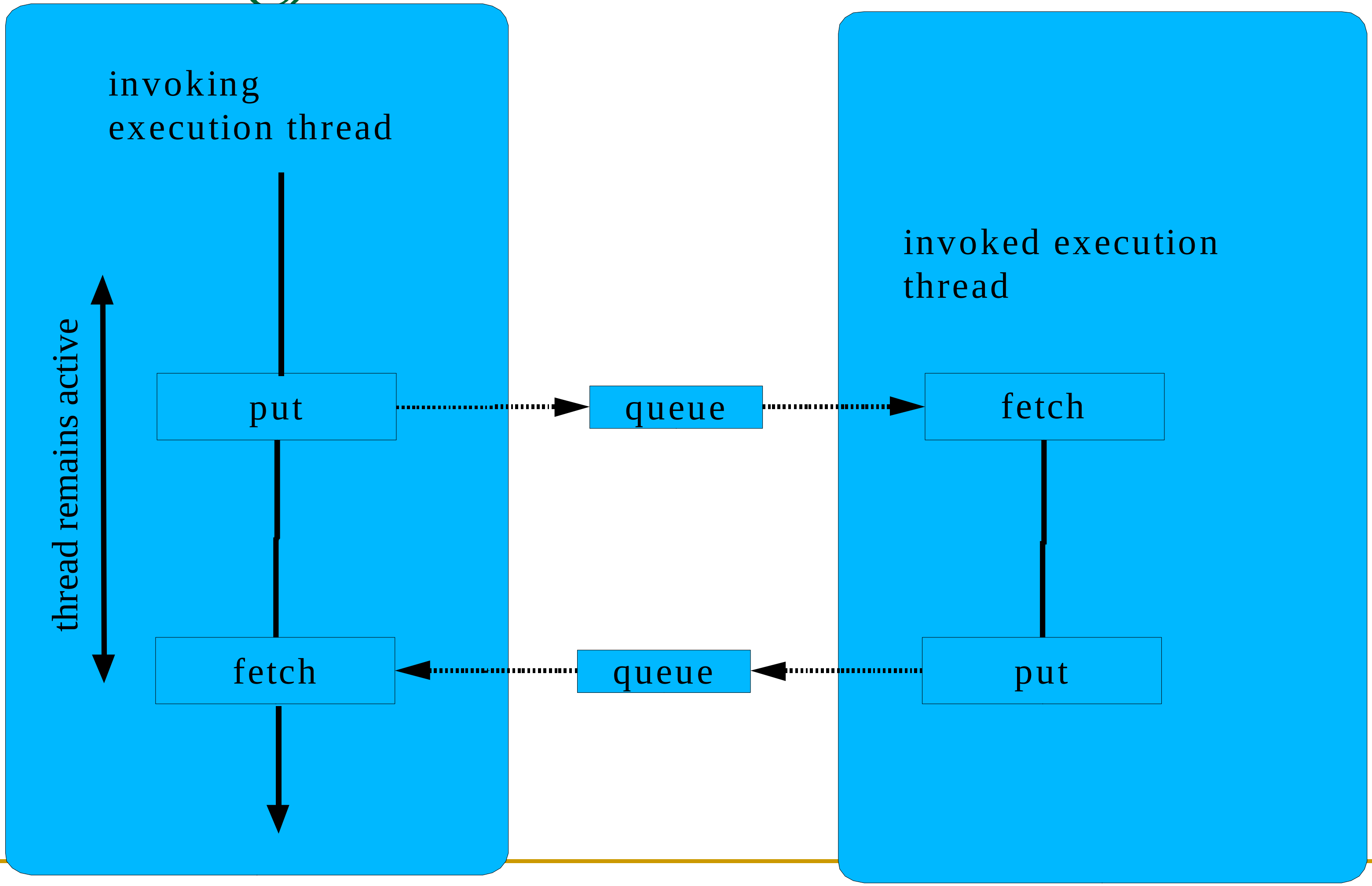
- If the client or the server fail, the context is **lost** and **resynchronization might be difficult.**
  - If the failure occurred before 1, **nothing has happened**
  - If the failure occurs after 1 but before 2 (receiver crashes), then the request is **lost**
  - If the failure happens after 2 but before 3, side effects may cause **inconsistencies**
  - If the failure occurs after 3 but before 4, the response is lost but the action has been performed (**do it again?**)
- Who is responsible for finding out what happened?



ASYNCHRONOUS INTERACTION

- **Provides Transactional interaction**: to enforce exactly once execution semantics and enable more complex interactions with some execution guarantees
- **Provides Service replication and load balancing**: to prevent the service from becoming unavailable when there is a failure (however, the recovery at the client side is still a problem of the client)
- Using **asynchronous** interaction, the caller sends a message that gets stored somewhere until the receiver reads it and sends a response.
- Asynchronous interaction can take place in two forms:
  - **non-blocking invocation** (a service invocation but the call returns immediately without waiting for a response, similar to batch jobs)
  - **persistent queues** (the call and the response are actually persistently stored until they are accessed by the client and the server)

asynchronous interactions (non blocking)



See u next week

- Developing Enterprise Application Techniques