A2 Verteilte Systemsoftware
Part 1 – Intro "Distributed Systems"

aus: Coulouris / Dollimore / Kindberg: "Distributed Systems: Concepts and Design", Addison Wesley/Pearson Internat. , 5. Ausg., 2012

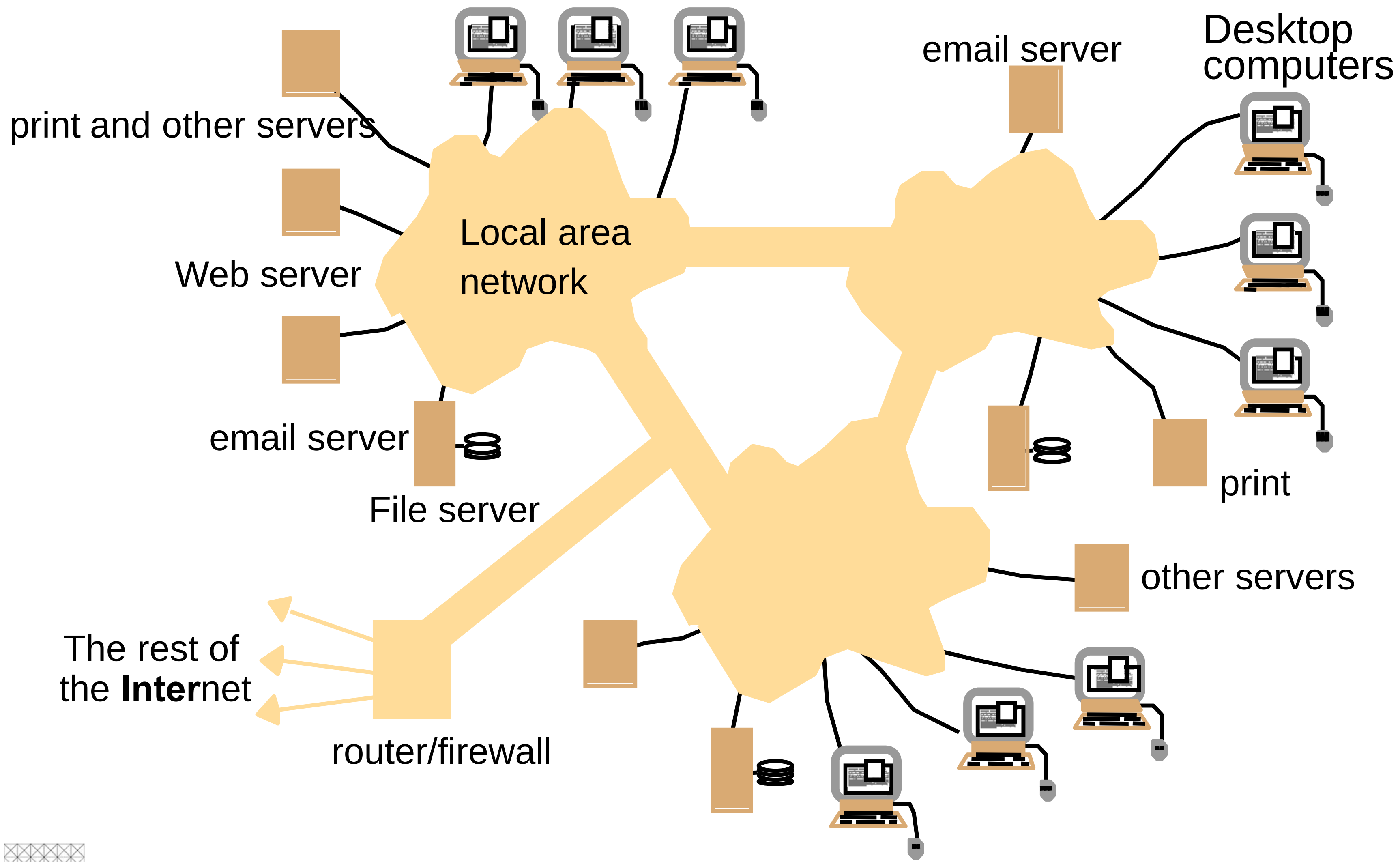
***"Distributed systems"* - simple definition:** **HW+SW components, located on global networks, which communicate & coordinate their actions only by message passing; important: *common global goal*!**

Typical characteristics:

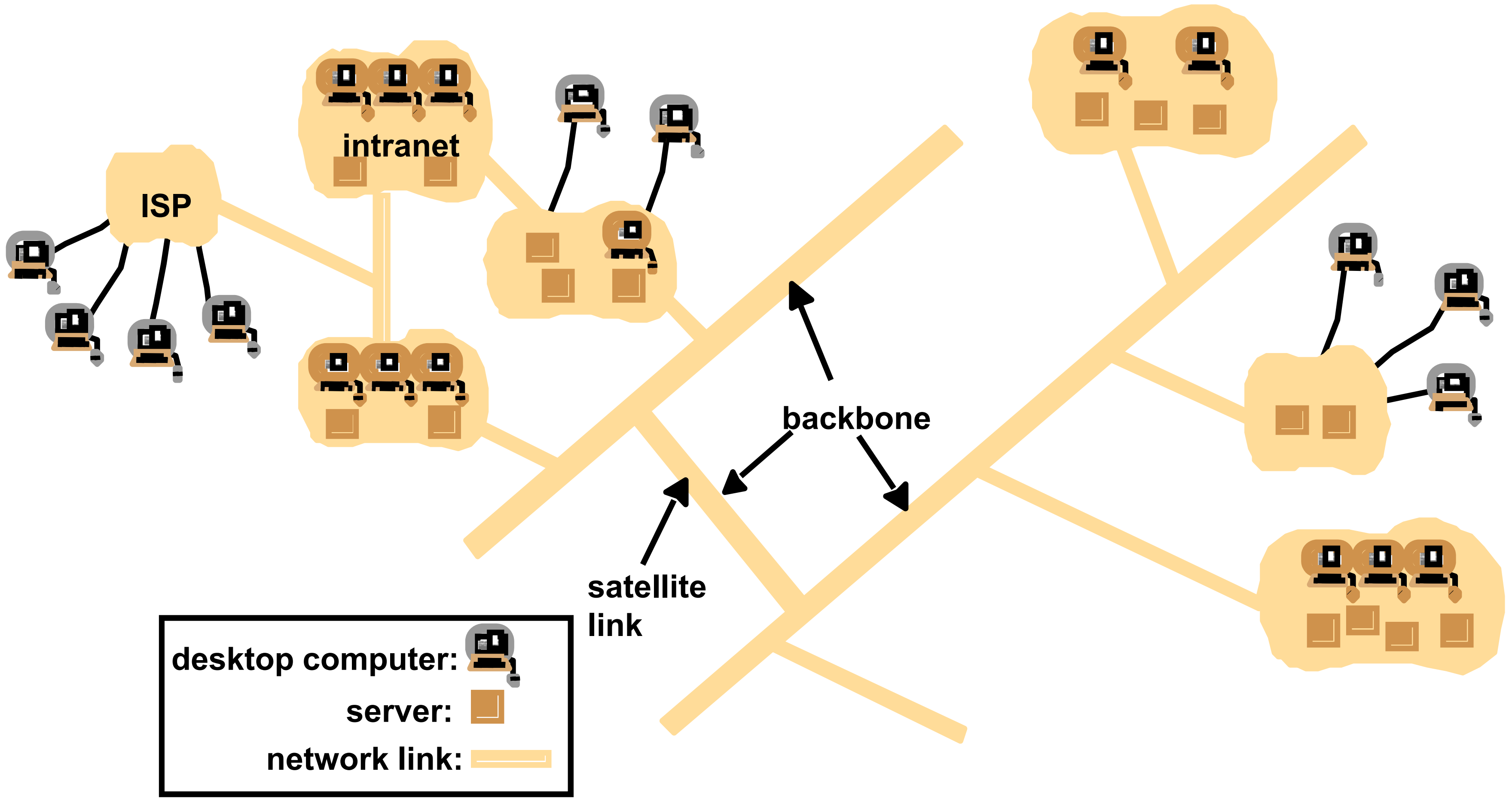
- ***Concurrency:*** **→ siehe "Nebenläufigkeit & Verteilung"**
- ***No global clock:*** **→ s. "Synchronisation" (+ Vorl. "VIS" später)**
- ***Independent failures:*** **→ alle Kapitel + "Transparenz"-Eigen-schaften**

Beispiele:

Distributed Systems: A Typical Part of an *Intranet*

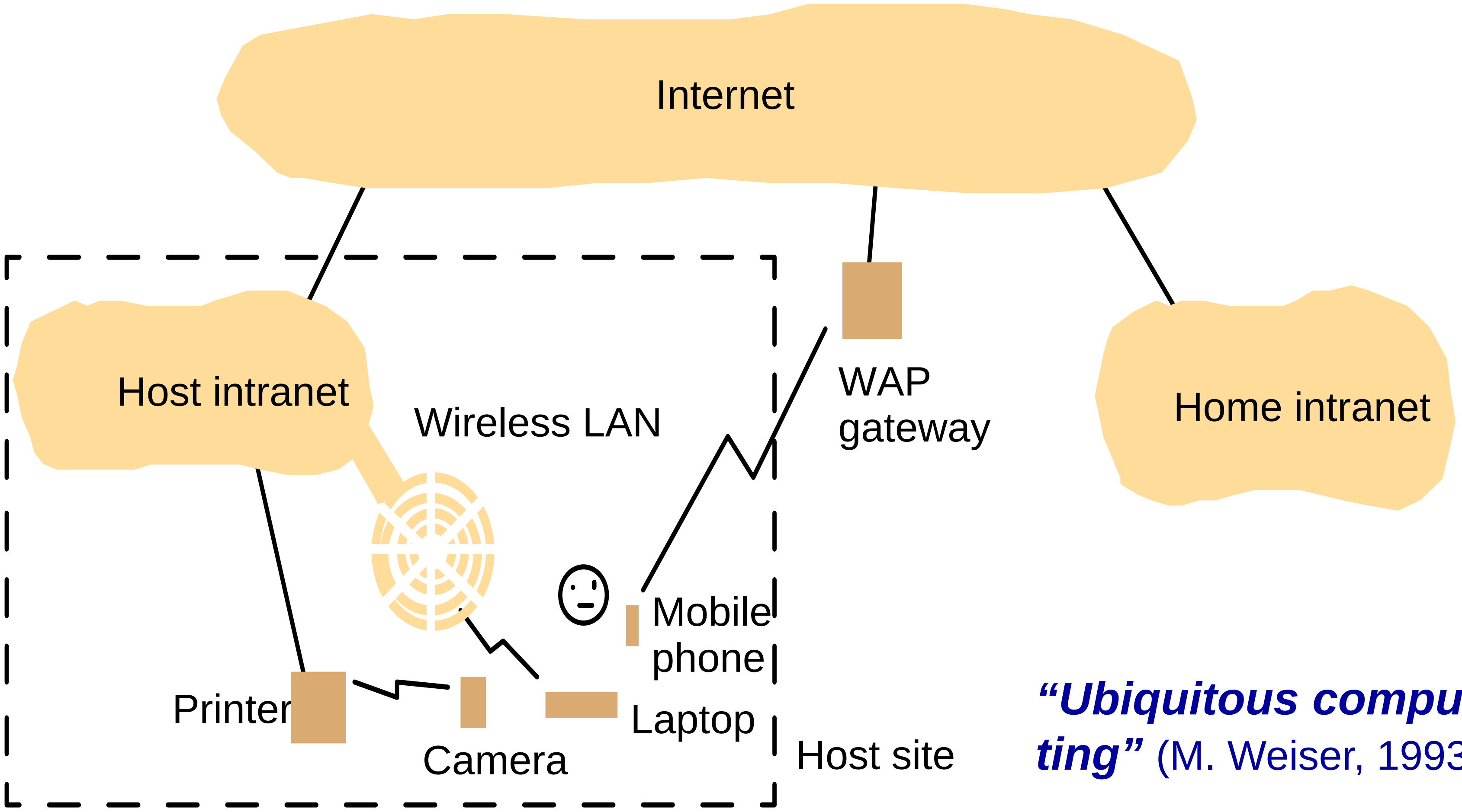


Distributed Systems: *“A typical portion of the **Internet**”*



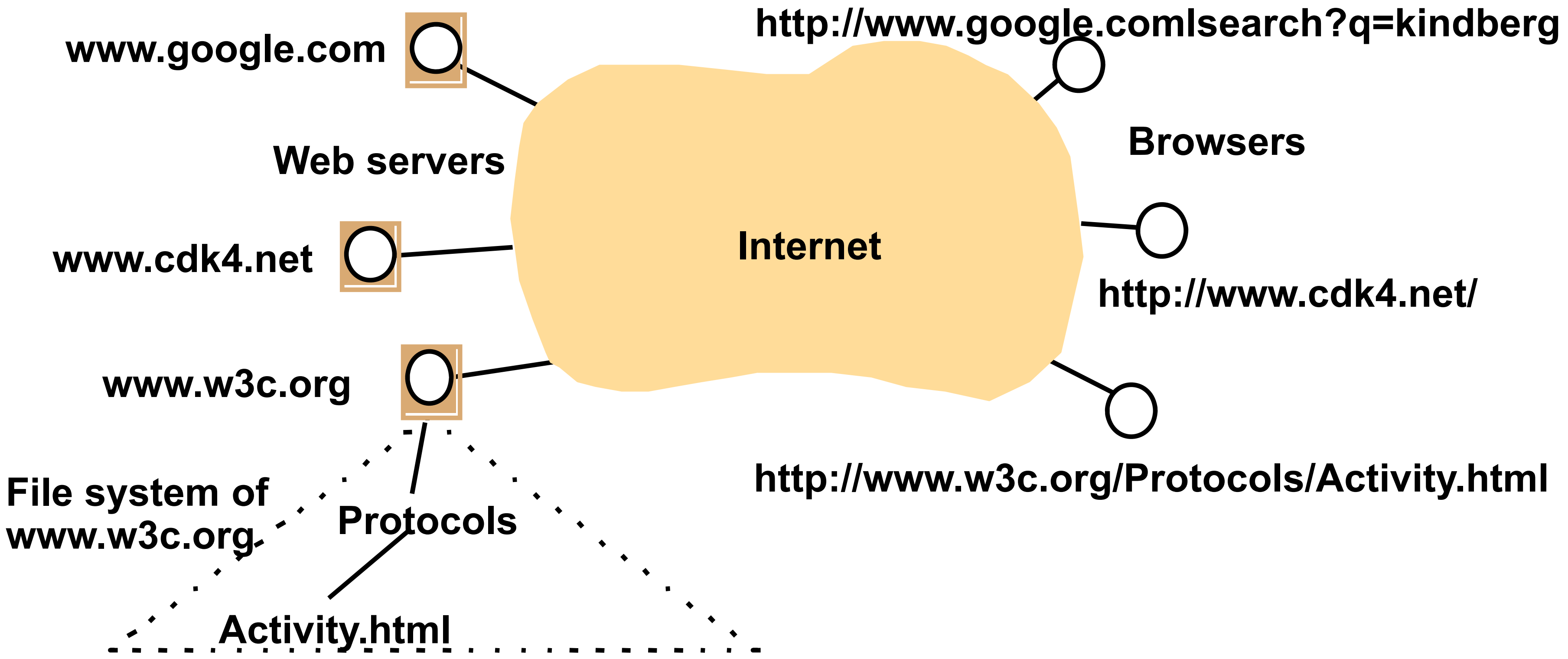
Communication, System software (i.e. Operating System), Middleware, Security

“Mobile Systems”:
Portable and handheld devices in a distributed system



“Ubiquitous computing” (M. Weiser, 1993)

(Web) Server: Web servers and web browsers


www.google.com
http://www.google.comlsearch?q=kindberg
Web servers
Browsers
www.cdk4.net
Internet
http://www.cdk4.net/
www.w3c.org
File system of www.w3c.org
Protocols
Activity.html
http://www.w3c.org/Protocols/Activity.html

Ressource sharing in the web: ***Servers, clients, remote service invocation, resource location (URL), interfaces (HTML), protocols (http), web services, service-oriented computing/ architecture (SOA)***

Number of Computers in the Internet

Challenges:

- *Heterogeneity*
- *Openness*
- *Scalability*
- *Security*

Datum	*# Computer* *(mit reg. IP-Addr.)*
1979, Dez.	**188**
1989, Juli	**130,000**
1999, Juli	**56,218,000**
2003, Jan.	**171,638,297**
….	**…………………..**
2011	**über 2 Mrd. IN Benutzer**
"IN of Things" (IoT)	
2016	**über 6 Mrd. IoT Geräte**
….	**…………………..**
2020 (?):	**~ 30 Mrd. Einheiten (?)**

Inzwischen:

"Internet of Things"

Distributed Systems Goals: *“Transparencies” (1)*

Overall goal: “Distribution Transparency” – can be subdivided into:

Access transparency: enables *local and remote* resources to be accessed using *identical* operations.

Location transparency: enables resources to be accessed *without knowledge of their location*.

Concurrency transparency: enables several processes to operate *con-currently* using shared resources *without inter-ference* between them.

Replication transparency: enables multiple instances of resources to be used to increase reliability and performance *without knowledge of the replicas* by users or application programmers.

….

Distributed Systems Goals: *“Transparencies” (2)*

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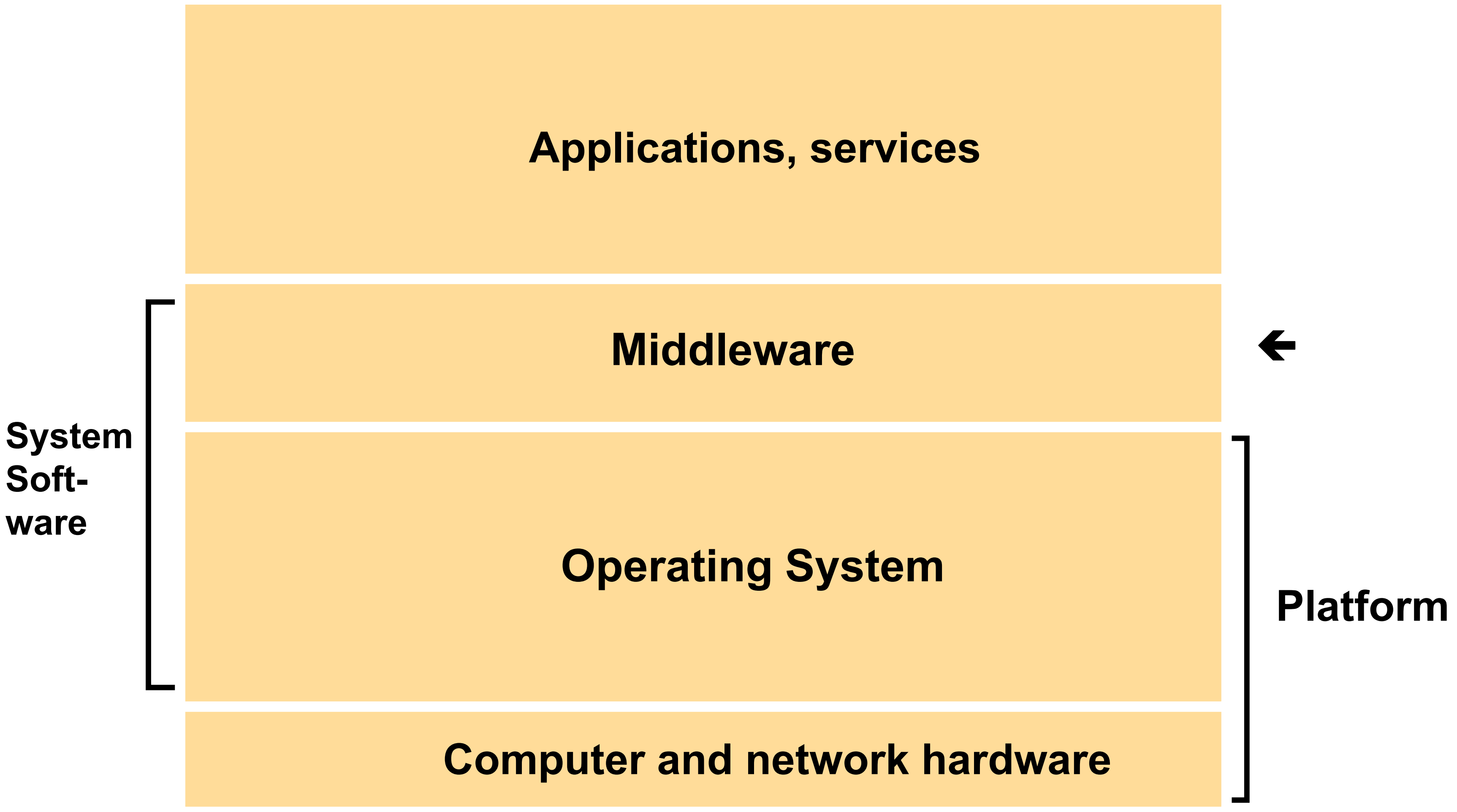
Failure transparency: **enables the *concealment of faults*, allowing users and application programs to complete their tasks despite the failure of hardware or software components.**

Mobility transparency: **allows the *movement of resources* and clients within a system without affecting the operation of users or programs.**

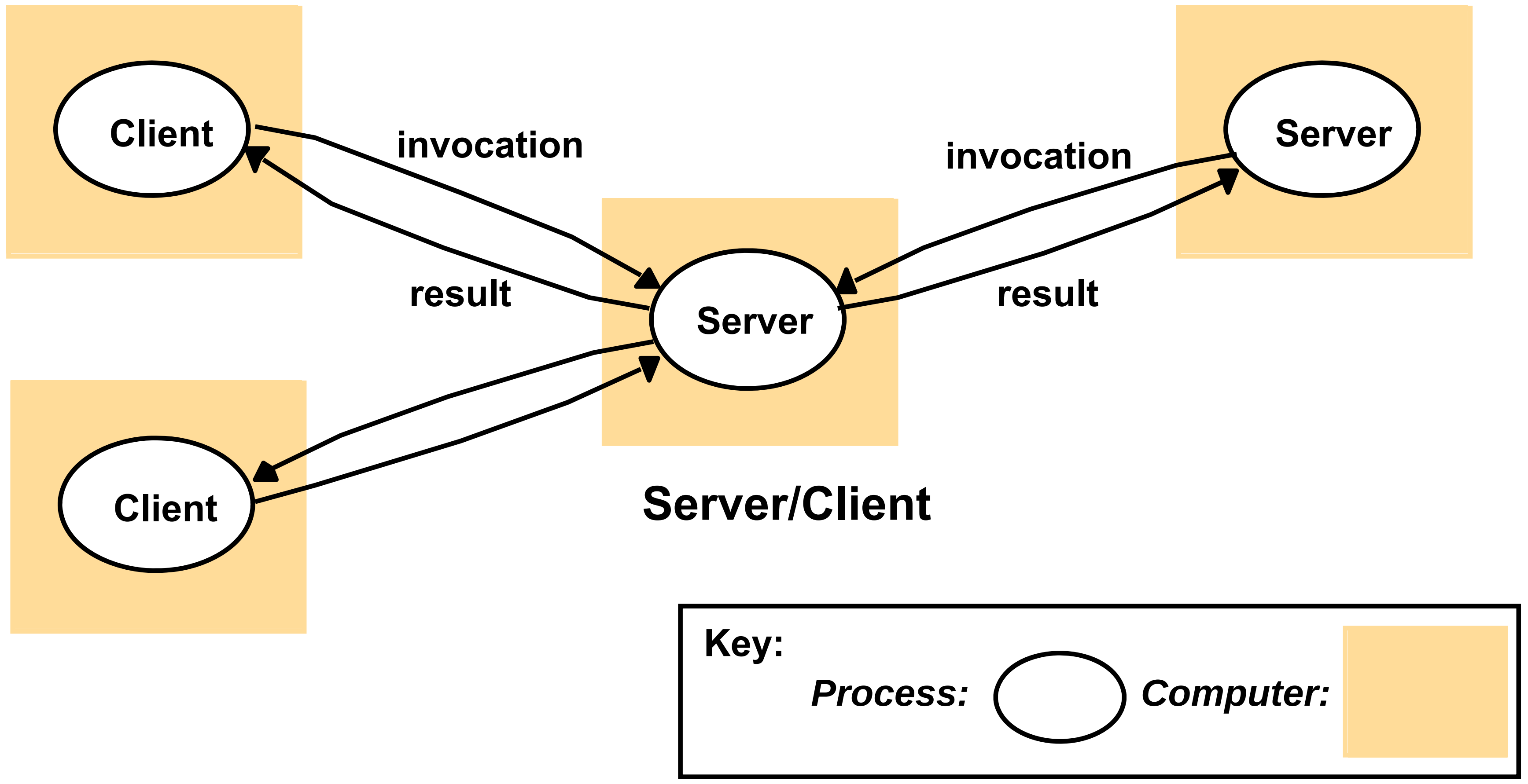
Performance transparency: **allows the system to be *reconfigured* to improve performance as loads vary.**

Scaling transparency: **allows the system and applications to *expand* in scale without change to the system structure or the application algorithms.**

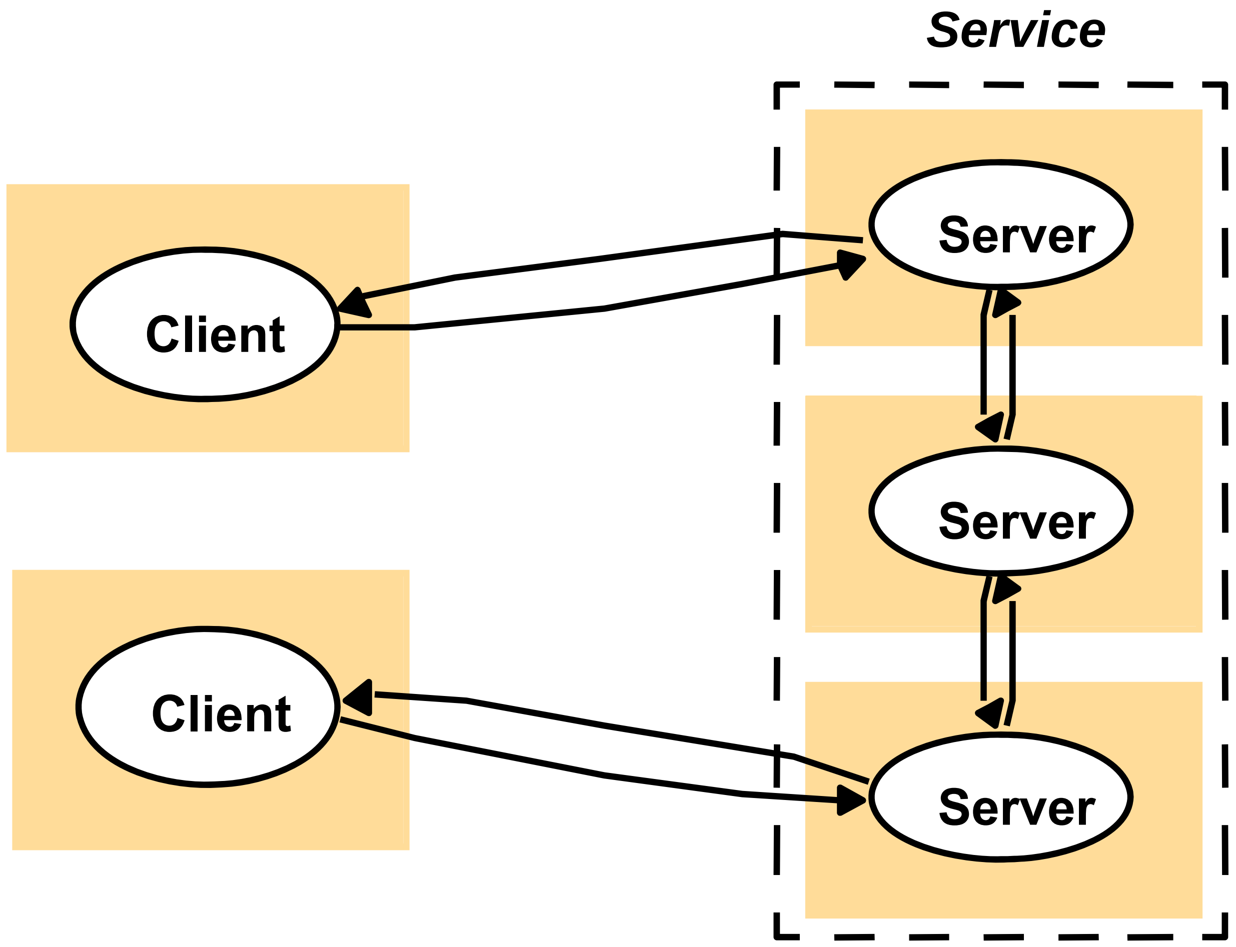
Part 2 - System Models:
Software and hardware service layers in distributed systems



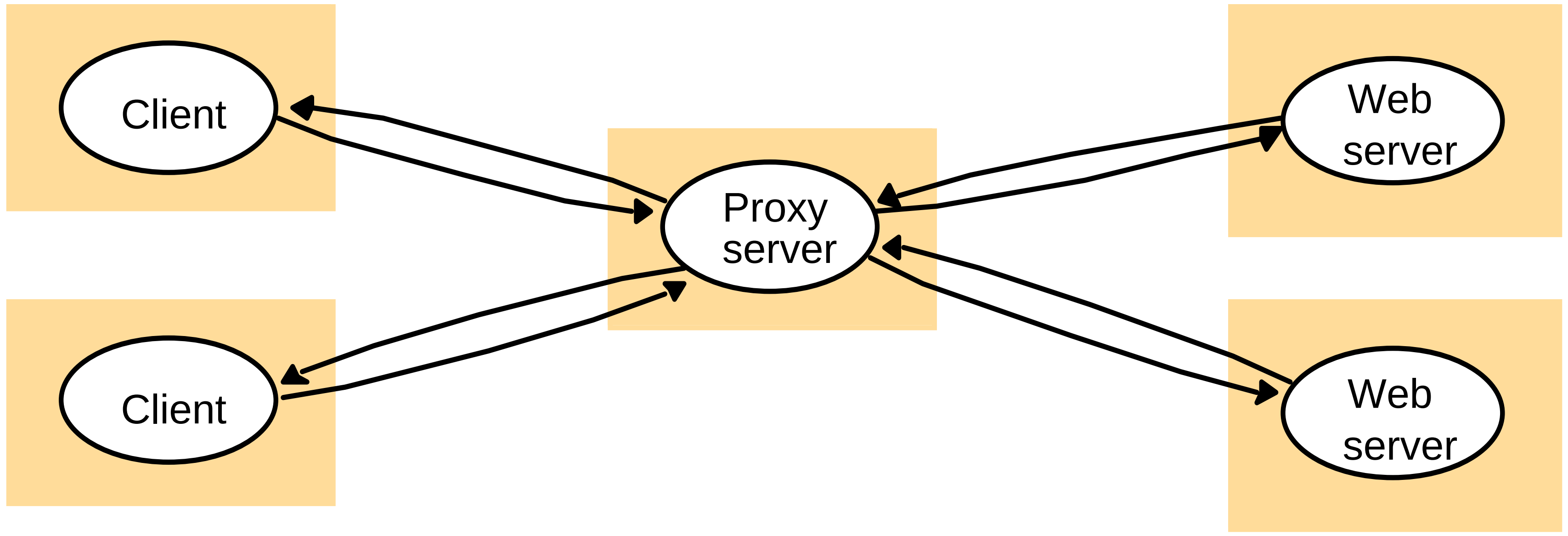
Client/Server: (a) Clients invoke individual servers



Client/Server:
(b) A ***service*** provided by multiple servers

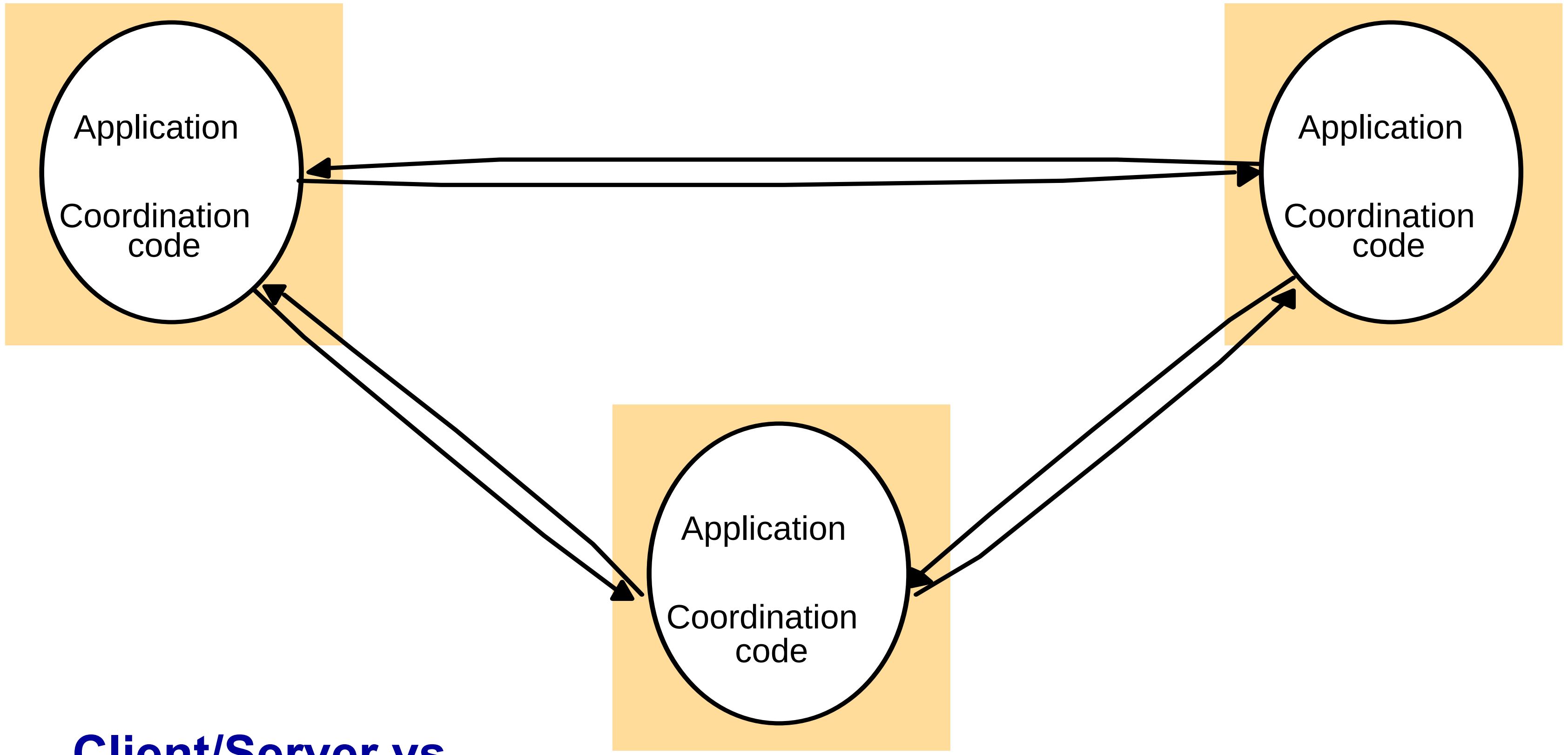


Client/Server: (c) Web proxy server



Proxy server: shared cache of web resources

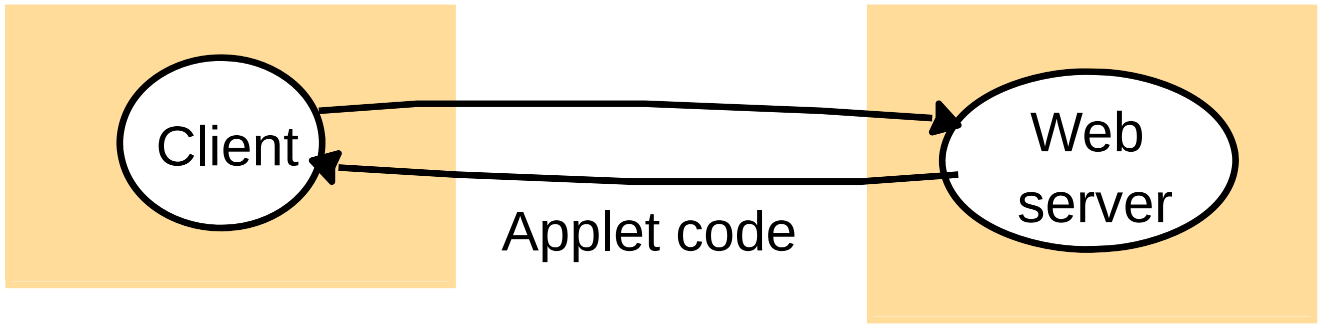
P2P: A distributed application based on peer processes



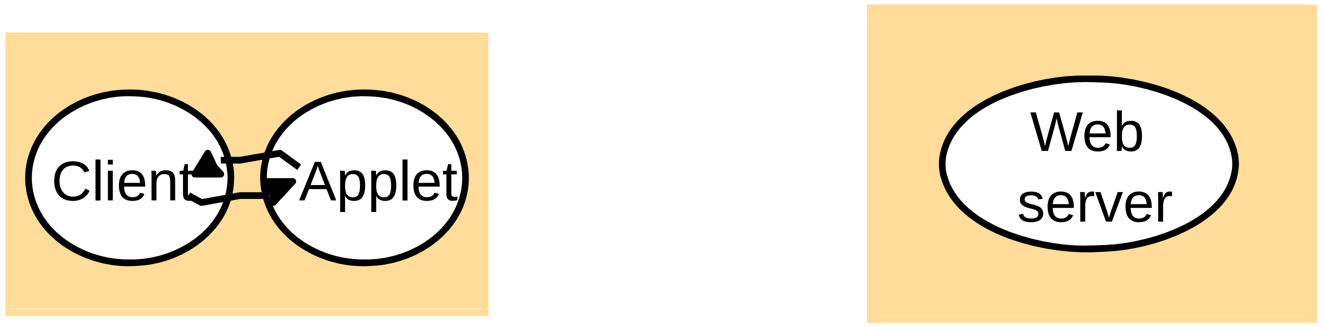
Client/Server vs. peer-to-peer (P2P)

Web applications: Web applets

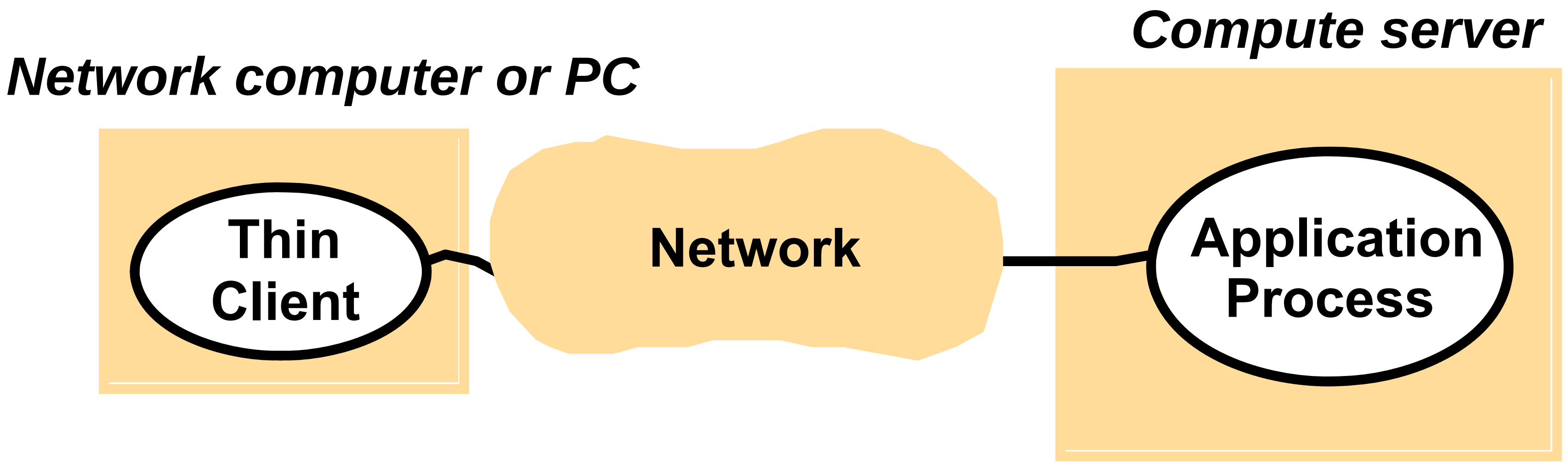
a) Client request results in the downloading of applet code



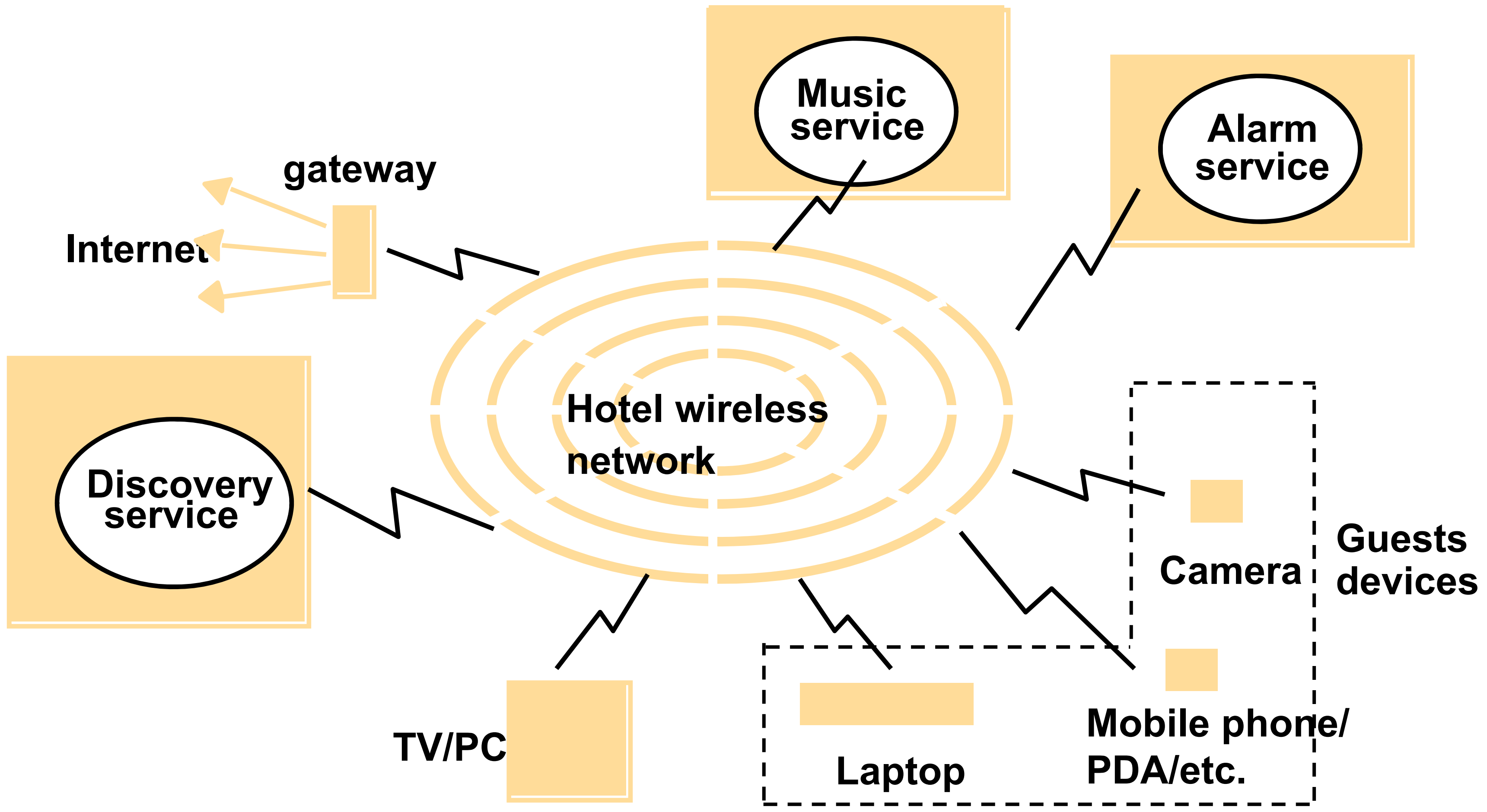
b) Client interacts with the applet



Client/Server: (d) Thin clients and compute servers

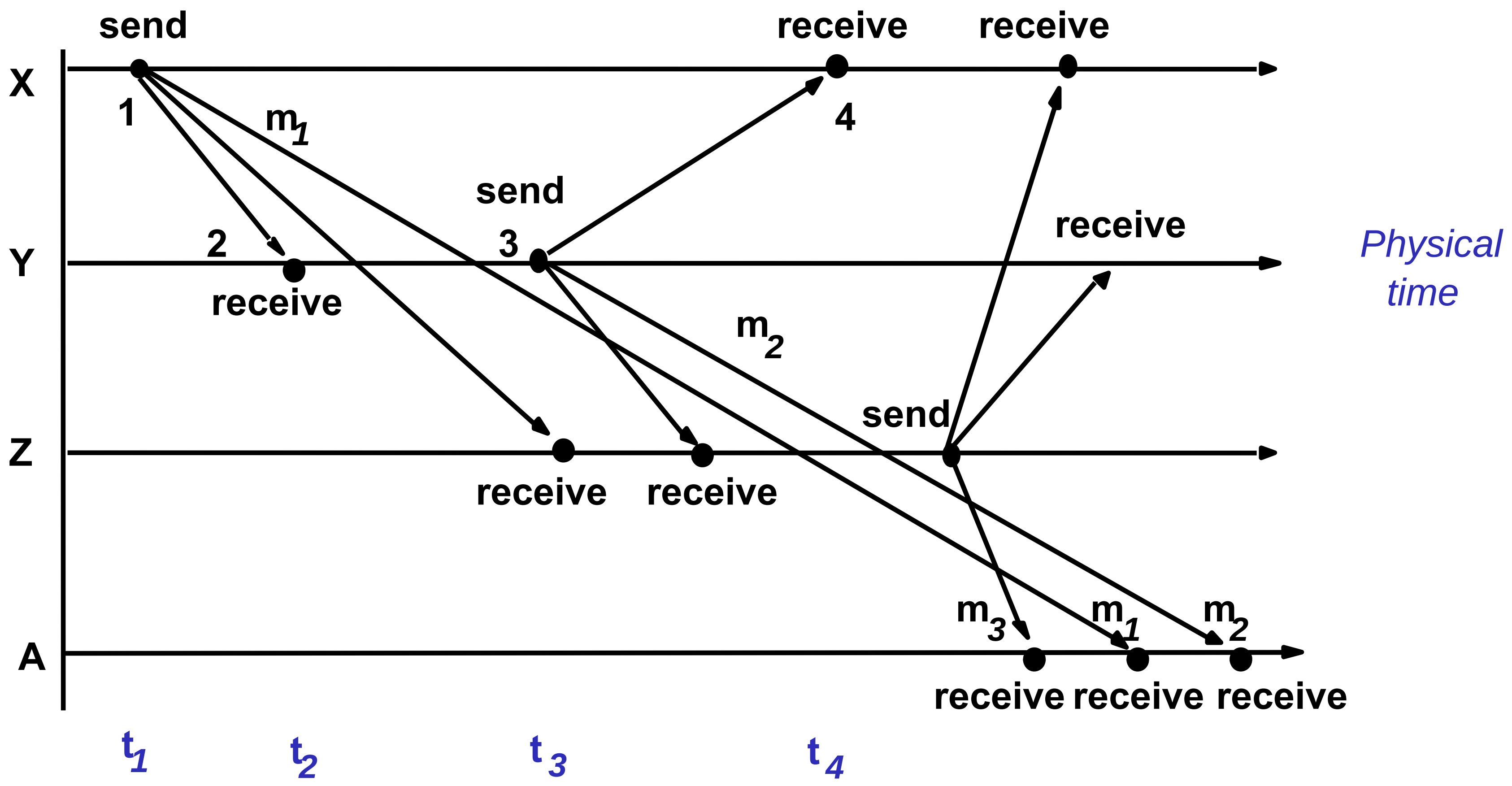


Application example: Spontaneous networking in a hotel

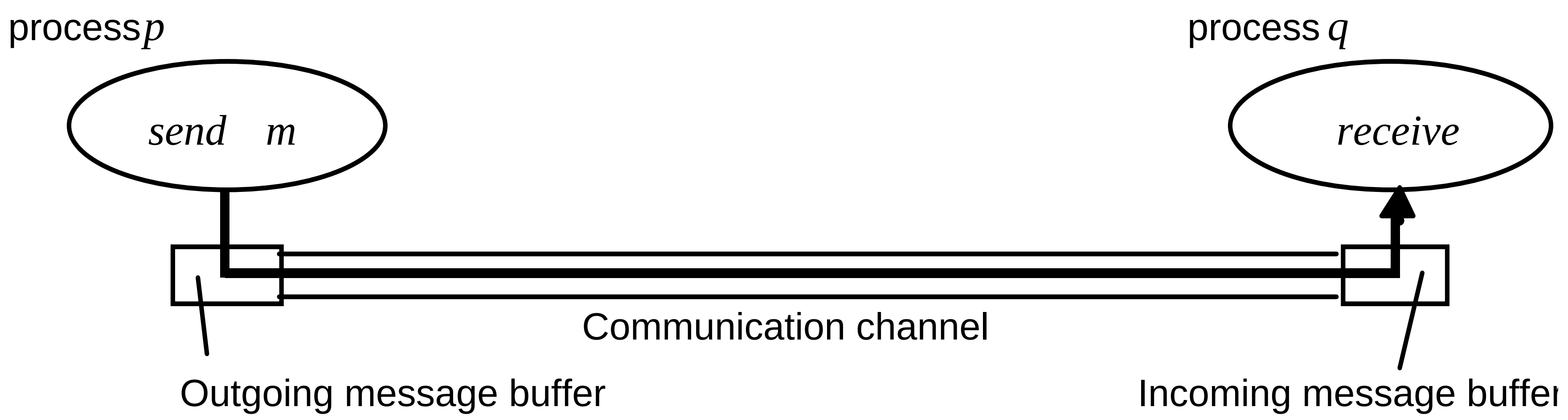


Timing models: Real-time ordering of events

Asynchronous & *synchronous* systems; *event ordering*



Failure models: Processes and channels



2 types of failures:

- **timing failures: in synchronous distributed systems**
- **arbitrary failures: (Byzantine failure) – „anything at any time“**

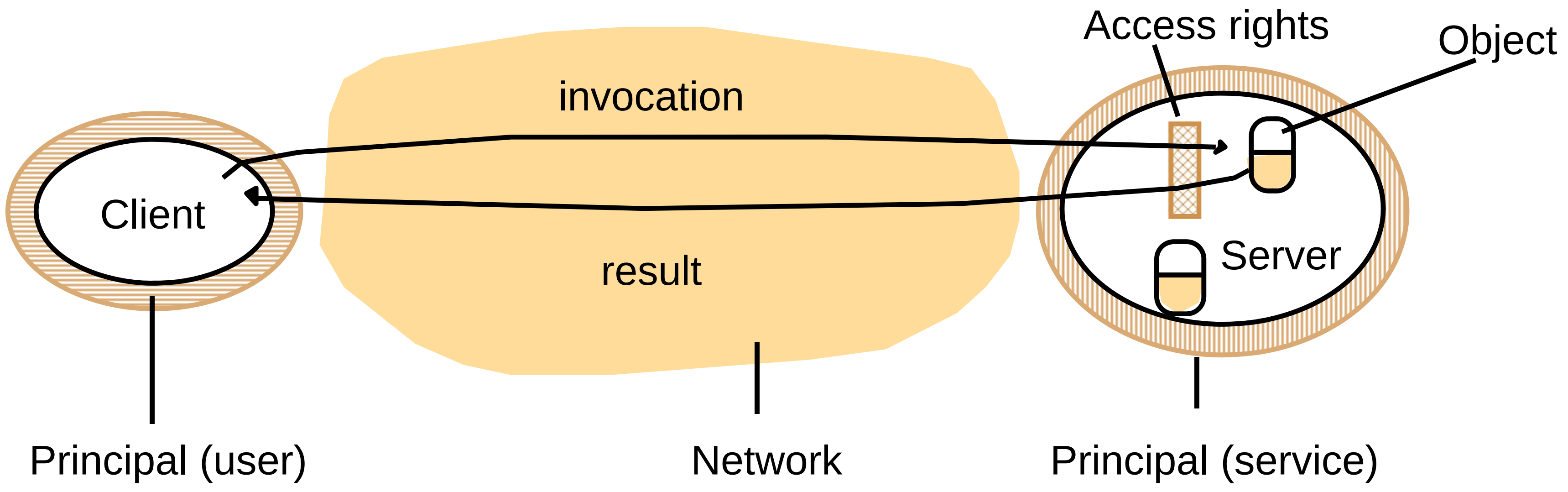
Timing failures

Class of Failure	Affects	Description
Clock	*Process*	Process's local clock exceeds the bounds on its rate of drift from real time.
Performance	*Process*	Process exceeds the bounds on the interval between two steps.
Performance	*Channel*	A message's transmission takes longer than the stated bound.

Omission and arbitrary failures

Class of failure	Affects	Description
Fail-stop	*Process*	Process halts and remains halted. Other processes may detect this state.
Crash	*Process*	Process halts and remains halted. Other processes may not be able to detect this state.
Omission	*Channel*	A message inserted in an outgoing message buffer never arrives at the other end's incoming message buffer.
Send-omission	*Process*	A process completes a *send,* but the message is not put in its outgoing message buffer.
Receive-omission	*Process*	A message is put in a process's incoming message buffer, but that process does not receive it.
Arbitrary (Byzantine)	*Process or channel*	Process/channel exhibits arbitrary behaviour: it may send/transmit arbitrary messages at arbitrary times, commit omissions; a process may stop or take an incorrect step.

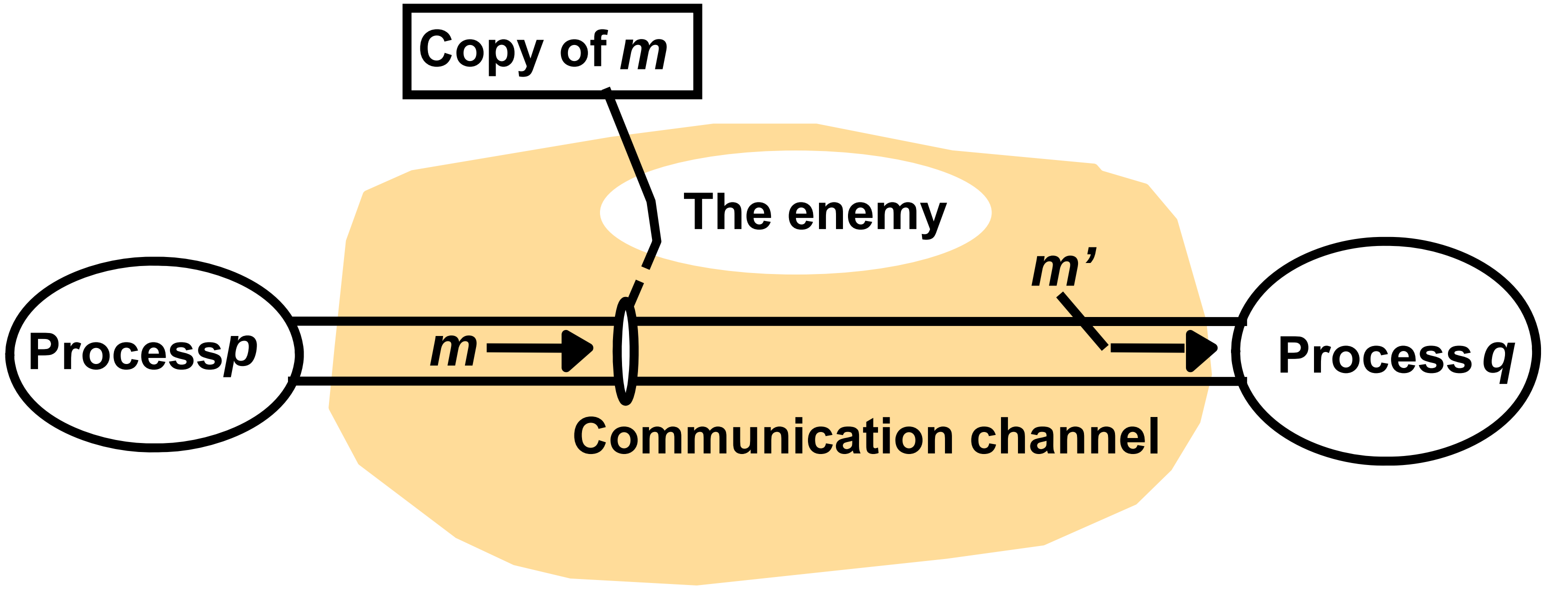
Security models: Objects and principals



Goals:

- **Protecting objects**
- **Securing processes and their interaction**
- **Client/Server → "Agent"** ***(Principal-agent theory)***

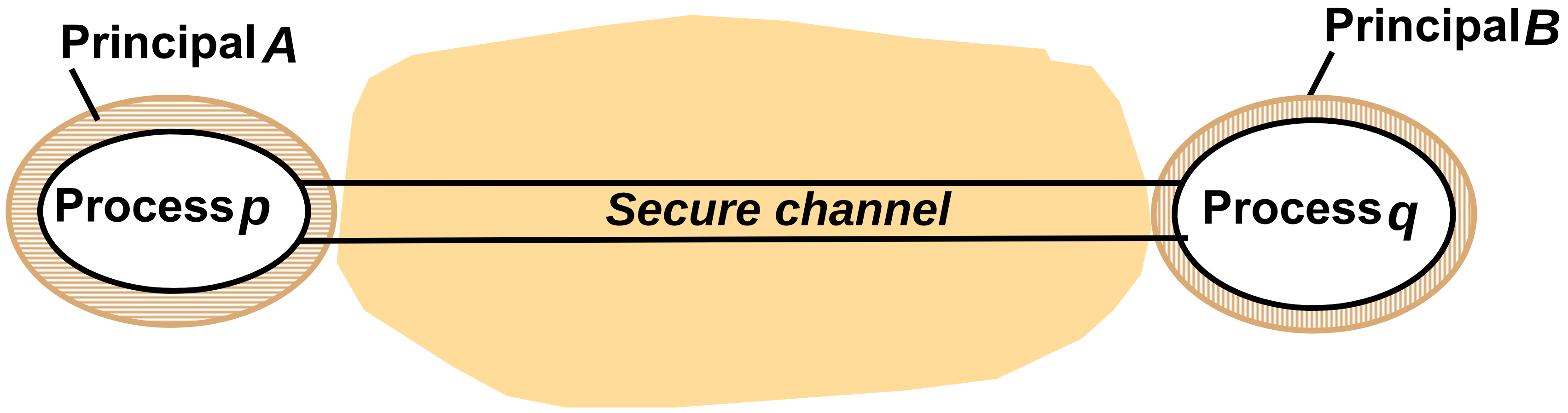
Security models: The enemy



Basis security threads:

- loss of messages
- unauthorised read and/or access
- corruption
- false/stolen identities

Security models: Secure channels



Basis security <u>techniques</u>:

- cryptography & shared secrets
- authorisation & authentication
- secure channels

→ Sicherheitsaspekte: anderer Teil der Vorlesung GSS!