Operating Systems II

Jörg Kaiser
IVS - EOS

4. Distributed Systems

roadmap:

- distributed systems' models
- interaction and sharing
- distributed state

Multi-Processor Systems

Bus-based Multi-Processor with single central memory.
Realization: Hardware.
Problems: Cache coherence and memory consistency.

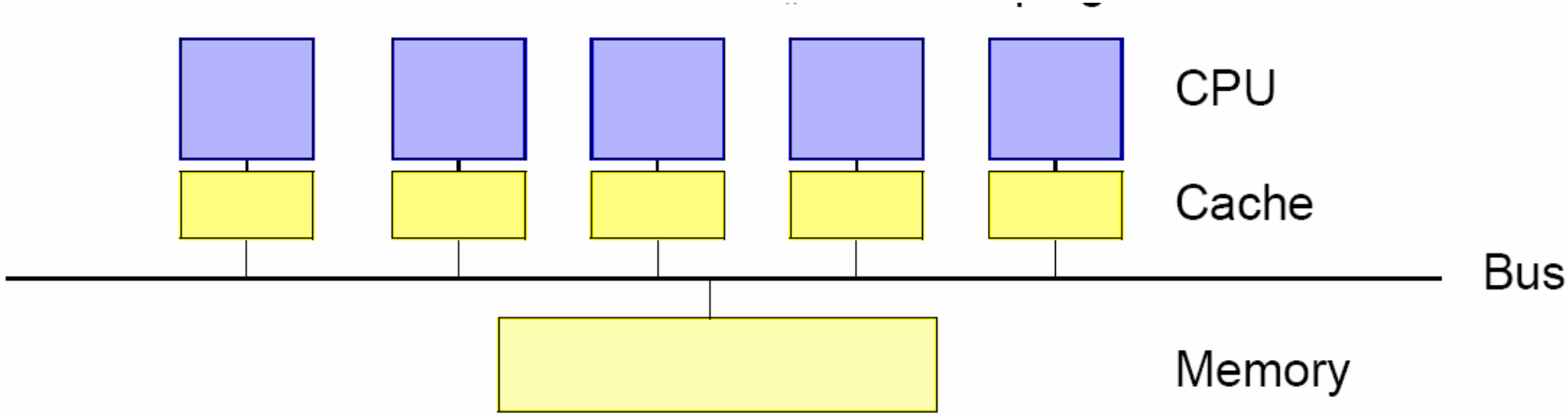
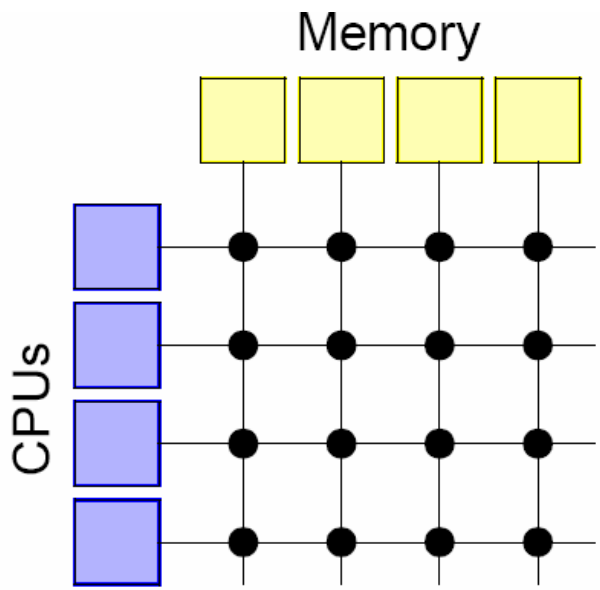
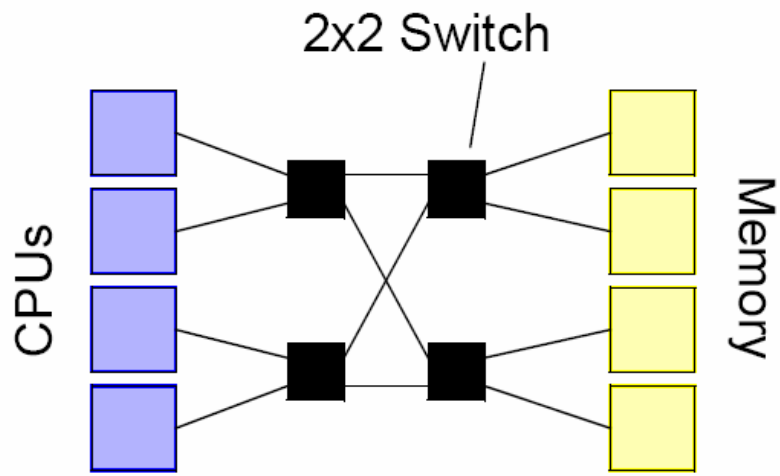


Abb.: F. Hauck: Modernen Konzepte verteilter Systeme (VL U.Ulm, 2002/02)

Multi-Processor Systems

Connection-based Multi-Processor with multiple memories.
Realization: Special switching network hardware (Omega networks, Banyan trees,..)
Problems: Complexity of the switching network.

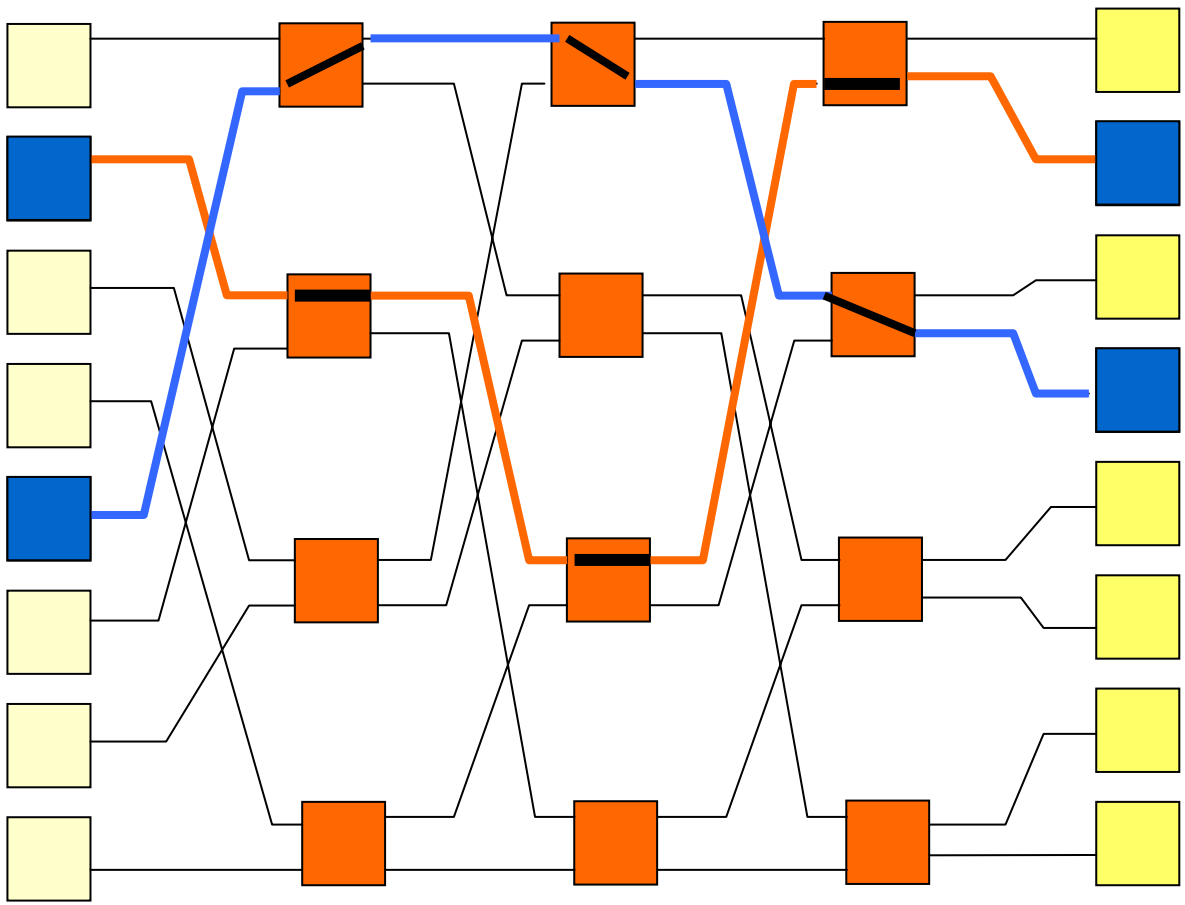




An Omega switching network

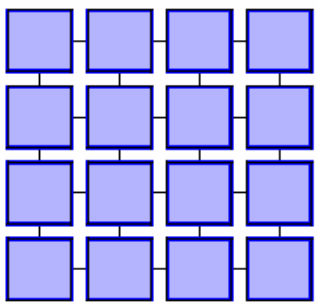
log2 n stages

$2^k = N$ inputs

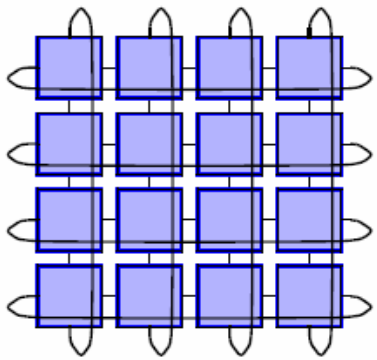


Multi-Processor Systems

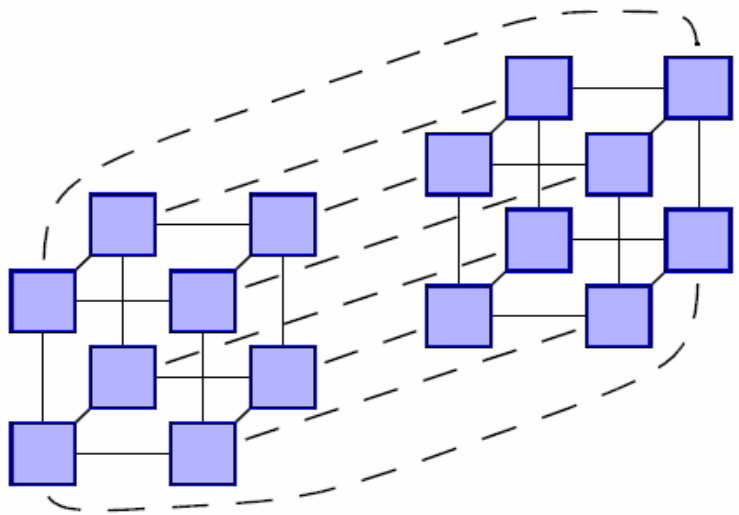
Grid



Torus



Hypercube



Types of Multi-Processor Systems

	data	control	
shared memory multiproc.	c	c	tight coordination of multiple execution engines
computer cluster	d	c	central coordination of proc/mem pairs working on distributed data
distributed system	d	d	no central component.

What is a distributed system?

Leslie Lamport:

You know you have one when the crash of a computer you have never heard of stops you from getting any work done.

Andrew Tanenbaum:

A distributed system is composed from multiple autonomous computers which appear as a single computer for a user.

George Coulouris:

A distributed system is composed from multiple autonomous computers which coodinate actions by exchanging messages.

What is a distributed system?

Essential properties:

- multiple computers (local CPU-/memory-/network-/I-O-components)
- computers are autonomous, i.e. they have an independent local control
- computers are connected by a network and basically communicate by exchanging messages
- there is no special central control and coordination facility

Distributed Data + Distributed Control

What is a distributed system?

Essential properties:

- Concurrency of computations
- No global clock
- Components fail independently

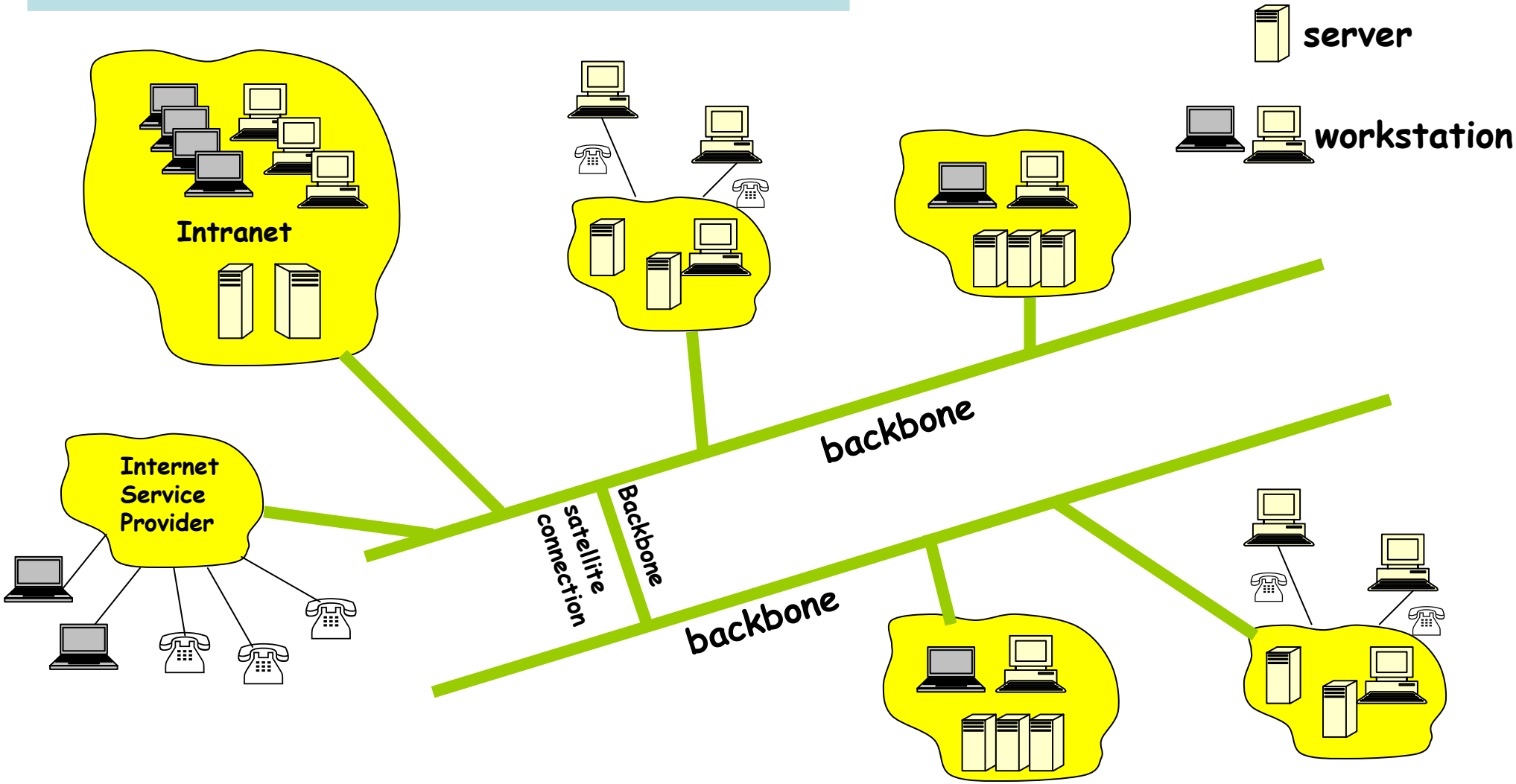
Why a distributed system?

- Performance
- Sharing of resources
- Independence of failure and no single point of failure
- Distributed nature of application
- Distributed data
- Extensibility and Scalability

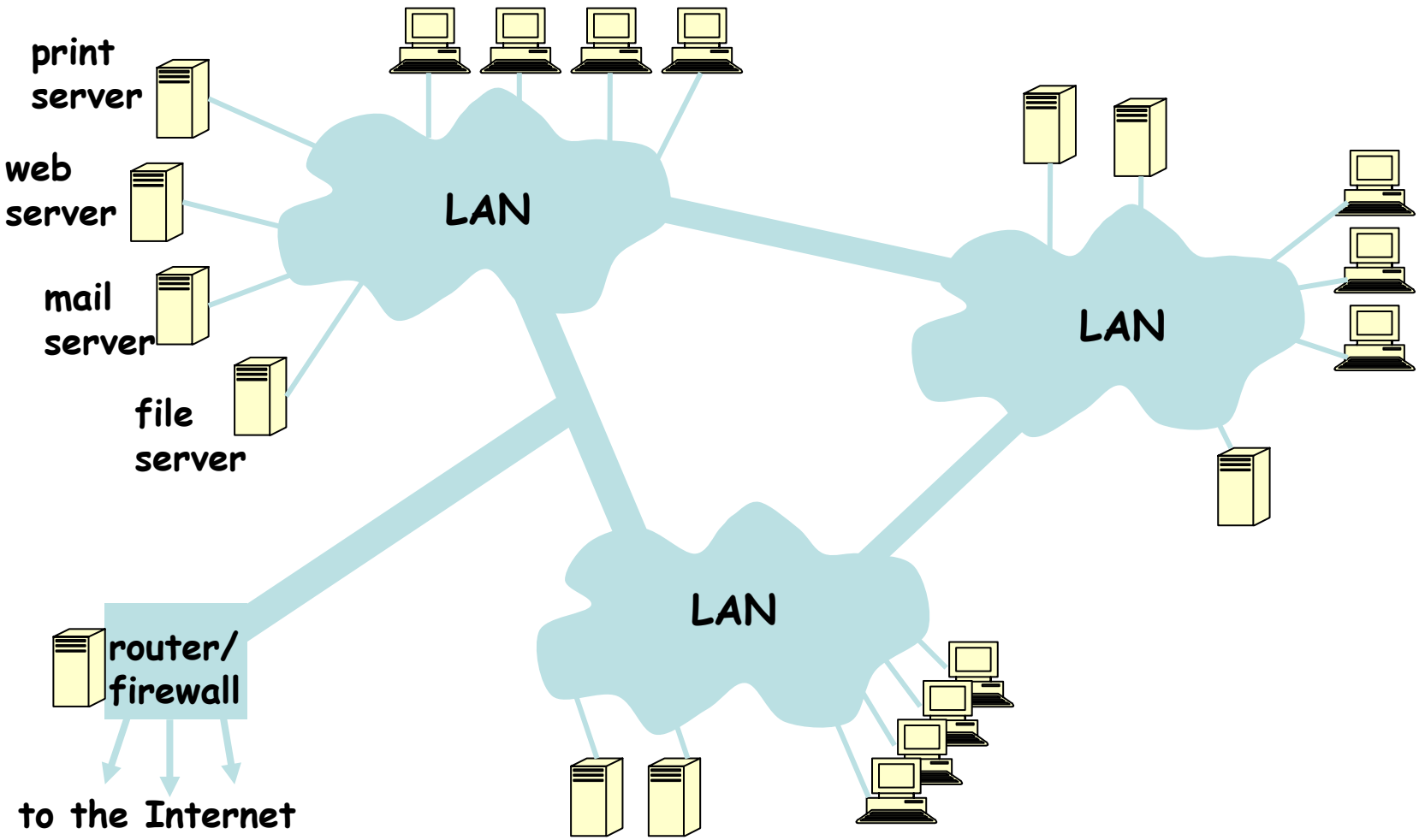
Examples

- The Internet
- An Intranet
- Distributed Control Systems
- Ubiquitous and mobile computing environments

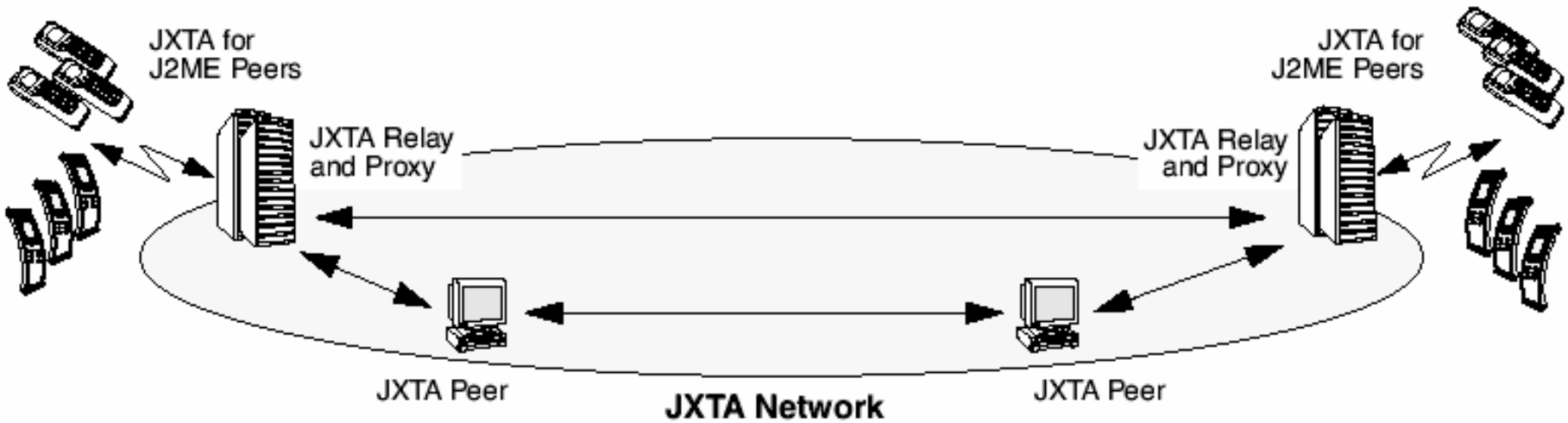
Example: Internet



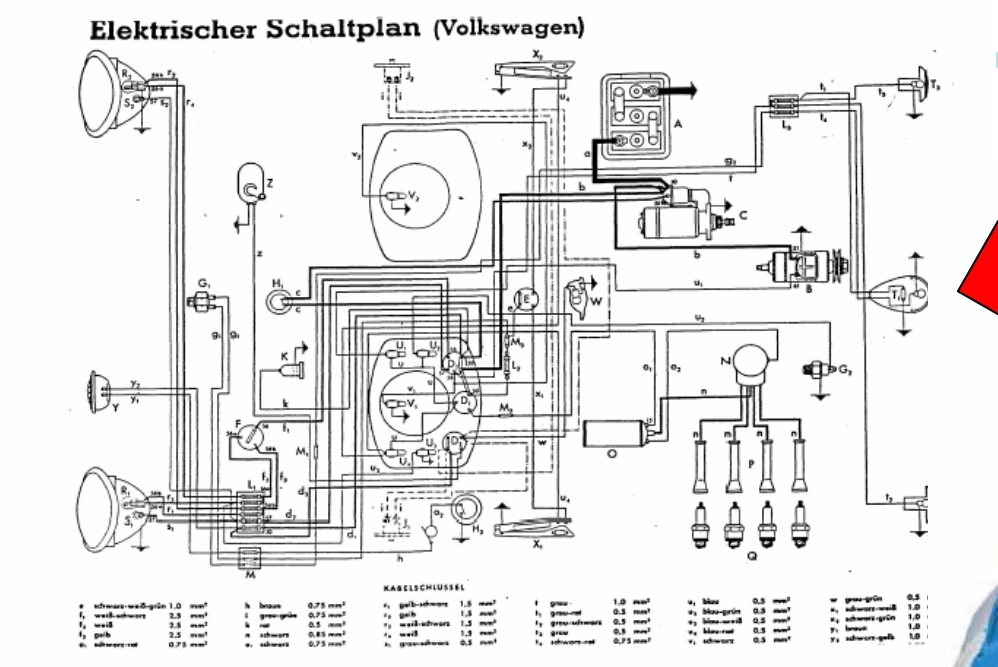
Example: Intranet



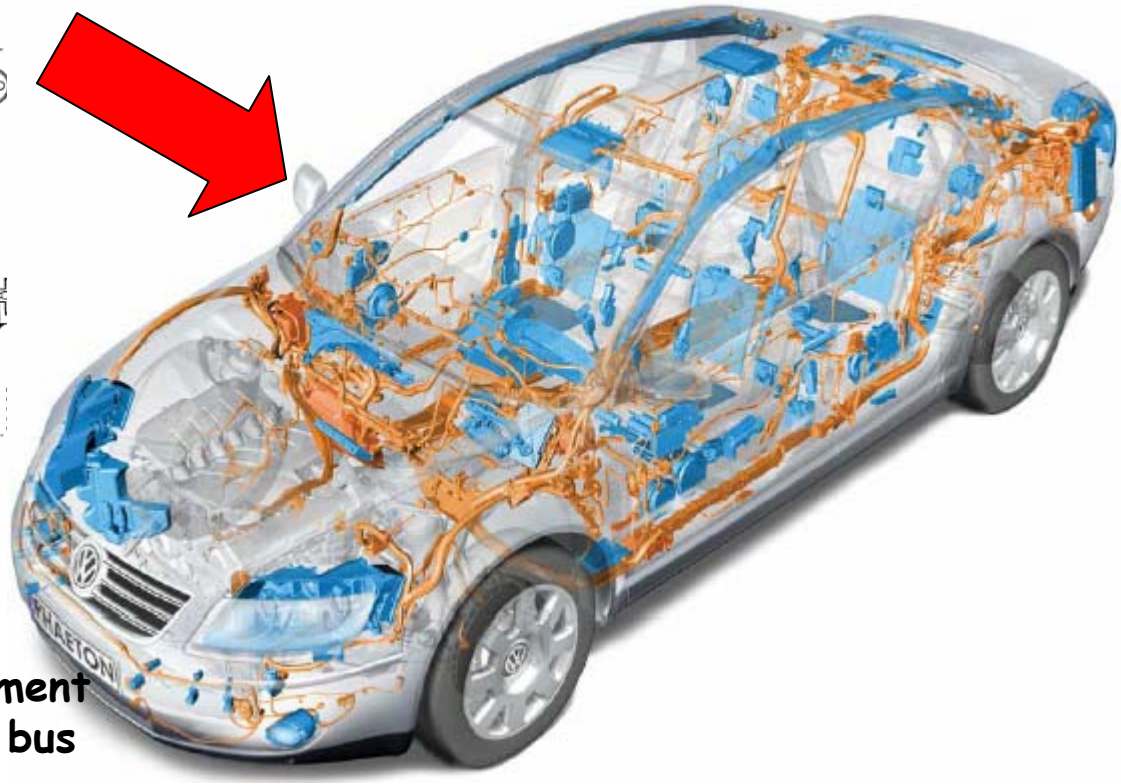
Example: „Edge Networks“



Example: Control Networks

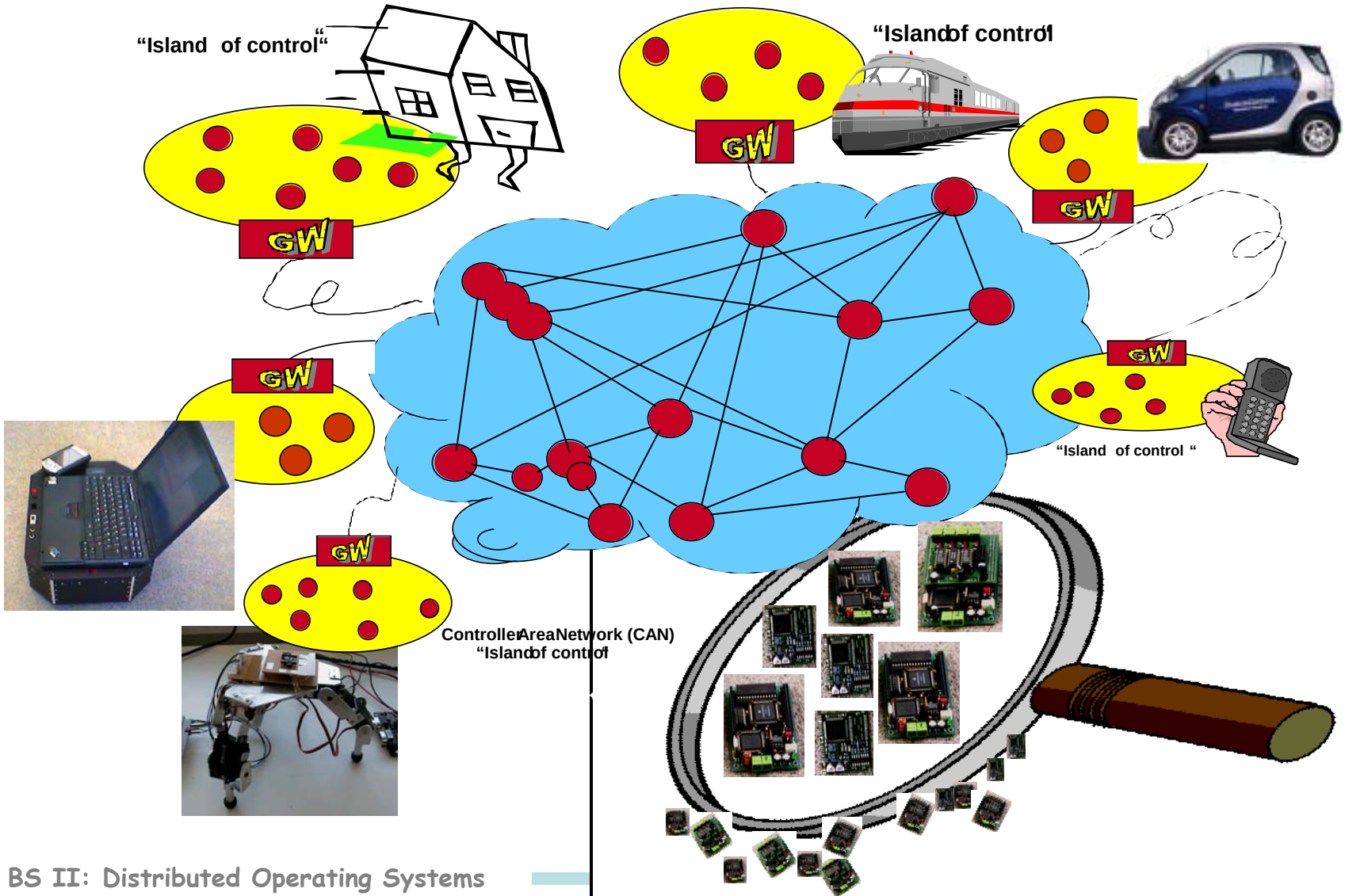


drastically increasing complexity



- 11.136 electrical parts
- 61 ECUs
- Optical bus for information and entertainment
- Sub networks based on proprietary serial bus
- 35 ECUs connected to 3 CAN-Busses
- 2500 signals in 250 CAN messges

Example: A networked physical world



Problems and desirable properties

- general problems: concurrency, faults
- more problems: heterogeneity, openness, scalability
- desirable properties:

A distributed system should be programmable like a local, centralized computer (→ see Tanenbaum).

???

- Support to deal with the above problems in an application specific way on an adequate level of abstraction. → Find a better definition!

Transparencies:

- Access transparency
- Location transparency
- Concurrency transparency
- Replication tranparency
- Fault transparency
- Mobility transparancy
- Scalability transparancy

Types of distributed operating systems

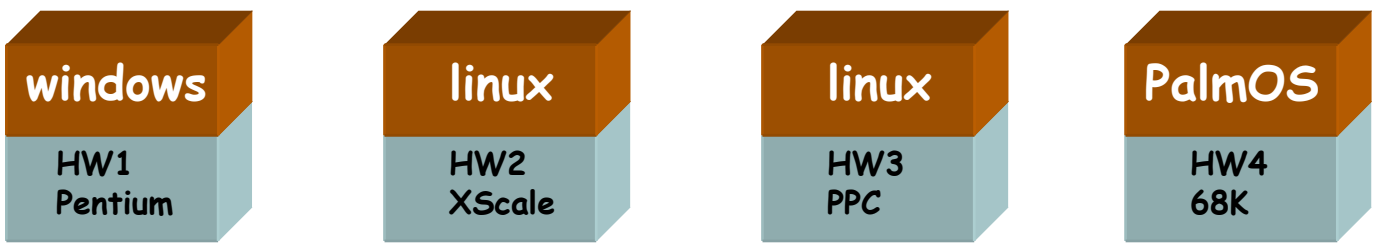
Network operating systems: basic support for communication between homogeneous local OS, individual computing nodes are visible
Examples: Windows NT, UNIX, Linux, distributed file systems (NFS)

Distributed operating systems: transparent IPC mechanism, no difference between local and remote interaction, unified name space, integrated file system, unified unser admin and protection/security mechanisms.
Examples: Amoeba, Emerald, Chorus, Clouds

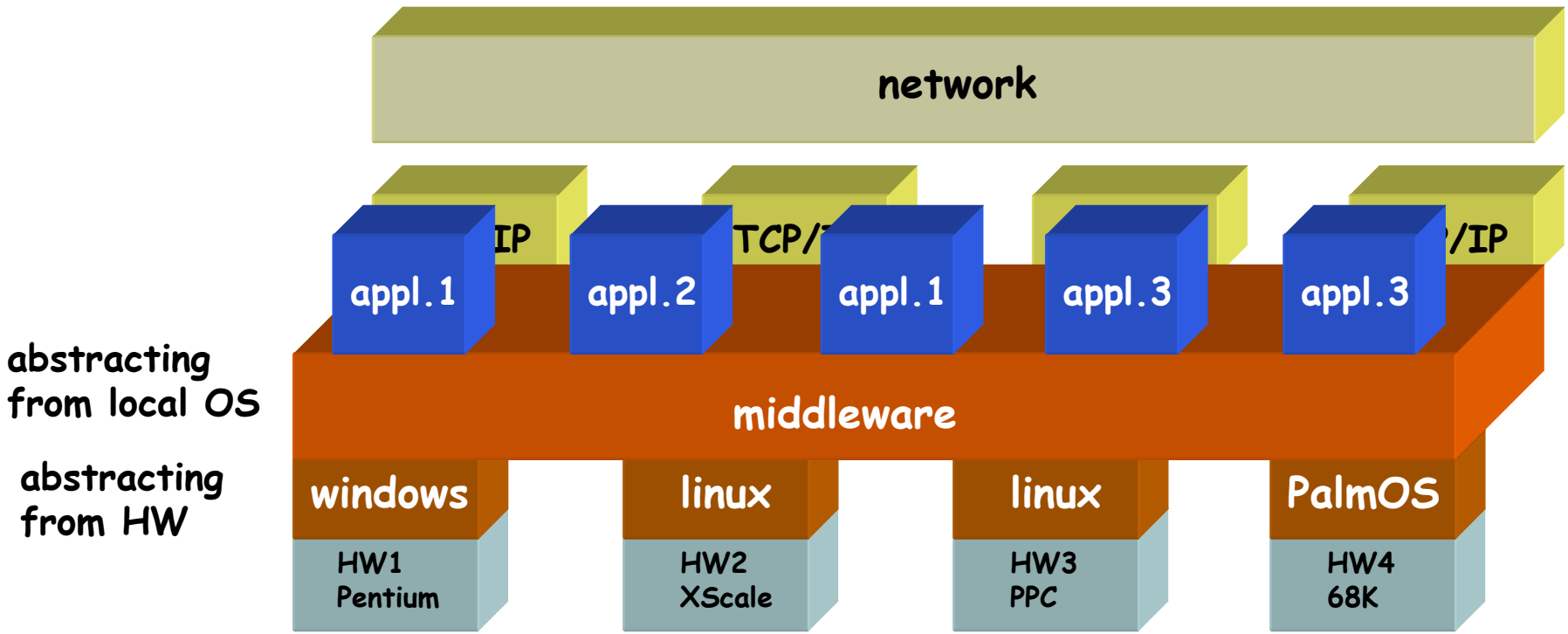
Middleware: builds on top of heterogeneous local OS, provides unified programming model, communication and cooperation mechanisms, maintains autonomy of local nodes but supports transparent access to shared resources.
Examples: CORBA, Java RMI, .NET, DCE

Distributed system architecture

abstracting from HW



Distributed system architecture

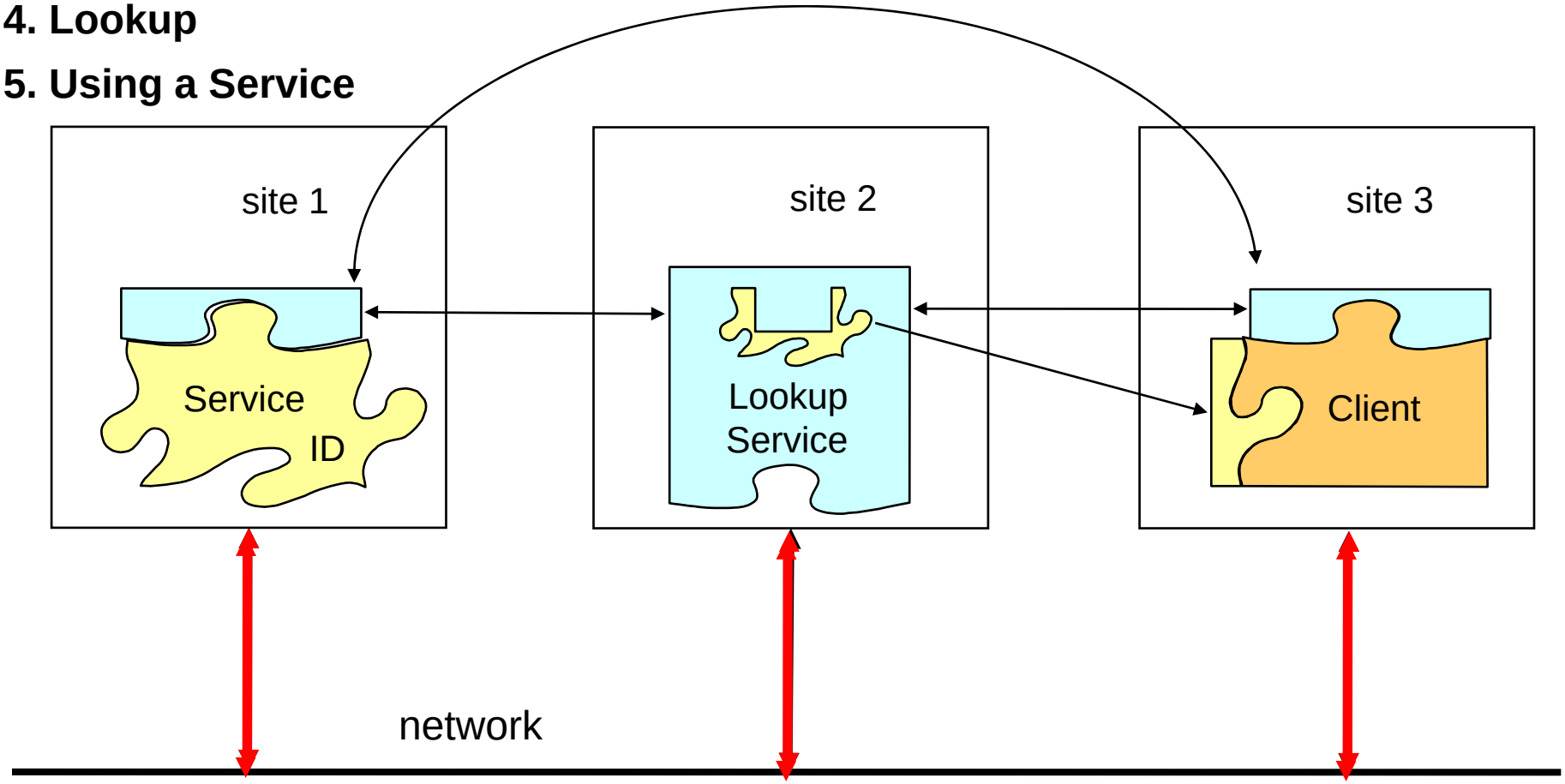


Types of middleware

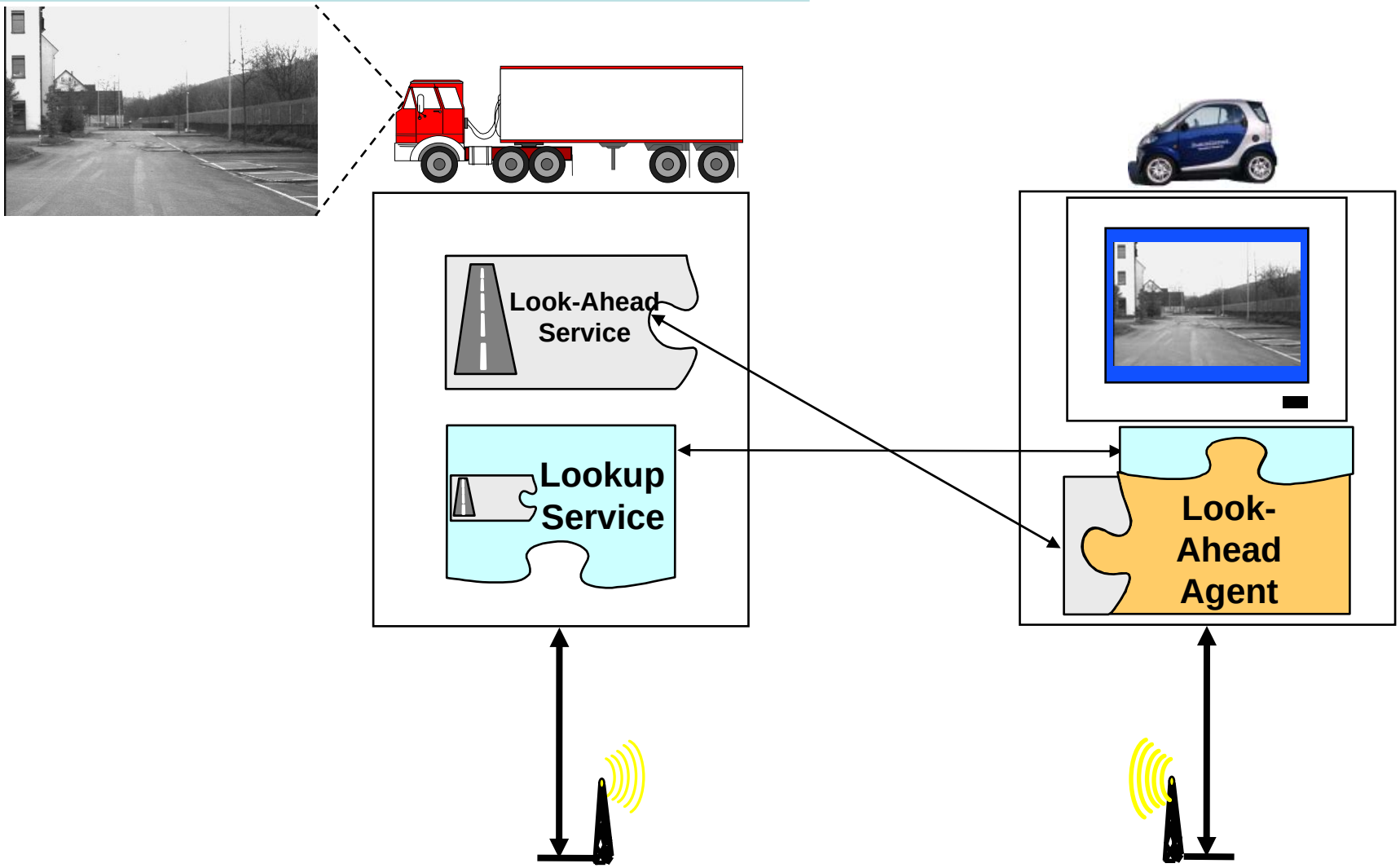
Document-based middleware: model: distributed data	Documents which contain (hyper-)links to other documents. Examples: World-Wide-Web
File-based middleware: model: distributed data	Transparent access to remote files. Examples: Andrew File System, NFS
Object-based middleware: model: distrib. functions	Transparent invocation of remote objects. Examples: CORBA, DCOM(windows only)
Service-based middleware: model: distrib. functions	Discovery and use of remote services. Examples: Jini, JXTA, UPnP
Coordination-based middleware: model: distrib. functions	Coordination through a shared information space. Examples: Linda, Java Spaces

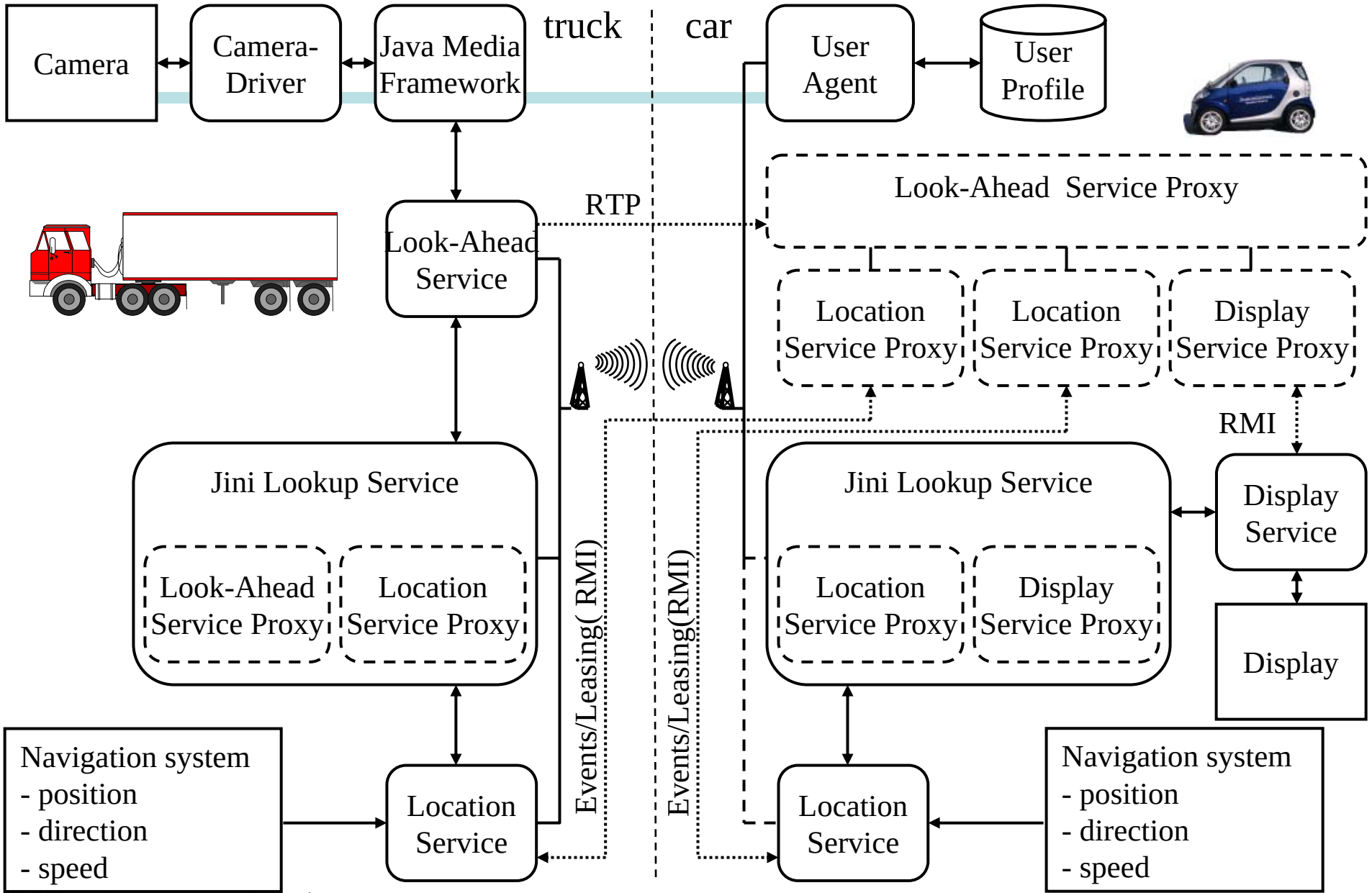
1. Discovery - Finding Lookup Services
2. Join - Service Registration

3. Discovery - Finding Lookup Services
4. Lookup
5. Using a Service



The Demo Scenario: A proactive car-to-car service




Camera
Camera-Driver
Java Media Framework
truck
car
User Agent
User Profile
RTP
Look-Ahead Service
Look-Ahead Service Proxy
Location Service Proxy
Location Service Proxy
Display Service Proxy
RMI
Jini Lookup Service
Look-Ahead Service Proxy
Location Service Proxy
Events/Leasing(RMI)
Events/Leasing(RMI)
Jini Lookup Service
Location Service Proxy
Display Service Proxy
Display Service
Display
Navigation system
- position
- direction
- speed
Location Service
Location Service
Navigation system
- position
- direction
- speed