

Middleware and Distributed Systems

Introduction

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What is Middleware ?

- Bauer et al. Software Engineering, Report on a conference sponsored by the NATO SCIENCE COMMITTEE Garmisch, Germany, 7th to 11th October 1968

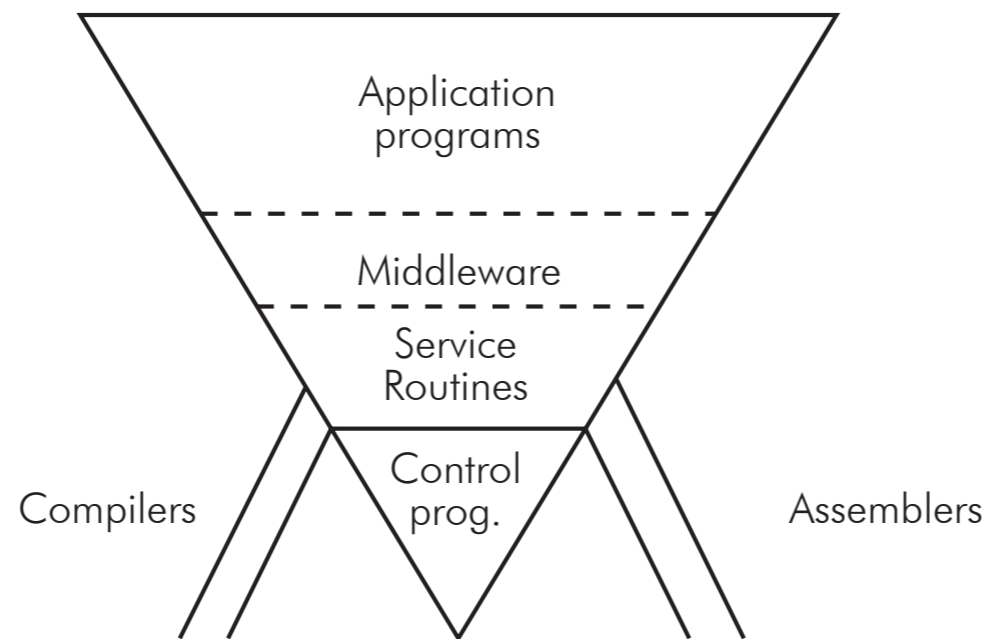


Figure 3. d'Agapeyeff's Inverted Pyramid

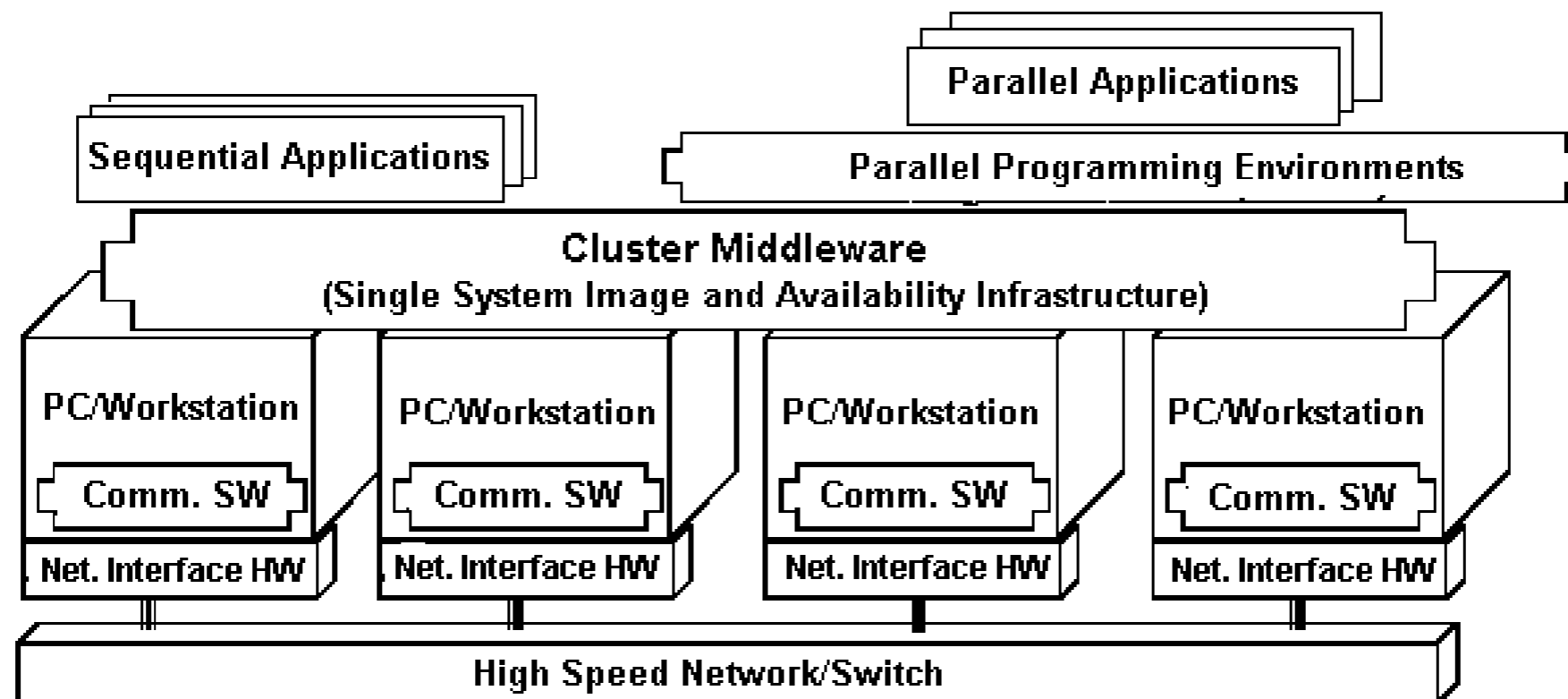
- *d'Agapeyeff*: "The point about this pyramid is that it is terribly sensitive to change in the underlying software such that the new version does not contain the old as a subset. It becomes very expensive to maintain these systems and to extend them while keeping them live."

What is Middleware? (2)

- Things that have been called "middleware" in the past:
 - Implementations of RPC protocols (DCOM, IONA Orbix)
 - Messaging Systems (MPI, MQSeries, Tibco Rendezvous)
 - Database systems (Oracle, PostgreSQL)
 - Run-time systems for programming languages (JVM, .NET Framework)
 - Application Servers (IBM WebSphere, IIS)
 - Transaction Processing Monitors (BEA Tuxedo, Microsoft MTS)
 - Specifications describing these systems
- Focus of this lecture: middleware for communications

Distributed Systems

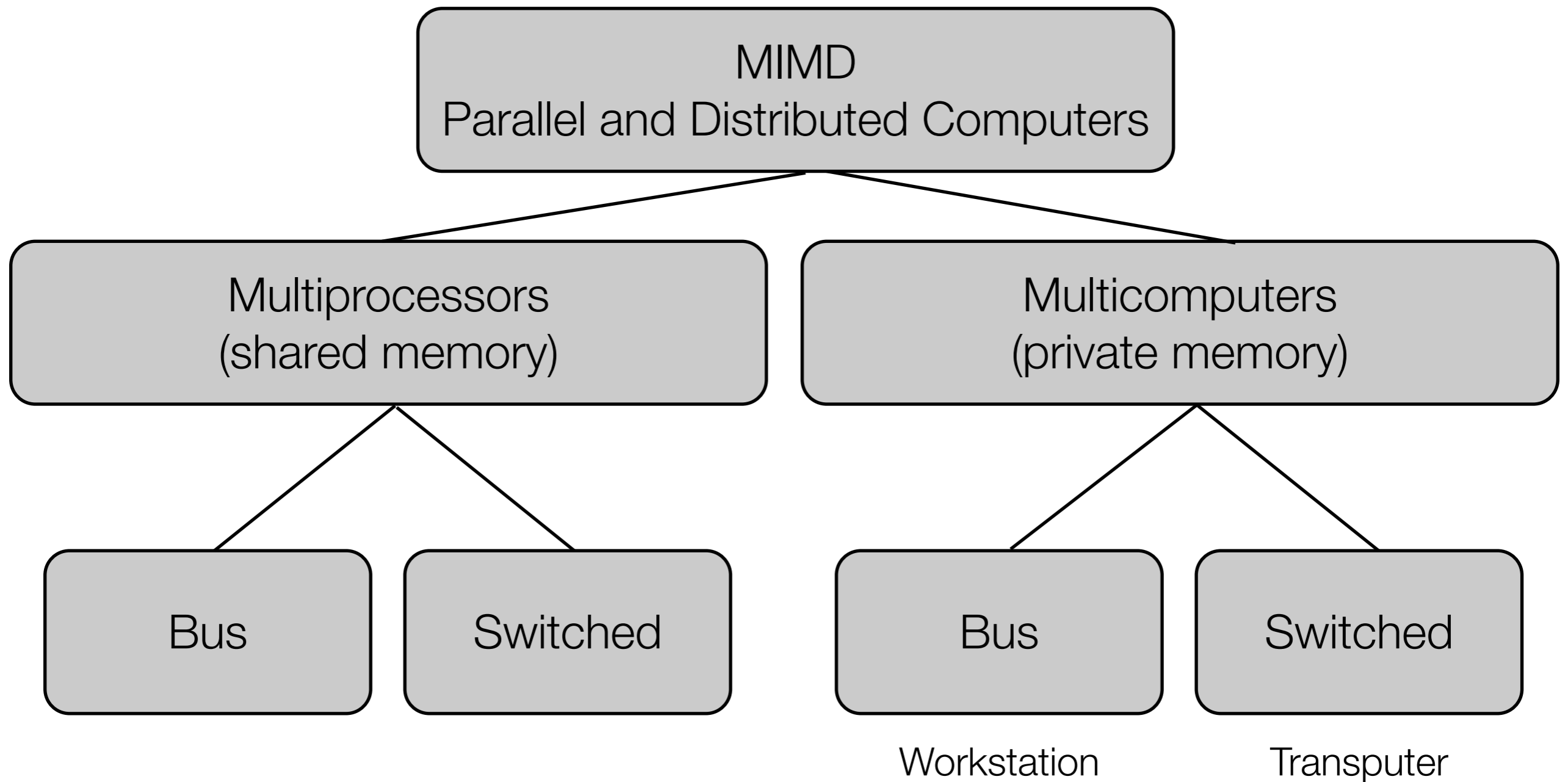
“A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable.”



Parallel vs. Distributed Systems

- Flynn 1966: SISD, MISD, SIMD, MIMD
 - MIMD is not distributed computing
 - Network speed
 - Multicomputer concept
- Data exchange for SIMD and MIMD
 - Shared memory, message passing
 - Interconnection network design

Taxonomy (Tanenbaum)

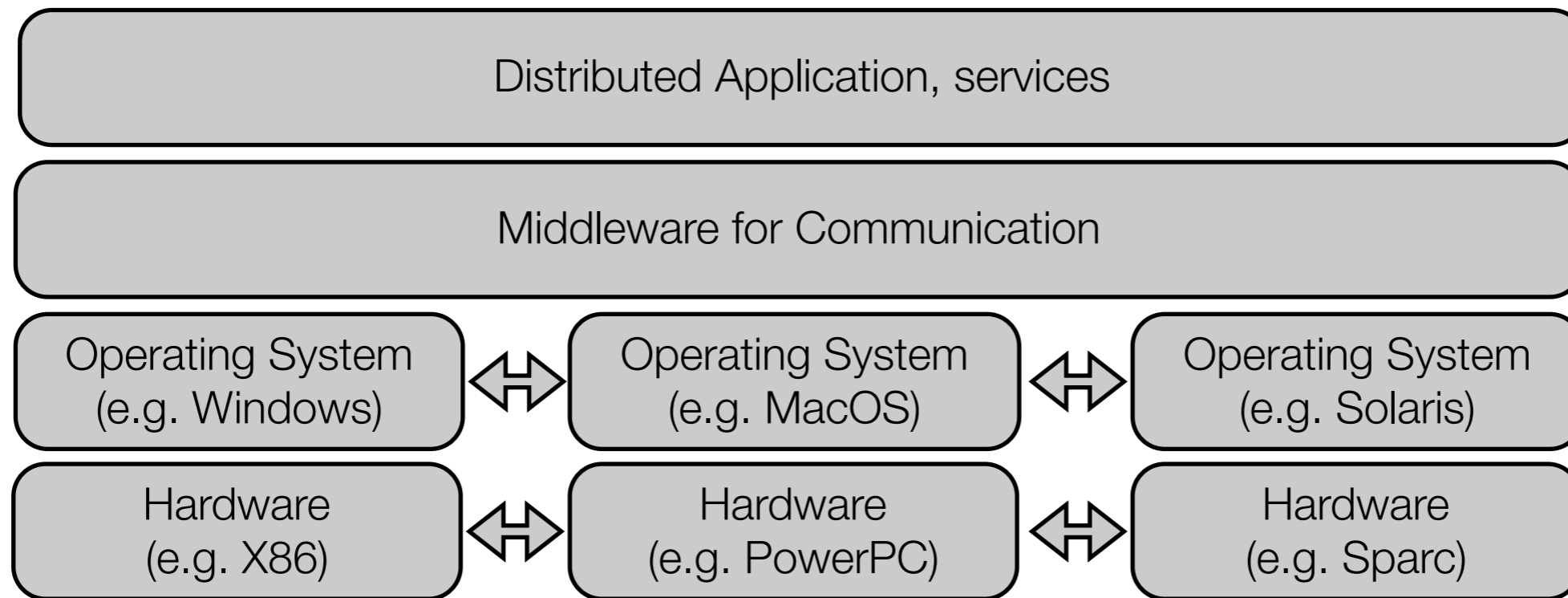


Distributed System: Definitions

- Tanenbaum (Distributed Operating Systems): A distributed system is a collection of independent computers that appear to the users of the system as a single computer.
 - example: network of workstations where a command started on one machine may arbitrarily run on any machine
- Coulouris et al.: [system] in which hardware or software components located at networked computers communicate and coordinate their actions only by passing messages.
 - Consequences: concurrency, no global clock, independent failures
 - Challenges: heterogeneity, openness, security, scalability, failure handling, concurrency, need for transparency

Our View of Distributed System

- Distributed system: Utilize ‘services’ on other nodes
 - Number of independent computing nodes, connected through network
 - Computing node
 - One or multiple processors with one or multiple layers of memory
 - Number of external devices
 - Distributed system can contain heterogeneous resources
- Parallel systems: Compute one parallel application
 - Typically communication through shared memory



Distributed application

- Number of programs or program parts, which are executed concurrently on one or more nodes
 - Different names: Tasks (Ada), Processes (Hermes, NIL), Objects (Corba)
 - Historically names as 'processes'
- Additional problems in contrast to sequential applications
 - Synchronization between processes
 - Communication between processes
 - Consideration of partial failures
- Middleware supports distributed application development
 - Inter-process communication and synchronization mechanisms

Lecture Objective

- Focus on middleware in distributed systems
- Ability to develop own middleware components
- Deep understanding of principles underlying distributed systems
- Lecture metadata
 - 4 SWS, 6 credit points, registration until 13.11.2009
 - Oral exam, 4 successful exercise presentations as precondition

Lab Exercise

- Development of an own middleware stack
- Given wire format and interface definition language
- New exercises every three weeks on Mondays
 - First exercise: TWP3 Echo protocol
 - To be presented by some groups in the lecture (14.11., 12.12., 16.1., 6.2.), some in consultations
 - 1-2 students per group

Topics

- Inter-process communication
 - Interface description, remote procedure call, message-oriented middleware, stream communication
 - OMG IDL, ASN.1, WSDL, ..., IIOP, XDR, ...
- Design patterns and algorithms in distributed systems
 - Broker, Proxy, Adapter, ..., Life Cycle, Identification and State, ...
- Naming services and registries
- Distributed systems architecture models
- Real-time middleware

Topics (contd.)

- Security in distributed systems
 - Kerberos, PKI
- Clock synchronization and coordination of distributed activities
- P2P systems
- Transactions and distributed shared memory

Topics not discussed

- Language Mappings
- Distributed File Systems
- Distributed Operating Systems
- Mobile Computing

TWP - The Wire Protocol

- Simple messaging protocol
- Support for few data types: integers, strings, binary, structs, arrays
- Extensible
- Protocols defined in TDL

- **Beispiel:**

```
protocol Echo = id 2 {  
    message Request = 0 {  
        string text;  
    }  
  
    message Reply = 1 {  
        string text;  
        int number_of_letters;  
    }  
}
```