Poseidon House
Castle Park
Cambridge CB3 0RD
United Kingdom

TELEPHONE: **Cambridge (01223) 515010**
INTERNATIONAL: **+44 1223 515010**
FAX: **+44 1223 359779**
E-MAIL: **apm@ansa.co.uk**

Training

ANSAwise - Networking in Distributed Systems

Chris Mayers

Abstract

This module of the ANSAwise training course programme describes and demarcates the role of networking in a distributed system. The approach is based on the OSI Reference Model, and identifies its uses and limitations.

The thrust is that distributed systems architects build on the network architecture, and so must have a clear grasp of key networking issues.

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Briefing Note

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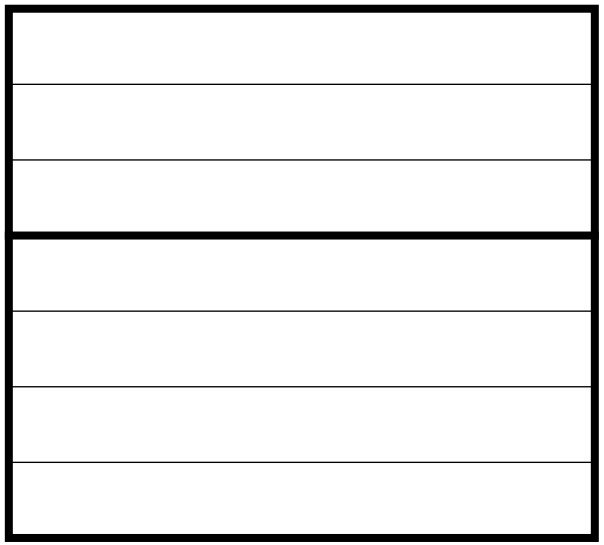
Networking in Distributed Systems

- Principles and Functions



7 Application

6 Presentation

5 Session

4 Transport

3 Network

2 Link

1 Physical

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In this session

- *Review the basic ideas of networking*
- *Show which of these ideas apply to distributed systems*
- *Explore relevant standards*

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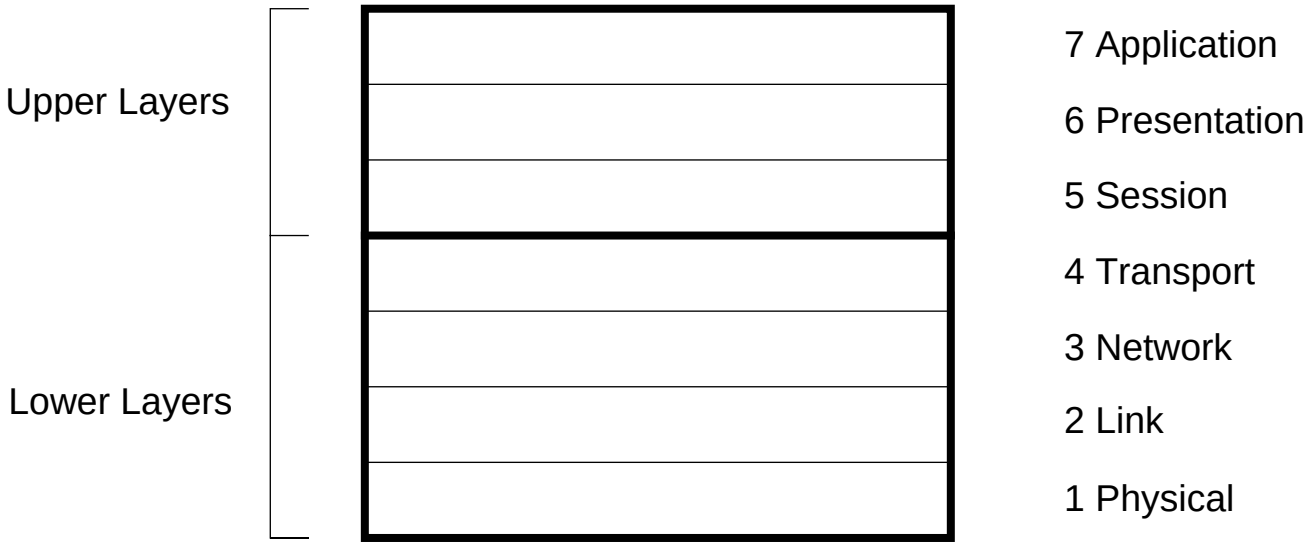
The OSI Reference Model (est. 1978)

- ***Standardized as ISO 7498, ITU-T X.200***



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Principles of the OSI Reference Model - Simplicity

- ***Keep the structure simple; keep the number of layers small***

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Principles of the OSI Reference Model - Boundaries

- *Minimize the interaction across boundaries*
- *Choose boundaries based on successful past experience*
- *Match architectural boundaries to possible physical boundaries*

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Principles of the OSI Reference Model - Layering

- *Collect similar functions within a layer*
- *Place dissimilar functions in different layers*
- *Create different layers for different levels of abstraction*

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Principles of the OSI Reference Model - Independence

- *Do not allow changes to functions or protocols to affect other layers*
- *Do not allow functions or protocols to depend on a specific implementation*
- *Only allow a layer to interface with adjacent layers*

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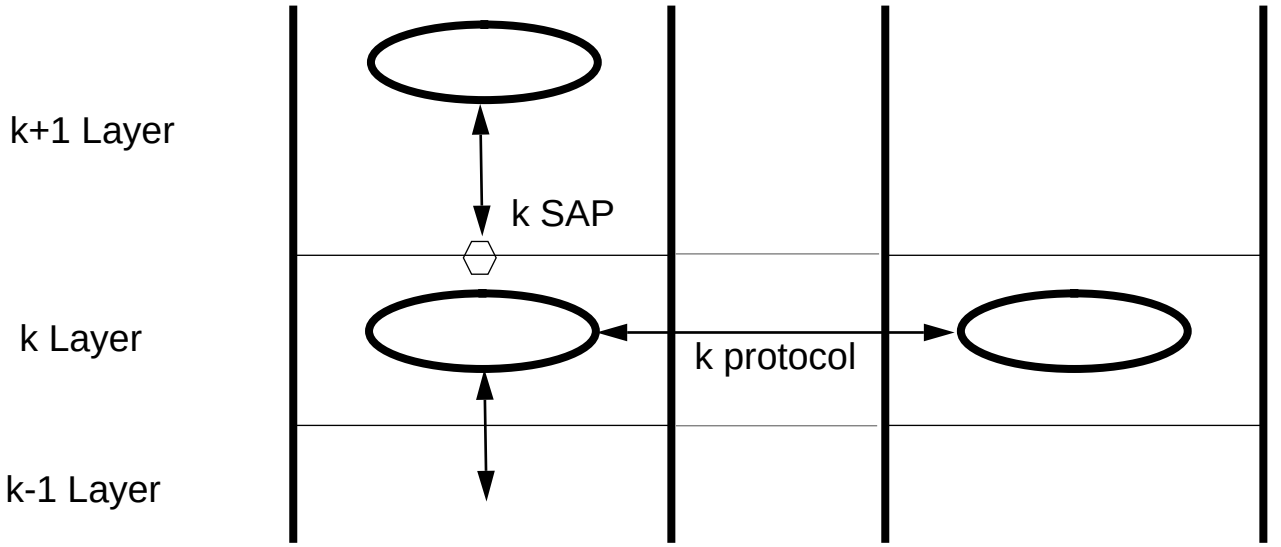
OSI Layer Entities

- ***Entities interface via Service Access points and protocols***



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Purposes of the layers

- *Application: common application service elements*
- *Presentation: data syntax*
- *Session: connection management, concurrency management*
- *Transport: fragmentation and reassembly*
- *Network: routing*
- *Data link: reliable point-to-point communications, error correction*
- *Physical: interface to the transmission medium*

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Influence of the OSI Reference Model

- ***The influence of the OSI Reference Model has been profound***
  - **the *principles* have withstood the test of time**
  - **it has been a framework for shared understanding...**
  - **...all network architectures refer to this model**
- ***You can apply the OSI Reference Model without OSI protocols***
  - **the OSI Reference Model does not imply OSI protocols**
  - **other protocol stacks can match the OSI Reference Model**

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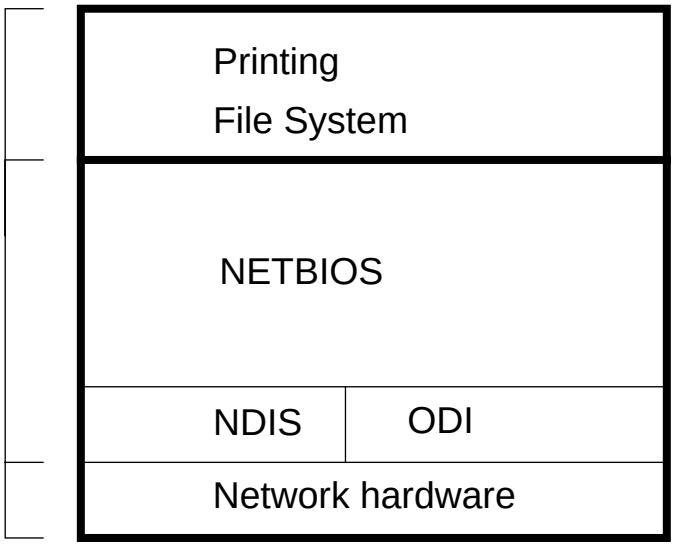
SMB Protocol Suite

- ***The protocols are mainly used on LANs***

NB:
Upper Layer
position



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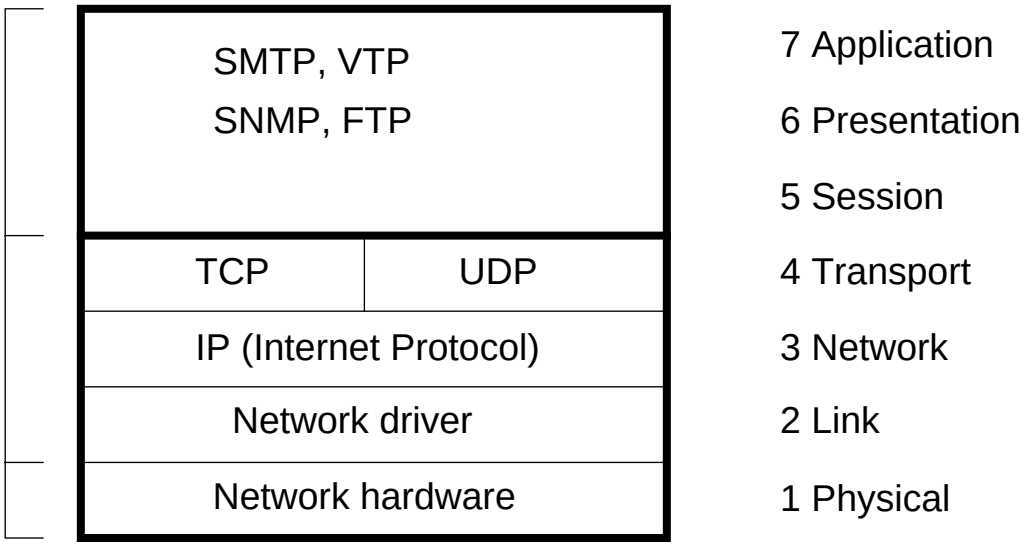
Internet Protocol Suite

- ***The protocols operate over LAN and WAN***



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The success of the Internet Protocol Suite

- *It has been driven by*
  - Timely solutions
  - Low-cost (or even free) implementations for many systems
  - Enthusiastic (and tolerant!) technical community
- *It has been hindered by*
  - Complex installation and configuration
  - Expensive implementations for PC LANs
- *These hindrances are now disappearing*
- *The rapid growth of the Internet will continue this success*

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Is the OSI Reference Model enough?

- ***Distributed systems need more...***
  - **interaction types more complex than peer-to-peer**
  - **object-based applications rather than simple layering**

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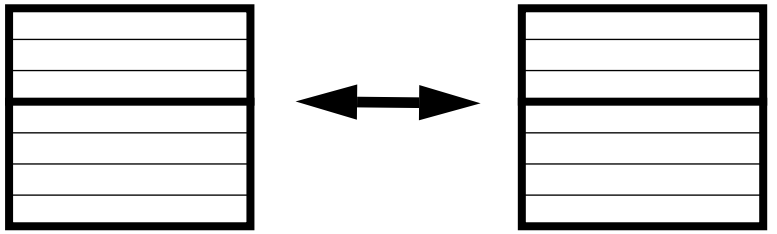
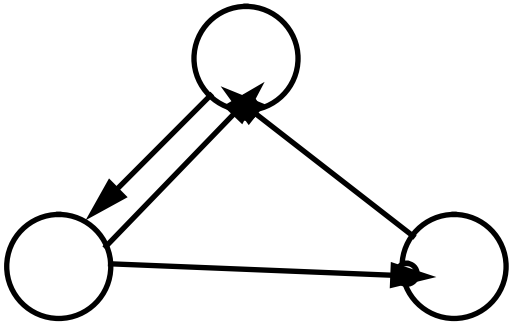
OSI and Distributed Systems views of the world

- ***OSI***



- ***Distributed systems***



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The end-to-end principle

- ***With hindsight, the OSI Reference Model lacked one important principle***
  - **the ‘end-to-end’ principle**
- ***This can be stated as***
  - **“Only add reliability mechanism to a layer if it improves performance”**
- ***Higher layers have to perform error checking anyway***
  - **to provide end-to-end guarantees**

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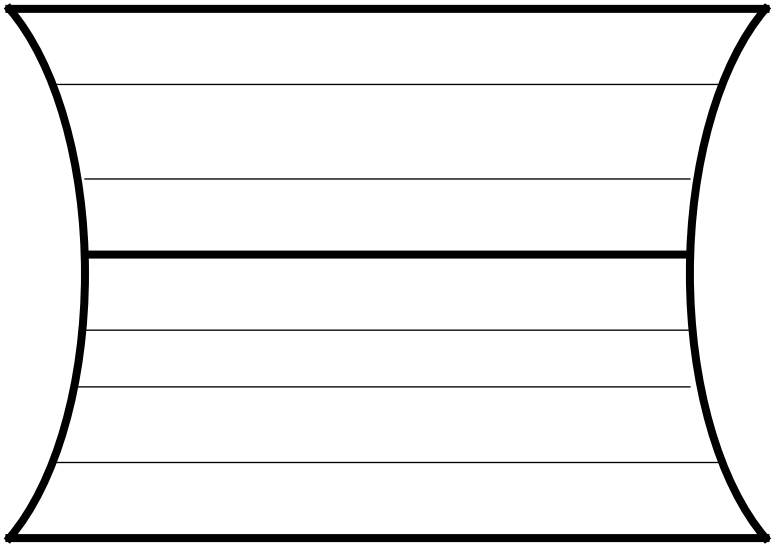
Protocol diversity

- ***We want to exploit maximum diversity in the applications, and in the physical technologies***



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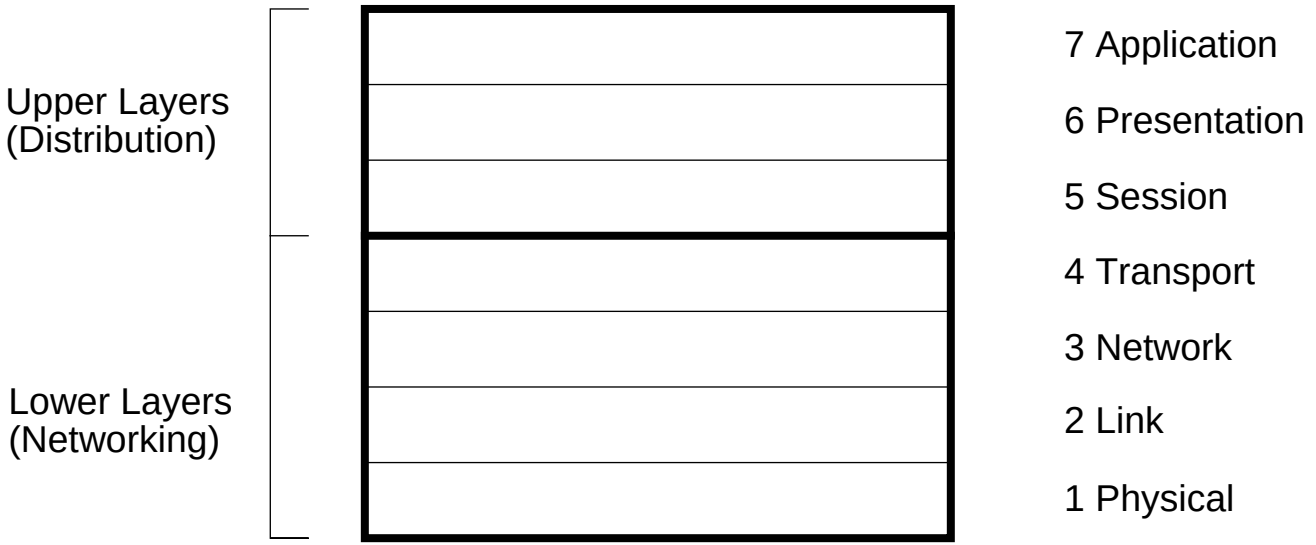
Upper and Lower Layers

- ***As a gross generalization (treat with caution!)***
  - **Distributed systems is concerned with the upper layers**



  - **... the lower layers are the concern of networking**

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Distributed Systems and Networking

- *It is important to understand the lower layers, because*
  - Distributed systems will make specific demands on the lower layers...
  - ... for example, quality of service/performance characteristics
  - ... you must understand how these demands will be met
- *Many of the lower layers concepts are common with the upper layers*
- *Practical understanding also helps*
  - to assemble a complete system
  - to test and debug a complete system
  - when working with networking specialists

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What else is missing?

- *No control over quality-of-service (QoS)*
- *No synchronization capability*
- *No multicast capability*
- *Ease of management*

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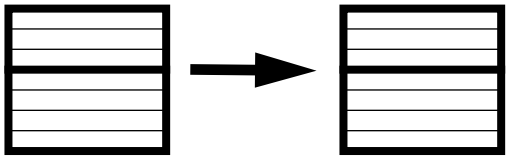
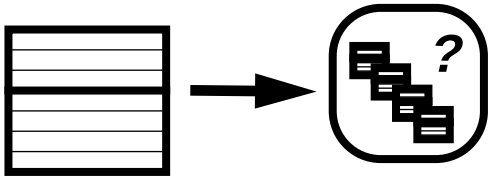
Group communications mechanisms

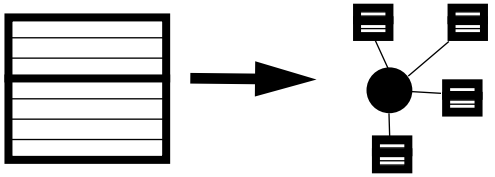
- ***Unicast***



- ***Broadcast***



- ***Multicast***



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Group communications mechanisms

- ***Unicast (point-to-point)***
  - **simple, but only suitable for 1-1 communications**
- ***Broadcast***
  - **Broadcast protocols don't scale to large networks**
  - **The scope of a broadcast protocol is usually physical (e.g. an Ethernet LAN segment; this is unrelated to logical distributed systems needs**
- ***Multicast (point-to-multipoint)***
  - **promising, but requires a sophisticated mechanism to manage the membership of the multicast group**

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Connectionless and connection-orientated

- *Connectionless protocols are suitable for call-response interactions*
- *Connection-orientated protocols are needed for continuous media*
  - for example, video, audio
- *A connectionless k-protocol can be layered over a connection-orientated k-1 protocol (and vice-versa)*
- *Newer networks have faster call setup*
  - encouraging connection-orientated use

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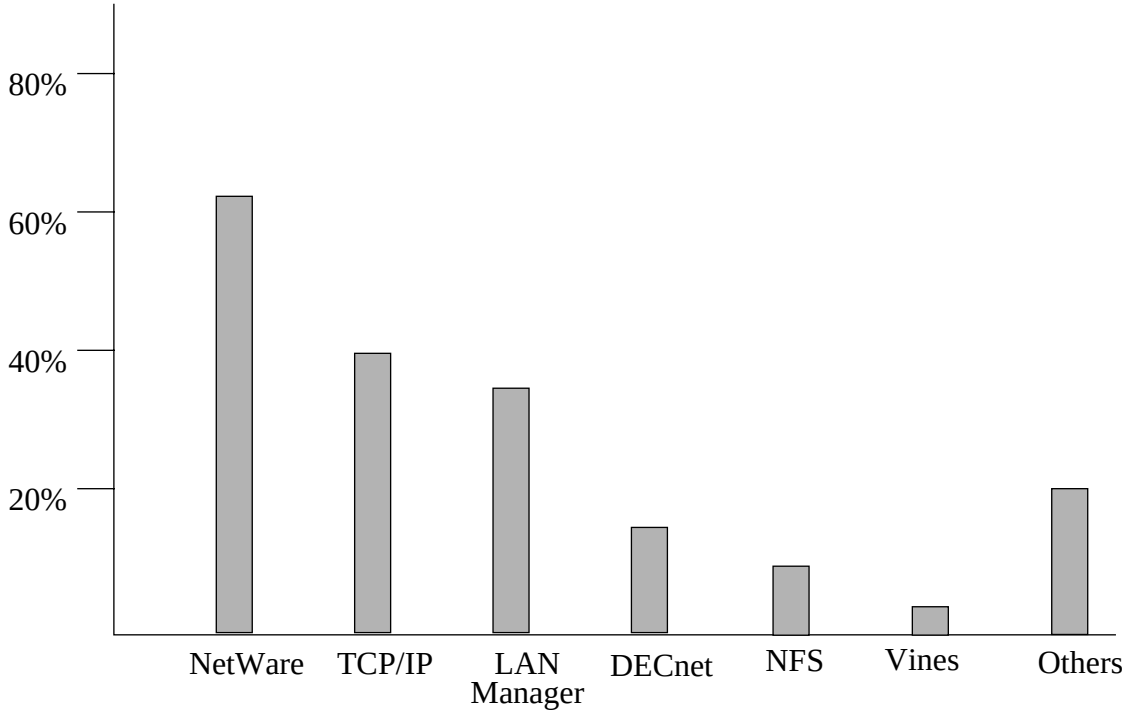
PC LAN protocols in practice

- ***PC networks in Times Top 1000 Companies***



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LAN protocol diversity - an example

- *Hughes Aircraft Corp. have 51,000 staff*
- *Hughes Enterprise Network Architecture has to cope with*
  - 50,000 ports
  - 860 hubs
  - 9 protocols (NetWare IPX, TCP/IP, Vines IP, Appletalk, DECnet, LAT, NETBIOS, SNA, OSI TP)
- *They aim to get down to 6 protocols*
- *They'd like to get down to 2 protocols*
- *They think it will take until the year 2000*

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LAN protocol summary

- *This is a legacy problem...*
  - it makes technical support difficult (particularly routing and bridging)
  - it slows down the use of new technologies
- *...But it is one that the network architects must solve*

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Networking challenges - protocols

- *Provide new and updated protocols for*
  - scaleable performance
  - dependability (fault tolerance)
  - predictability (real-time communications)
  - mobility
  - ubiquity
  - security (highly controversial!)

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Networking challenges - new technology

- ***Develop new hardware technologies***
  - **wireless (radio and infra-red)**
  - **very low cost networks**
  - **very high speed networks (broadband)**

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Corresponding challenges for distributed systems

- *Distributed systems depend on these for new applications*
  - multimedia
  - telepresence
  - UPT (universal personal telecommunications)
- *The challenges will affect*
  - the engineering of distributed systems
  - the design of distributed applications
  - the management of both distributed systems and distributed applications

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Summary

- ***Networking and distributed systems issues are separate***
  - **but strongly related**
- ***Networks have an architectural model***
  - **the OSI Reference Model**
- ***Networks by-and-large use non-OSI protocols***
- ***To find out more:***
  - ***Computer Networks*, Andrew S. Tanenbaum (Prentice-Hall)**
  - ***Distributed Computing: A Practical Synthesis*, by Amjad Umar (Prentice Hall)**
  - ***Internetworking with TCP/IP, Volume I*: Douglas E. Comer (Prentice-Hall, 1991)**

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Networking and Distributed Systems - a note

- ***Tanenbaum says:***
  "There is confusion in the literature between a computer network and a distributed system. The key distinction is that in a distributed system the existence of multiple [...] computers is not visible [...]"

- ***Indeed there is confusion!***

  - **Tanenbaum describes what we would call a distributed *operating* system**

  - **In a true distributed system, the existence of multiple computers may or may not be transparent**

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