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Training

ANSAwise - Exploiting High Performance Networks

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Abstract

There are many wide-area-networking technologies available. Organizations may be unclear how the selection of such a networking technology will influence their distributed systems strategy.

This module of the ANSAwise training programme discusses the characteristics of current and future wide-area networking technologies, and their impact on distributed systems. It also discusses the quality-of-service needs of distributed systems, and current work in communications quality-of-service

[Note: this is not an ATM primer!]

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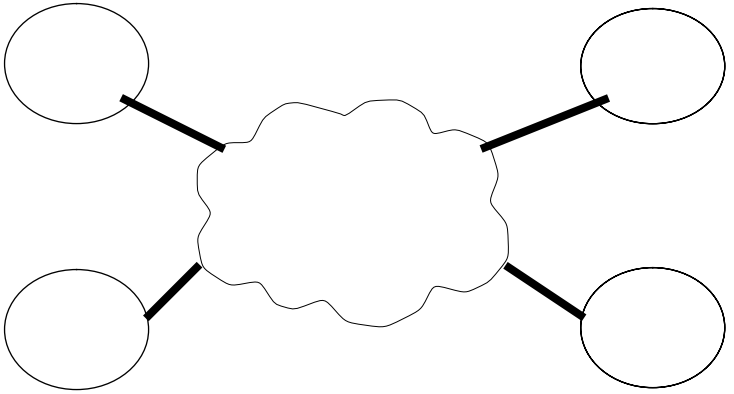
Briefing Note

Distribution:
Supersedes:
Superseded by:

Exploiting High Performance Networks

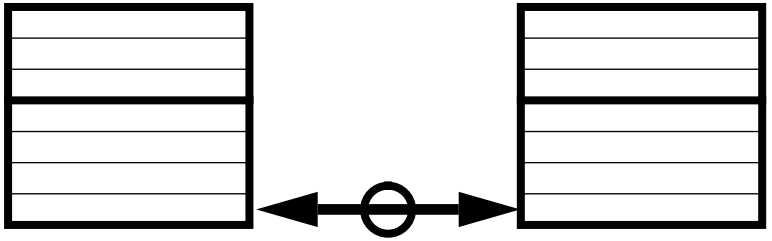


In this session

- *Examine today's network assumptions*
- *Examine relevant features of future network technology*
- *Show how distributed systems can exploit high-performance networks*
- *Explore quality-of-service in high-performance networks*

Repeaters

- *Repeaters connect at the physical layer*

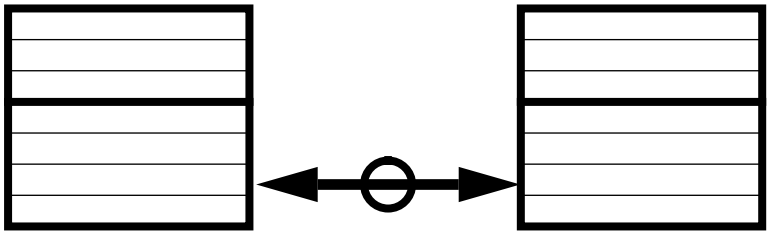


- *... for LAN extension (overcoming physical limits)*

- *Transparent to all network/link layer protocols*

Bridges

- ***Bridges connect at the link layer***

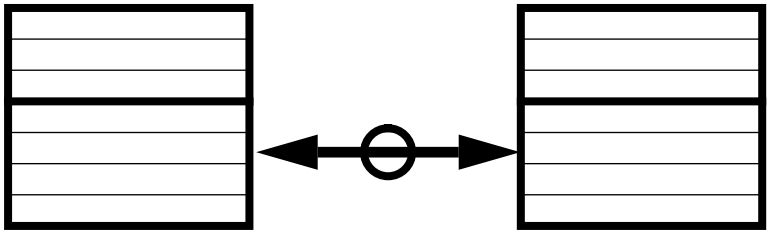


  - **... for LAN interconnection and segmentation**
  - **... and physical layer conversion**

- ***Transparent to all network protocols***

Routers

- ***Routers connect at the network layer***



  - **... for LAN interconnection and segmentation**

- ***Routers must understand network protocols***

  - **in particular, their addressing schemes**

- ***Routers must understand network topology***

User take-up of WAN services

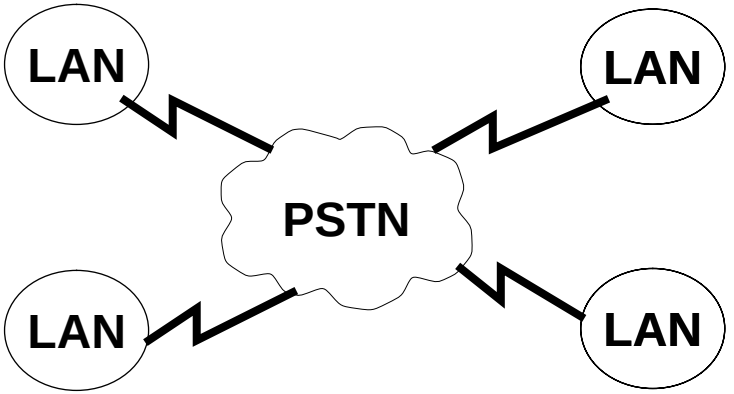
	In use	To be installed
Analogue leased lines	65.6	6.4
Digital leased lines	64.6	21.7
Packet switching	50.5	15.4
T1/E1 1.5M/2M leased lines	44.5	21.4
Digital leased lines 56/64K	43.1	11.1
Frame relay	8.7	25.1
SMDS	4.0	10.0
ATM/cell relay	2.7	34.0

Source: Datapro 1993/1995 International Networking Survey

Some networking options for LAN interconnect

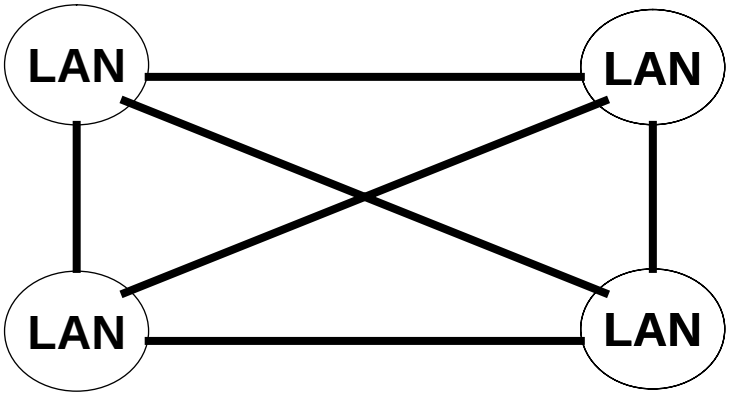
- *Dial-up*
- *Leased line*
- *T1/E1 Mux*
- *X.25*
- *Frame relay*

Dial-up



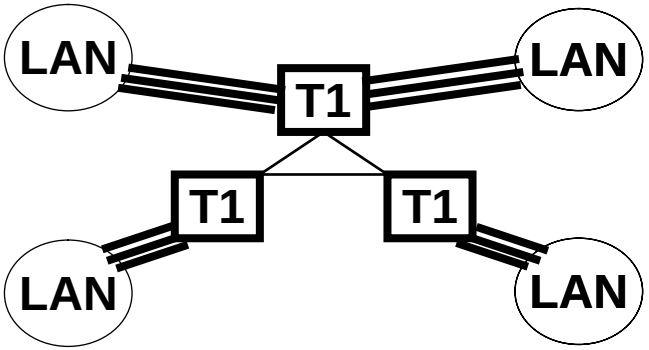
Switched	Yes	
Call Set-up	Slow	10 seconds (or longer with dial-back)
Transmission	Slow	Typically 14.4 Kbit/sec
Cost-Effective for Bursty Traffic	Yes	Low speeds only
Protocol Insensitive	No	
Alternate routing	No	
Network Management by customer	Limited	

Leased line

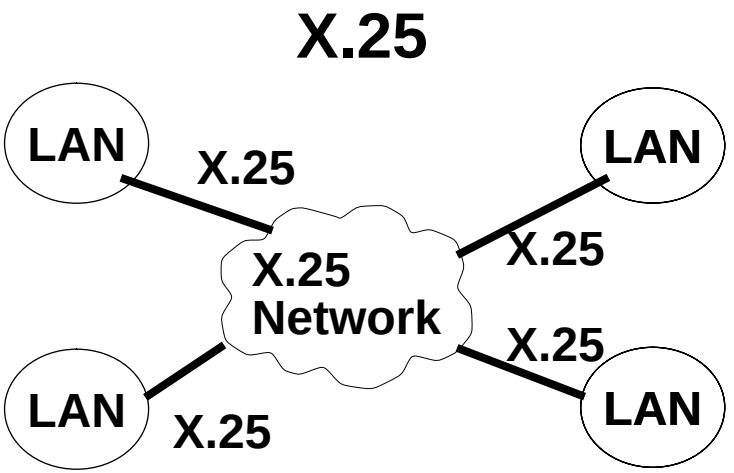


Switched	No	
Call Set-up	Fast	
Transmission	Slow to Fast	
Cost-Effective for Bursty Traffic	No	
Protocol Insensitive	Yes	
Alternate Routing	No	
Network Management by customer	Limited	

T1/E1 Mux

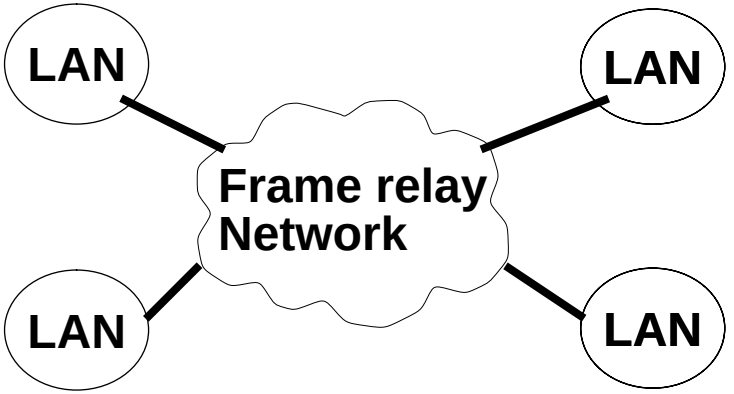


Switched	No	
Call Set-up	Fast	
Transmission	Slow to Fast	
Cost-Effective for Bursty Traffic	No	
Protocol Insensitive	Yes	
Alternate Routing	Yes	
Network Management by customer	Yes	



Switched	Yes	
Call Set-up	Fast	Typically less than 1 second
Transmission	Slow to Medium	Typically 19.2 Kbit/second
Cost-Effective for Bursty Traffic	Yes	
Protocol Insensitive	No	
Alternate Routing	Yes	
Network Management by customer	Yes	

Frame relay



Switched	Yes	
Call Set-up	Fast	
Transmission	Fast	Typically 64-256 Kbit/sec
Cost-Effective for Bursty Traffic	Yes	
Protocol Insensitive	Yes	
Alternate Routing	Yes	
Network Management by customer	Yes	

Why did frame relay evolve from X.25?

- *The world has changed since X.25 was introduced*
  - workstations and PCs are the endpoints, not dumb terminals
  - the network transmission is much more reliable
  - networks are tunnelling other traffic
- *We now require fast switching/low latency as well as high bandwidth*

Frames and cells

- ***Frames are variable-length***
  - **can hog the network**
  - **more complex to implement**
  - **spread the overhead of large transmissions**
- ***Cells are fixed-length***
  - **tend to be fair**
  - **easier to implement - particularly in hardware**
  - **any overhead hurts**
  - **re-assembly is a nuisance**
- ***Frames suit bulk data (file transfer); cells suit RPC***

Cost of channels versus cost of switches

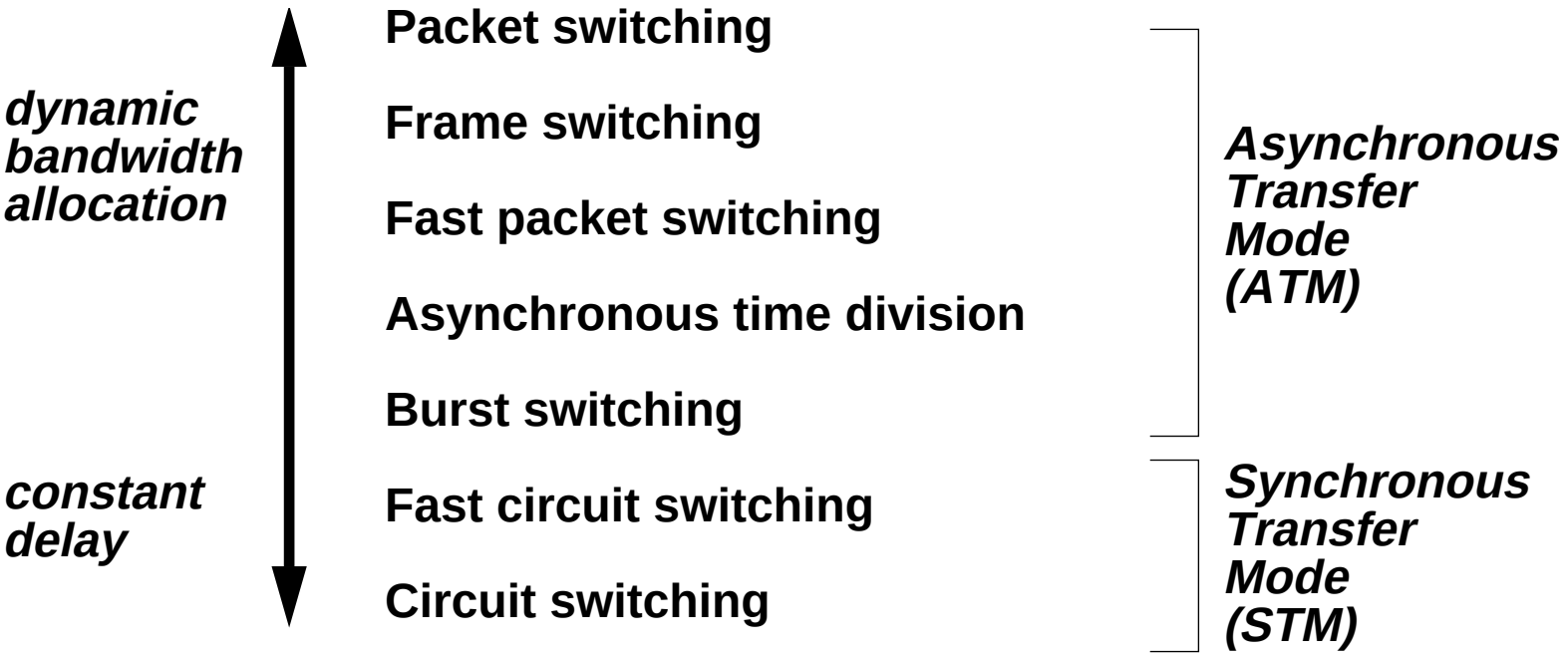
- *Early days of communications: channels were expensive*
  - low-paid human operators!
- *Mid-20th-century: switches were expensive*
  - circuit switching introduced
- *1970s: channels were expensive*
  - VLSI promoted packet switching
- *1980s/90s: switches are expensive*
  - fibre-optics

New demands on networks

- *Multi-service/Multi-media (voice and non-voice together)*
  - constant bit-rate (voice, entertainment video)
  - variable bit-rate (business video)
  - available bit-rate (bursty data)
- *Connection-oriented and connectionless data service*
- *Global interconnection*

Packet switching and circuit switching

- *ATM (cell relay) embraces many modes*



Distributed systems functions supported by ATM

- ***Multimedia capability***
  - **in the same network**
- ***Multicast support***

Distributed systems needs met by ATM

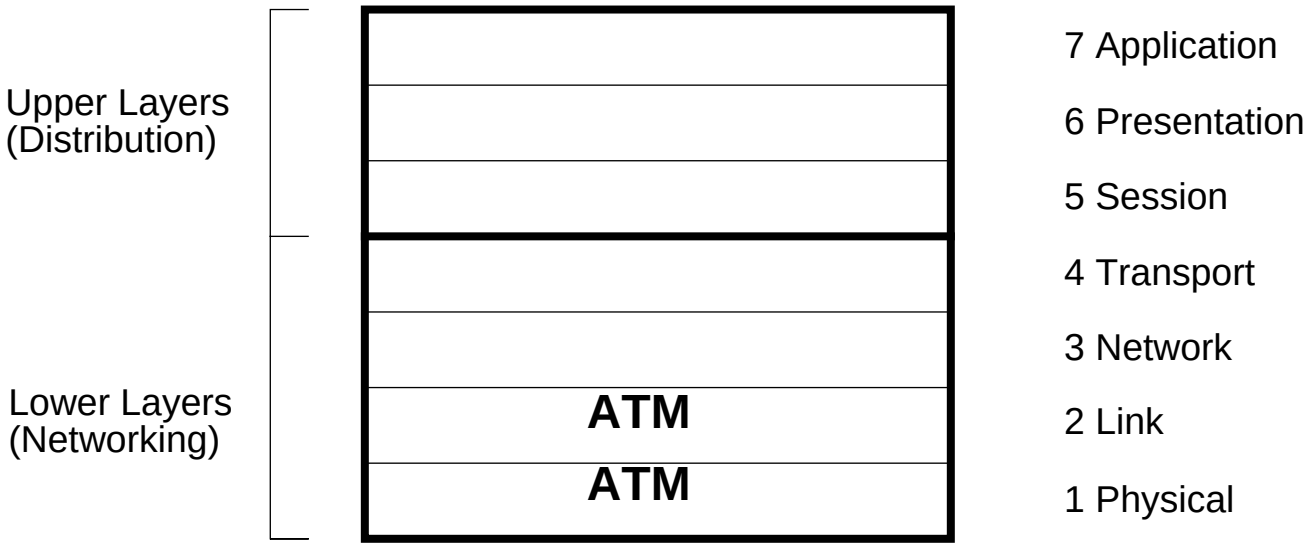
- *Scalable communications*
  - from LAN to WAN
- *Quality of service selection*
  - including bandwidth reservation

Quality-of-service selection

- ***Quality-of-service has two aspects***
  - **specifying requirements**
  - **negotiating acceptable alternatives if the original requirements cannot be directly satisfied**
- ***A quality-of-service requirement places constraints on the underlying communications***
  - **it is not part of the computational specification (IDL)**
- ***Services that do require QoS guarantees should not prejudice services that don't***
  - **they should not affect their scaling or performance characteristics**

Weaknesses in networking

- ***ATM will not solve the complete problem...***



- ***... there are weaknesses at higher layers***

Weaknesses in higher layers

- ***Missing functionality***
  - **synchronization**
  - **rate-controlled as well as flow-controlled protocols**
  - **multicast capability**
- ***Inflexible protocol stacks***
- ***Inefficient but widely-used protocols***
- ***Weak QoS concepts and support***

Weaknesses in quality-of-service support

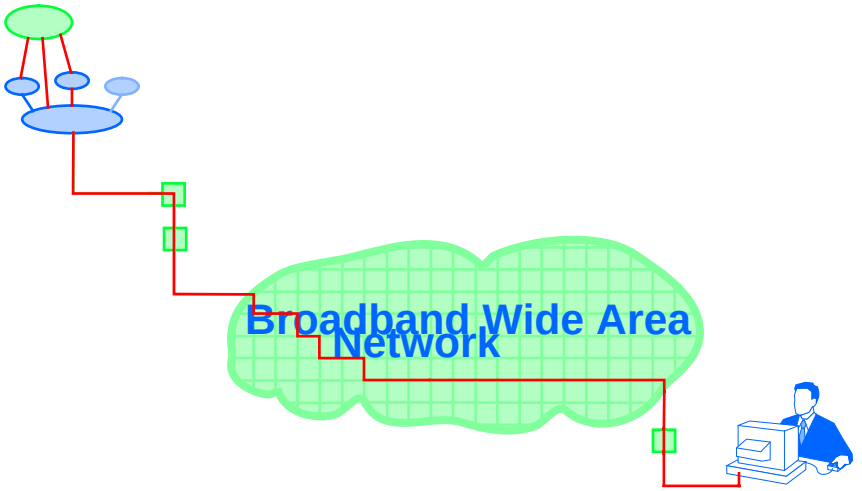
- *The service user has no guarantee that the requested QoS parameters will be respected and maintained by the service provider*
  - the service provider does not monitor them
- *Changes to the requested values are not reported to the service user*
  - ...and renegotiation is not possible during a connection
- *No limit can be specified for the weakest acceptable values*
- *For example, the Internet TCP protocol has a fixed QoS*
  - no parameters can be specified

Tackling the weaknesses

- ***Filling in missing functionality***
  - **being included in new protocols**
- ***Reworking inflexible and inefficient protocol stacks***
  - **new protocols (for example XTP - Xpress Transfer Protocol)...**
  - **... eventually to be implemented in hardware?**
- ***Strengthening weak QoS concepts and support***
  - **being tackled in new protocols**
  - **concepts strengthened in QoS framework standardization**

End-to-end quality-of-service support

- ***End-to-end QoS requires support in not only***



  - **the network**
  - **the end systems**
  - **... but also in the routers that connect them**

Quality-of-service standardization

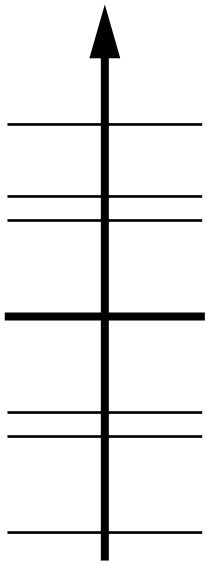
- *The standardization process for communications QoS is under way*
  - in ISO/IEC JTC1/SC21
- *The QoS framework is specifically wider than OSI communications*
  - all communications, not just those based on OSI protocols
- *The QoS framework is tackling the new functionality too*
  - synchronization
  - multicast

Basic quality-of-service concepts

- ***Separation of functional QoS parameters from performance-related QOS parameters...***
- ***...for example***
  - **‘error correction scheme’ is a functional parameter**
  - **‘peak throughput’ is a performance-related parameter**
- ***Connection establishment through a fully-confirmed three-way handshake***
  - **with option negotiation**

Trigger points and operational targets

- *Two limits, multiple thresholds*



Controlled Highest Quality (CHQ) Limit

Upper Threshold(s)

Operating Target

Lower Threshold(s)

Lowest Quality Acceptable (LQA) Limit

Associated actions

- ***Several actions are possible on reaching a threshold or limit***
  - **take no action**
  - **modify the operation of the service provider to attempt to stay within limits**
  - **store a value for future reference (for later enquiry)**
  - **send a signal to the service user**
  - **abort the service**
- ***Limits are part of the levels of agreement***

Levels of agreement

- ***Best efforts***
  - **no assurance**
- ***Compulsory***
  - **communication will be aborted if QoS cannot be achieved**
  - **... for example if a higher-precedence service arrives**
- ***Guaranteed***
  - **guaranteed**
  - **... (subject to force majure - for example, equipment failure)**

Implication for distribution mechanisms

- ***There must be engineering support for QoS***
  - **associated with (but not part of) computational specifications**
- ***It must be possible to express these requirements generally***
  - **consistent with the communications QoS framework**
  - **... but including QoS requirements that apply to local engineering resources as well**
  - **... for example, memory resources**
- ***It must be possible to insert application-specific policies for QoS renegotiation***
  - **for fallback and graceful degradation**

Network design challenges

- *Congestion control and traffic management*
- *Management*
  - including testing, maintenance, and administration
- *Billing*
  - on what basis will customers wish to pay?

Summary

- ***In the short term, network diversity will increase...***
  - **ATM is yet another technology to accommodate**
- ***...in the long term ATM will enable rationalization***
- ***Distributed systems will have to cope with all of these, in combination***
- ***Applications that only need best-effort service can have it today***
  - **those requiring QoS guarantees over WAN will need to wait for standards and infrastructure to stabilize**
- ***Applications requiring new functionality will need new protocols***

More information

- ***For more on this topic***

  - **on QoS in multimedia, see *Integrating Multimedia into the ANSA Architecture* (TR.028)**

  - **on QoS for explicit bindings, see *The ANSA Binding Model* (APM.1314)**