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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!]

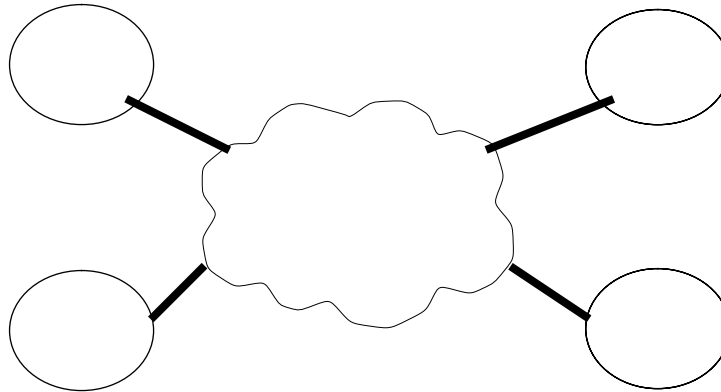
APM.1357.02

Approved
Briefing Note

14th February 1996

Distribution:
Supersedes:
Superseded by:

Exploiting High Performance Networks



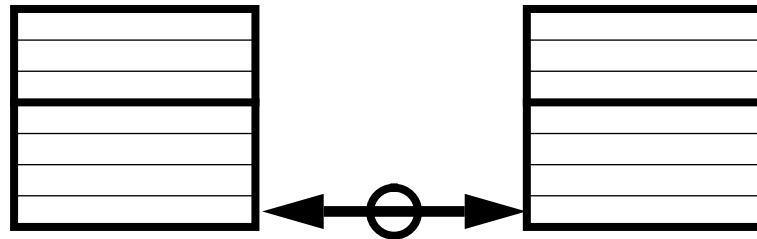


In this session

- *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

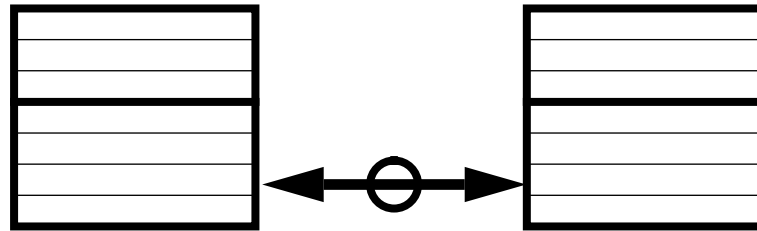
- *Repeaters connect at the physical layer*



- *... for LAN extension (overcoming physical limits)*
- *Transparent to all network/link layer protocols*

Bridges

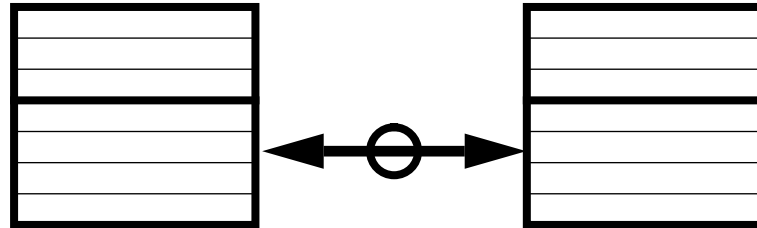
- *Bridges connect at the link layer*



- ... 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 percentage 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

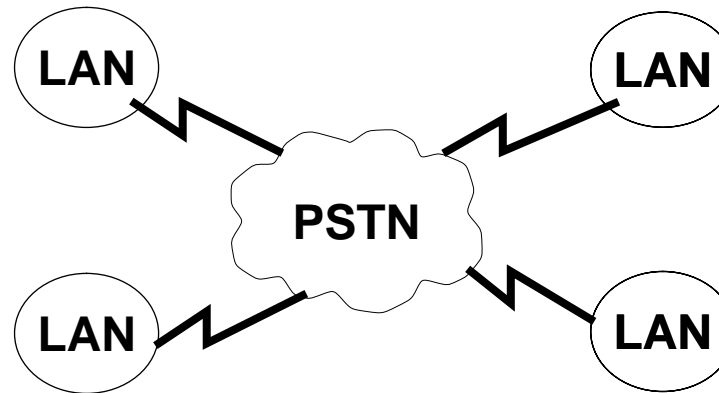
Source: Datapro 1993/1995 International Networking Survey



Some networking options for LAN interconnect

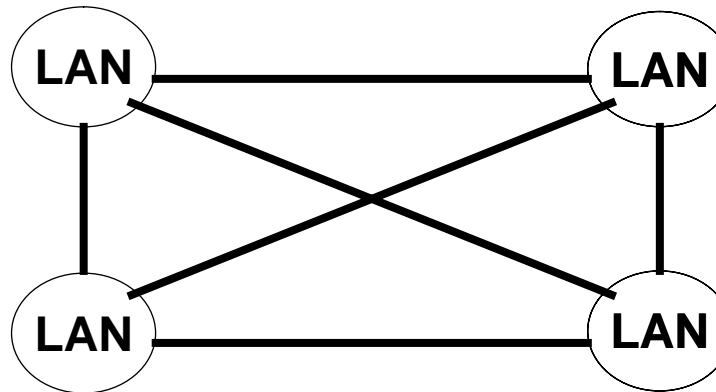
- *Dial-up*
- *Leased line*
- *T1/E1 Mux*
- *X.25*
- *Frame relay*

Dial-up



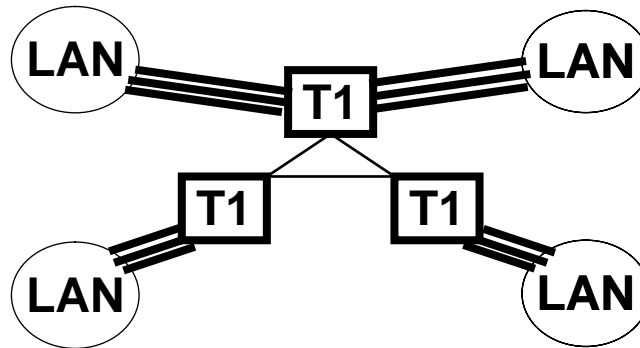
Switched	Yes	
Call Set-up	Slow	10 seconds (or longer with dial-back)
Transmission	Slow	Typically 14.4 Kbit/sec
Cost-Effective for Bursty Traffic	Yes	Low speeds only
Protocol Insensitive	No	
Alternate routing	No	
Network Management by customer	Limited	

Leased line



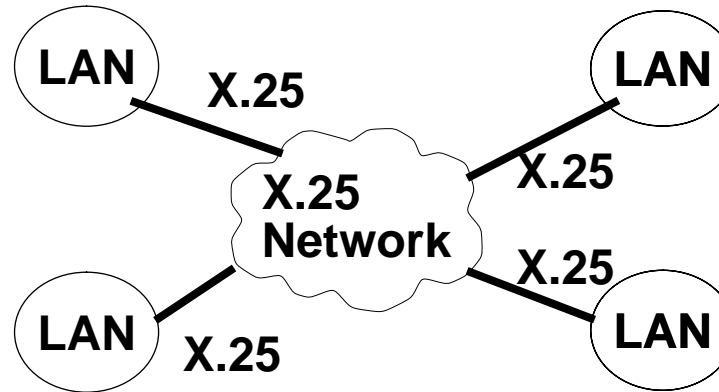
Switched	No	
Call Set-up	Fast	
Transmission	Slow to Fast	
Cost-Effective for Bursty Traffic	No	
Protocol Insensitive	Yes	
Alternate Routing	No	
Network Management by customer	Limited	

T1/E1 Mux



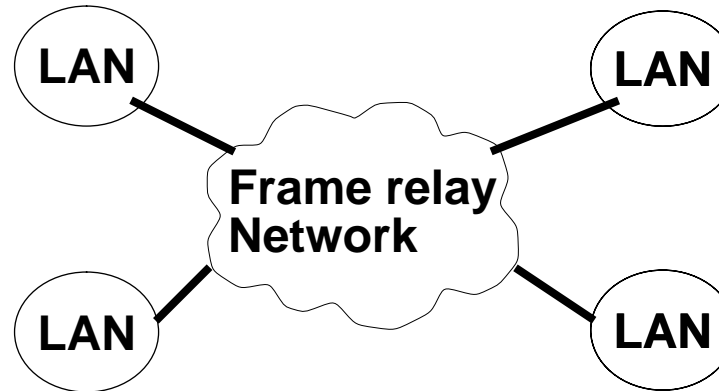
Switched	No	
Call Set-up	Fast	
Transmission	Slow to Fast	
Cost-Effective for Bursty Traffic	No	
Protocol Insensitive	Yes	
Alternate Routing	Yes	
Network Management by customer	Yes	

X.25



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



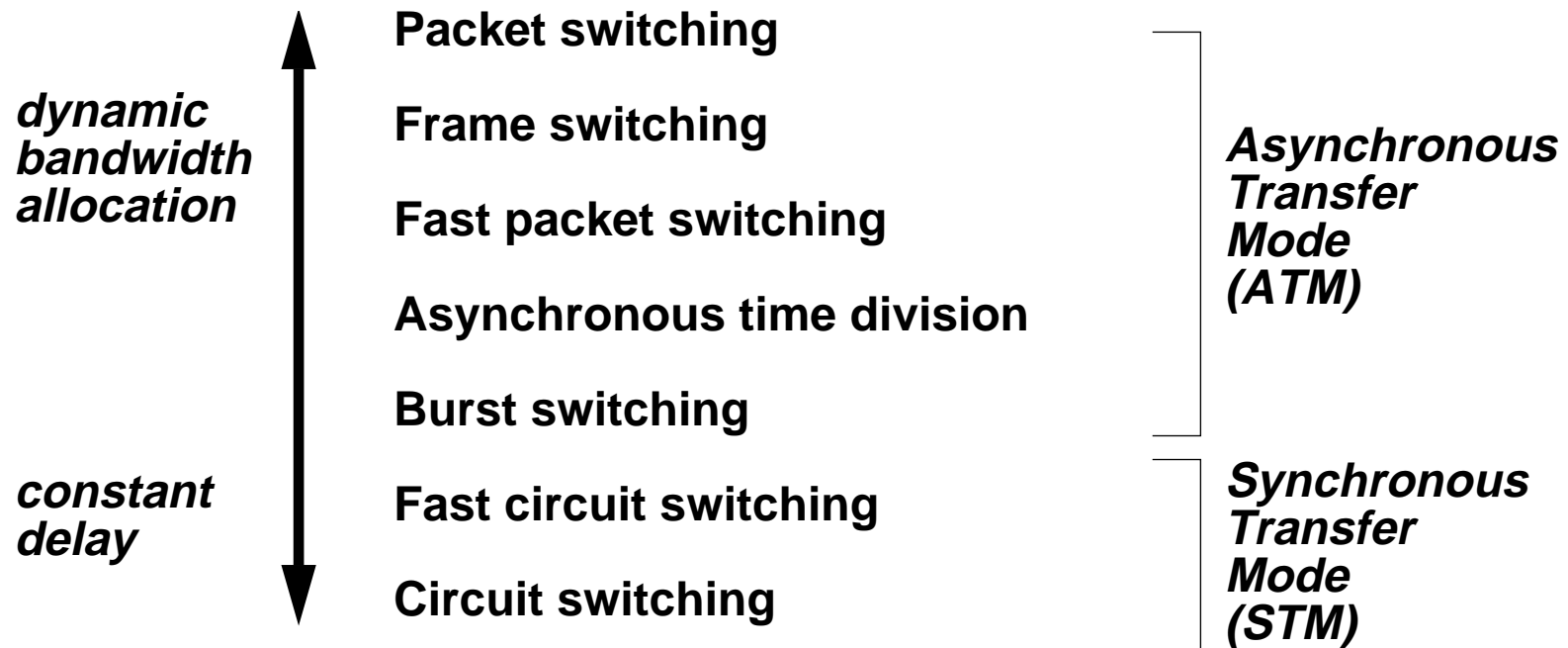
New demands on networks

- ***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

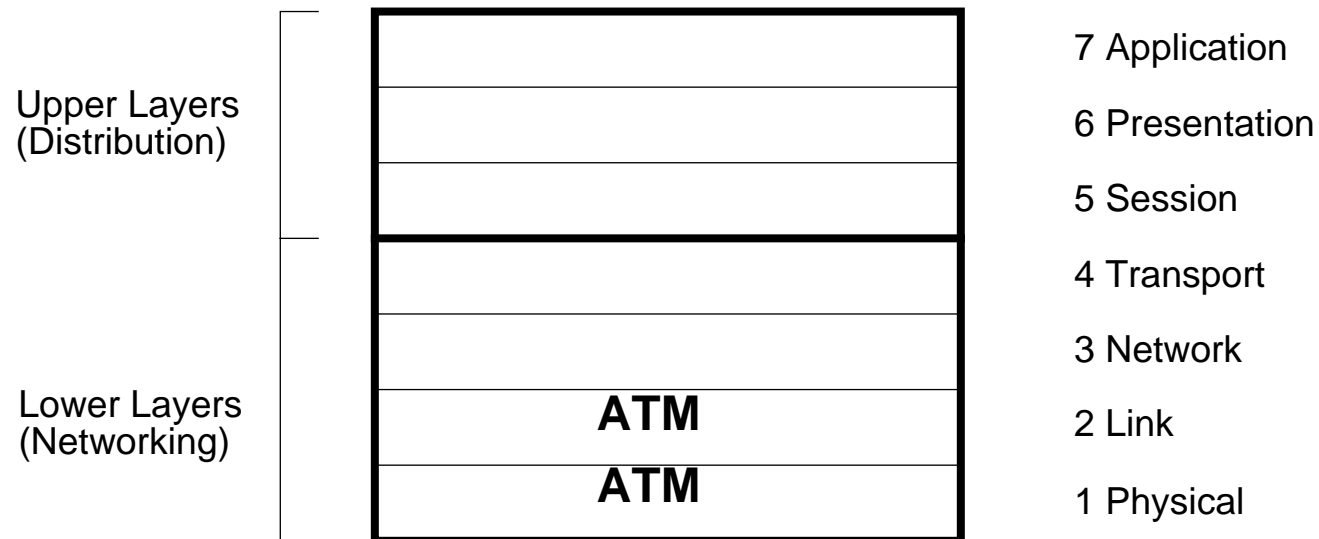


Quality-of-service selection

- *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

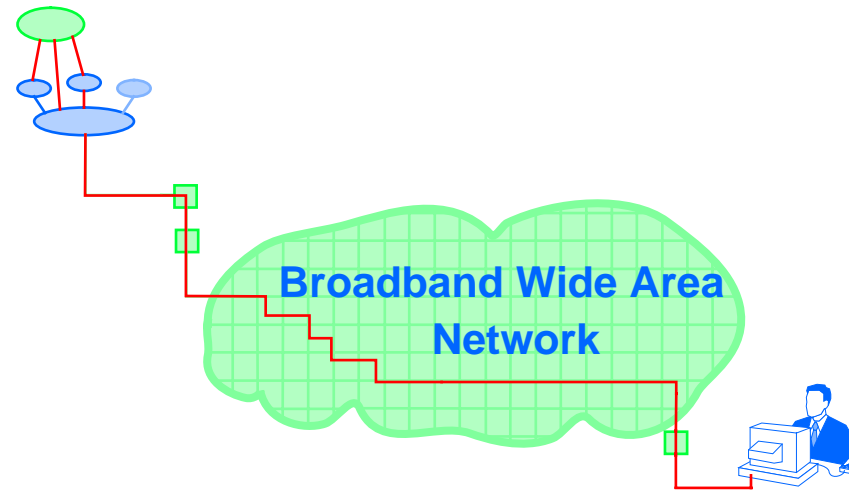


Tackling the weaknesses

- ***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



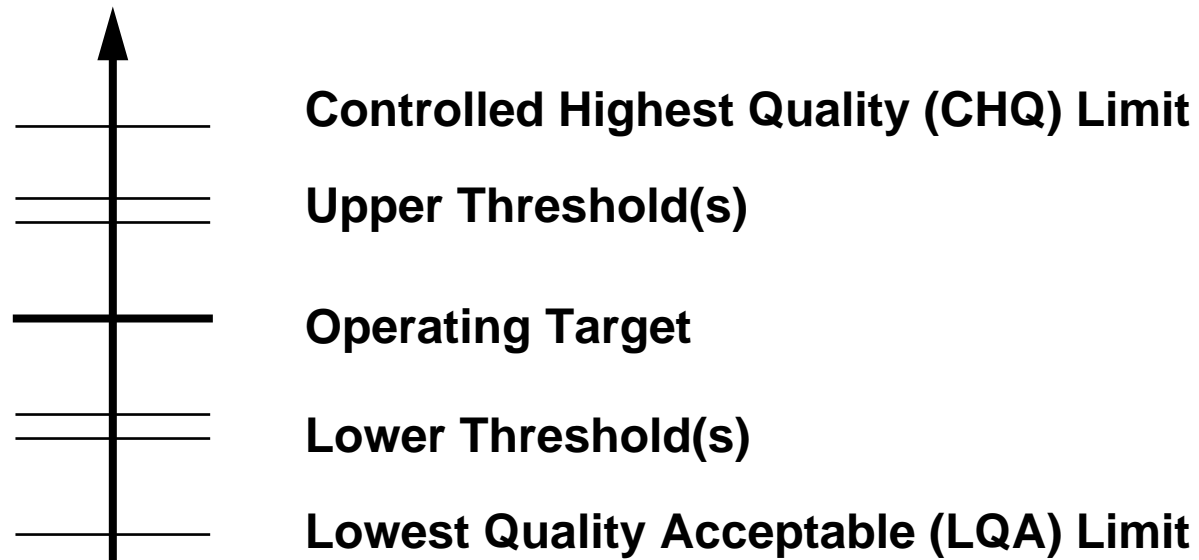
Basic quality-of-service concepts

- *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*





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 majeure - 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 \(APM.1314\)](#)***