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Asynchronous Transfer Mode (ATM);
Provision of internet applications via ATM based networks and interworking with IP networks

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Services and Protocols for Advanced Networks (SPAN).

Introduction

Internet applications have been written in the context of an IP-based network, and do not take advantage at all of the ATM network capabilities since they are hidden by this connectionless IP layer. The provision of Internet applications directly on top of ATM, described here, removes the overhead and the functional redundancies of a protocol layer, and makes it possible to take advantage of the various service categories offered by ATM networks, while maintaining the interworking with the IP-based network.

1 Scope

Some Internet applications can be provided over ATM networks using ATM addresses instead of IP addresses, while keeping existing domain names. The present document describes:

- how such applications can be provided over ATM networks; and
- the interworking between ATM networks and IP networks for the support of those applications.

This technical report gives some possible solutions (but probably not all) for the interworking of ATM network and IP network for the support of Internet applications. The document does not prescribe any specific solution.

The customer access configuration over ATM network to the IP network is not covered by the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] IETF RFC 793 (1981): "Transmission Control Protocol".

[2] IETF RFC 1945 (1996): "Hypertext Transfer Protocol - HTTP/1.0".

[3] IETF RFC 2068 (1997): "HyperText Transfer Protocol - HTTP/1.1".

[4] ATM Forum, af-saa-069.000 (1996): "ATM Name System Specification v1.0".

[5] ATM Forum, af-uni-0010.002 (1994): "ATM User-Network Interface Specification, Version 3.1".

[6] IETF RFC 2225 (1998): "Classical IP and ARP over ATM".

[7] Internet Draft, IETF (1998): "NBMA Next Hop Resolution Protocol (NHRP)".

[8] ITU-T Recommendation I.363 (1993): "B-ISDN ATM Adaptation Layer specification".

[9] IETF RFC 1034 (1987): "Domaomain Names - Concepts and Facilities".

[10] IETF RFC 1035 (1987): "Din Names - Implementation and Specification".

[11] "Design, implementation, and performance measurement of a native-mode ATM transport layer (extended version)", R. Ahuja, S. Keshav and H. Saran, IEEE/ACM Transactions on Networking, August 1996, pp. 502-515.

[12] TR 101 734: "Internet Protocol (IP) based networks; Parameters and mechanisms for charging".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

AAL-5: ATM Adaptation Layer Type 5: AAL functions in support of variable bit rate, delay-tolerant connection-oriented data traffic requiring minimal sequencing or error detection support (see [8])

ATM Name Server: server program which supplies name-to-address translation, mapping from names of ATM end-systems to ATM address (see [4]). ANS is an extension of the IETF DNS

ATM Address: defined in the UNI Specification as 3 formats, each having 20 bytes in length including country, area and end-system identifiers

Domain Name Server: server program which supplies name-to-address translation, mapping from domain names to IP address (see [9] and [10])

IP-based network: general term denoting networks initially designed for data communication using IP or related protocols, where the specifications are produced by IETF

Internet application: any application normally running on TCP/IP or UDP/IP as described in IETF standards

Transport protocol: any transport service protocol running on ATM/AAL5

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAL	ATM Adaptation layer
ANS	ATM Name Server
ARP	Address Resolution Protocol
ATC	ATM Transfer Capability
ATM	Asynchronous Transfer Mode
DNS	Domain Name System
HTTP	HyperText Transfer Protocol
IP	Internet Protocol
NHRP	NBMA Next Hop Resolution Protocol
QoS	Quality of Service
SVC	Switched Virtual Circuit
TCP	Transmission Control Protocol
TE	Terminal Equipment
UDP	User Datagram Protocol
UNI	User Network Interface
URL	Uniform Resource Locator

4 Reference Configurations

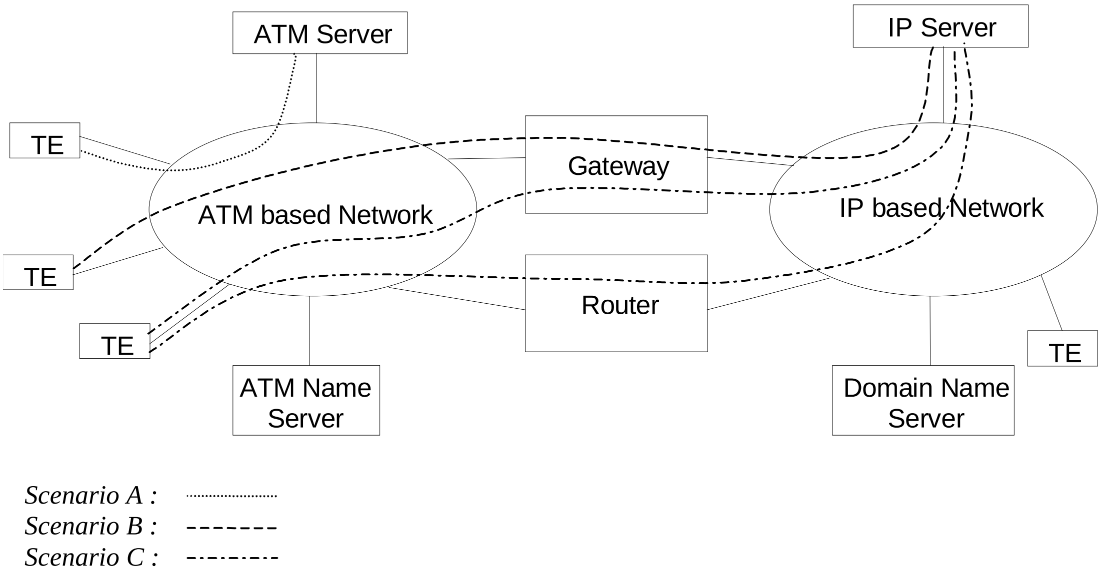

Figure 1: Reference Configuration

4.1 Scenarios considered

Three scenarios are considered here:

Scenario A: Between the TE and the ATM server over the ATM-based network
The IP stack is not supported by the TE nor anywhere else in the ATM-based network. The transport protocol is operated directly over AAL5/ATM. IP addresses are not relevant in this scenario.

Scenario B: Between the TE and the IP server over the Gateway
The IP stack is not supported by the TE nor anywhere else in the ATM-based network. The transport protocol is then operated directly over AAL5/ATM. The transport protocol on the ATM side does not have to be similar to the one used in the IP-based network (although it could still be TCP [1], or a transport protocol designed specifically for ATM such as the one in [11]).

The **gateway** provides the interworking with IP-based network.

In scenario B, **only** applications which use a **host name** to identify the destination host, are supported.

Scenario C: Between the TE and the IP server over either the Gateway or the Router
In this option, a dual protocol stack is supported: the transport protocol is directly operated on top of ATM, together with a traditional IP stack in the TE. It is then possible for the TE to access existing IP-based application server without any restriction:

When the application identifies the destination host using a **host name**, the **gateway** provides the interworking with IP-based network.

When the application uses an **IP address** to identify the destination host, the IP stack has to be used in the ATM-based network; IP connectivity over ATM is achieved using existing architecture (e.g. Classical IP [6] or NHRP [7], …), and the interworking with Internet is done through a **router**.

4.2 Functionalities

This subclause describes the functions of the various equipment involved in the provision of the service.

4.2.1 Native-Mode ATM transport

The native-mode ATM transport protocol stack is used in a number of equipments. It is as follows.

Internet application
Transport Protocol
AAL5
ATM
Physical layer

Figure 2: Native mode ATM transport protocol stack

The transport protocol is operated directly over AAL5/ATM (an example of such a working implementation in case of TCP as the transport protocol is described in "Internet Applications over Native ATM"). The transport protocol used in the TE and the ATM server does not have to be similar to the one used in the IP-based network (although it could still be TCP [1], or a transport protocol designed specifically for ATM such as the one in [11]).

4.2.2 ATM Network

The ATM-based network could be an ATM-based Intranet or public network using broadband access technologies. Connections within the ATM-based network are standard ATM SVCs, with standard UNI [5]. These connections can take full advantage of ATM QoS, as long as the application is able to specify the traffic parameters and QoS required.

4.2.3 TE (Terminal Equipment)

In the following text, the abbreviation "TE" refers to the ATM-attached TE.

An ATM-attached TE (Terminal Equipment) can have access to Internet applications (e.g. WEB service) provided either by an ATM server or by an IP server.

The TE is able to access any ATM-based servers and interworking equipment connected to the ATM-based network, or any IP server on a IP-based network over the interworking equipment.

The U-plane protocol stack of the TE is different for a number of scenarios.

4.2.4 ANS (ATM Name Server)

The basic service of the ANS server is the domain name to ATM address translation and reverse. The functions supported by this server are already defined by the ATM Forum [4]. The U-plane protocol stack of the ANS server is:

ANS Application
AAL5 layer
ATM layer
Physical layer

Figure 3: The protocol stack of the ANS server, while communicating to its client (U-plane)

When the ATM-based network is a public network, then the ANS server, in case it can not resolve the host name completely, communicates hierarchically with other ANS servers, and returns the answer of the recursive resolution to the client.

When the ATM-based network is an Intranet, the ANS server knows the names of host directly attached to the ATM-based network, and does not communicate with other ANS servers.

4.2.5 ATM Server (Supporting Internet Applications)

The ATM server may fulfil the same functions as an IP server, on the level of Internet applications. In the ATM server, the Internet application (originally designed to use IP) is modified so that the primitives at the network layer act directly at the ATM level. The sequence of call of primitives remains the same. The port numbers are still valid.

The protocol stack of the ATM server is the Native-mode ATM transport protocol stack.

4.2.6 Gateway (between the ATM Network and the IP-based Network)

The Gateway acts as an application relay.

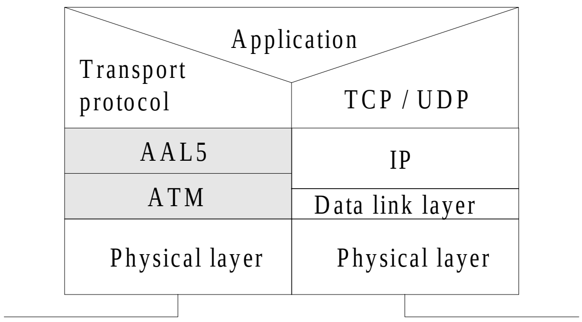

Figure 4: The protocol stack of the Gateway, (U-plane)

The IP stack is supported within the Gateway which could also include the functions of an appropriate proxy such as security and caching (see "Internet Applications over Native ATM").

4.2.7 IP server

The IP server is a server attached to the IP network and running Internet applications. The protocol stack is as follows.

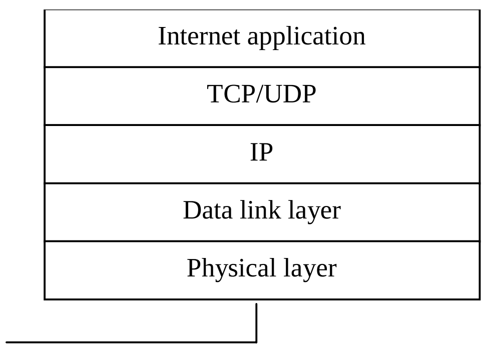

Figure 5: IP server protocol stack

Note that the "Data link" layer is used as a generic term. When the ATM-based network is a public network, then the proposed solution is not appropriate to the case of ATM as the data link layer in the IP-based network (see subclause 6.2). In case of an Intranet as the ATM-based network, the proposed solution is still valid when the data link layer consists of AAL and ATM layers.

4.2.8 IP Router

The IP router interfaces between the ATM network and the IP-based network. Towards the ATM network, the router is accessed for instance via Classical IP or NHRP; and towards the IP network, there is a traditional IP protocol stack. So the interworking between the networks is performed on an IP basis.

Please note that the aim of the present document is not to give the exhaustive list of the possible ways to provide IP over ATM. Classical IP and NHRP are given here as mere examples.

The protocol stack of the IP router looks as follows:

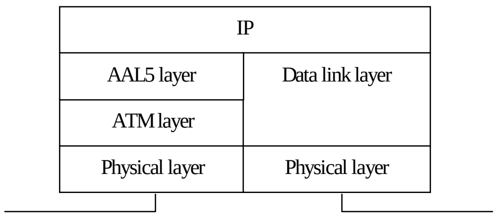

Figure 6: IP router protocol stack

Note that the "Data link" layer is used as a generic term. When the ATM-based network is a public network, then the proposed solution is not appropriate to the case of ATM as the data link layer in the IP-based network (see subclause 6.2). In case of an Intranet as the ATM-based network, the proposed solution is still valid when the data link layer consists of AAL and ATM layers.

5 Scenario A Description

5.1 Terminal U-plane protocol stack

The TE protocol stack in this scenario is the Native-mode ATM transport protocol stack.

5.2 Procedures for the TE access to the ATM server

When the application refers to the destination host using the host name:

- the TE sets up a connection to the ANS server;
- the TE sends a query over this connection to the ANS, requesting the ATM address associated to the host name of the ATM server;
- the ANS gives back a positive response to the TE with the ATM address of the ATM server;
- having received the response from the ANS, the TE connects to the ATM server using the ATM address it got from the query, using DSS2 signalling at the access.

When the application refers to the destination host using the host ATM address:

- the TE sets up a connection to the ATM server, using DSS2 signalling at the access;
- both the TE and the ATM server use the Native mode ATM Transport layer protocol stack from figure 2 over the established connection;
- no interworking procedures are used.

5.3 ATM Network Related Issues

Connections within the ATM-based network can take full advantage of ATM ATC and QoS. ATC, traffic parameters and QoS are to be chosen for each ATM connection. Existing applications have no means to specify such parameters. Hence, a mechanism which could be external to the application but internal to the terminal, is required. For instance a configuration file in the terminal or the use of a server per application or per user could be envisioned. This issue is beyond the scope of the present document.

In the case of the access to the Internet, the QoS can only be guaranteed between the terminal on the ATM network and the gateway. How to guarantee the QoS when accessing a server on the Internet side is an IP-level issue which is out of the scope of the present document.

5.4 Charging Issues

The charging mechanisms of the ATM switched network could be used.

6 Scenario B Description

6.1 Terminal U-plane protocol stack

The TE protocol stack in this scenario is the Native-mode ATM transport protocol stack.

6.2 Procedures for the TE access to the IP server

- The TE sets up a connection to the ANS server; the protocol stack of the connection is the native mode ATM transport protocol stack.
- The TE sends a query over this connection to the ANS, requesting the ATM address associated to the host name of the IP server.
- In the case of an Intranet, where the ANS does not have the name of the IP server in its information base, then two possibilities can be envisaged:
  - either the ANS automatically gives the ATM address of the Gateway (this implies that there is only one Gateway to the Internet), or
  - the ANS gives back a negative response to the TE. Then using a local configuration, the TE connects to the gateway.
- In the case of a public network (and no ATM layer available on the IP-based network) the ANS gives back a negative response to the TE, since the IP server does not have an ATM address. Then using a local configuration, the TE connects to the gateway.

NOTE: If the ATM layer were available on the IP-based network, the IP server would also have an ATM address; the ANS server would communicate hierarchically with other ANS servers and would return the ATM address of the IP server, enabling end-to-end ATM connection between the TE and the IP server.

- Having received the response from the ANS, the TE connects to the Gateway using the ATM address it got from the query. The connection uses the native ATM Transport protocol stack.
- Over this connection, the gateway gets the host name from the application level.
- The Gateway does a DNS query to the DNS server, and gets the IP address of the IP server.
- The gateway communicates the IP datagrams from the TE application to the IP server and reverse. In fact, the Gateway acts as a relay at the application level.

6.3 Example using a web server application

In the following, the gateway is considered where HTTP protocol (HyperText Transfer Protocol) [2] and [3], operates on top of TCP [1] which is connection-oriented. In this example, TCP is running on both sides of the gateway.

A HTTP request message, from a client to a server, includes within the first line of that message: *request-type*, ***request-URL*** and *HTTP-version*. A restriction is made here to the case where the host name is imbedded in the URL (Uniform Resource Locator) which is itself a compound name.

On the ATM side of the gateway, a TCP connection is mapped one to one into an ATM SVC.

The gateway listens on the TCP ports on the ATM side, then opens TCP ports on the Internet side and relays HTTP messages (there are two types of HTTP messages: requests and responses; the client requests and the server makes responses):

- when the gateway receives an HTTP request message on a TCP port on the ATM side, it extracts the domain name from the target URL and analyses it;

- the gateway gets the IP address corresponding to the domain name, by requesting the DNS (Domain Name Server) on the Internet side;

- having the destination IP address, the gateway opens a TCP connection to the Web server on the Internet side. Then, on this TCP connection, the gateway copies the HTTP message which was received on the ATM side;

- HTTP/1.1 [3] introduces the notion of "persistent connections": several requests and responses can be pipelined on the same TCP connection. Thus, with HTTP version 1.1, several HTTP requests may follow the first request which initiated the opening of the TCP connection on the Internet side. The following requests received on the same TCP connection, are copied on the TCP connection on the Internet side, without being analysed.

All messages received on TCP ports on the Internet side are sent back on the TCP ports on the ATM side:

- the gateway receives the server's response on the TCP port, and copies this message on the associated TCP port on the ATM side;

- the server denotes the end of its response by closing the TCP connection, which is relayed by the gateway by clearing the associated TCP connection on the ATM side and the ATM SVC.

On the other side, the gateway has to be able to relay the clearing of the TCP connection on the ATM side by closing the associated TCP connection on the Internet side. This is, for instance, the case when the user presses the STOP button.

6.4 ATM Network Related Issues

Connections within the ATM-based network can take full advantage of ATM ATC and QoS. ATC, traffic parameters and QoS are to be chosen for each ATM connection. Existing applications have no means to specify such parameters. Hence, a mechanism which could be external to the application but internal to the terminal, is required. For instance a configuration file in the terminal or the use of a server per application or per user could be envisioned. This issue is beyond the scope of the present document.

In the case of the access to the Internet, the QoS can only be guaranteed between the terminal on the ATM network and the gateway. How to guarantee the QoS when accessing a server on the Internet side is an IP-level issue which is out of the scope of the present document.

6.5 Charging Issues

The charging mechanisms of the ATM switched network could be used.

7 Scenario C Description

7.1 Terminal U-plane protocol stack

In this case, both the native ATM transport protocol stack and the IP over ATM protocol stack are supported by the TE.

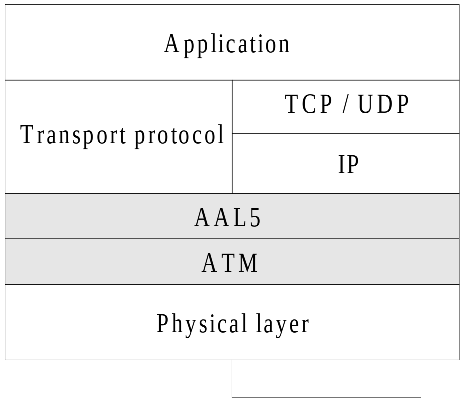

Figure 7: The protocol stack of the TE, (U-plane)

7.2 Procedures for the TE access to the IP server

When the TE application refers to the destination IP server using the **host name**, the situation is like in Scenario B. It could be envisioned that when the ANS gives back a negative response to the TE, the application takes the initiative in accessing the DNS using its IP stack, through the router. Here the decision to switch from one stack to the other, would be made at the application level.

When the TE application refers to the destination IP server using the **IP address**, the TE uses its IP protocol stack:

The IP address resolution is done respectively by:

- ATM ARP [6] in case of Classical IP: by looking in its routing table, first the TE gets the router IP address, then requests the resolution of the address of the router; or
- NHRP Resolution mechanism [7] for instance, which gives back the ATM address of the router to the TE;

NOTE: This description is made in the case where the ATM layer is not present in the IP-based network (otherwise the ATM address of the server itself would be returned in the NHRP Resolution Reply based on the server IP address, and the TE would connect directly to the IP server).

- the TE connects to the router using its ATM address;
- then, the router sends to the IP server the IP datagrams received from the TE.

7.3 Example using a web server application

In the following, the gateway is considered where HTTP protocol (HyperText Transfer Protocol) [2] and [3], operates on top of TCP [1] which is connection-oriented. In this example, TCP is running on both sides of the gateway.

A HTTP request message, from a client to a server, includes within the first line of that message: *request-type, request-URL* and *HTTP-version*. A restriction is made here to the case where the **host name** is imbedded in the URL (Uniform Resource Locator) which is itself a compound name.

Then the gateway behaves like in Scenario B (see subclause 6.3).

7.4 ATM Network Related Issues

When the transport protocol is operated directly over ATM (that is when the application refers to the destination host using the host name), connections within the ATM-based network can take full advantage of ATM ATC and QoS. ATC, traffic parameters and QoS are to be chosen for each ATM connection. Existing applications have no means to specify such parameters. Hence, some particular way which could be external to the application but internal to the terminal, is required. For instance a configuration file in the terminal or the use of a server per application or per user could be envisioned. This issue is beyond the scope of the present document. In the case of the access to the IP-based network, the QoS can only be guaranteed between the terminal on the ATM network and the gateway. How to guarantee the QoS when accessing a server on the IP-based network side is an issue out of the scope of the present document.

When the application has to make use of the IP stack, Classical IP [6] or NHRP [7] for instance, is used in the ATM-based network, over ATM SVC with best-effort service class and no QoS guaranty.

7.5 Charging Issues

When the transport protocol is operated directly over ATM (that is when the application refers to the destination host using the host name), the charging mechanisms of the ATM switched network could be used.

When the application has to make use of the IP stack, the charging mechanisms described in TR 101 734 [12] could be used when the application has to make use of the IP stack in the ATM-based network.

Bibliography

The following material, though not specifically referenced in the body of the present document (or not publicly available), gives supporting information.

- IETF RFC 768 (1980): "User Datagram Protocol".
- "Internet Applications over Native ATM", D. Bonjour, O. Elloumi, H. Afifi, Computer Networks and ISDN Systems, July 1998.

History

Document history		
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