IP over ATM WG
Internet-Draft

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Expires in six months

ATM Signaling Support for IP over ATM
<draft-ietf-ipatm-sig-01.txt>

1. Status of this Memo

2. Abstract

This memo describes how implementations of IP over ATM should use ATM call control signaling procedures to establish and release ATM connections. It is intended to serve implementations of IP and multiprotocol interconnection over ATM that use ATM signaling as specified in the ATM Forum User-Network Interface (UNI) Specification Version 3.0 [ATMF93]. In particular, during development of this memo, the IP over ATM working group has focused its activities on the Classical IP over ATM model, as described in RFC 1577 [LAUB94]; therefore particular attention is given to support RFC 1577.

This document is an implementors guide intended to foster interoperability among RFC 1577, RFC 1483, and UNI ATM signaling. It serves as an intermediary role between IP and ATM call control signaling which establishes and releases ATM calls/connections on behalf of IP. Specifically, this memo details the coding of ATM signaling messages when used to support IP.

This memo applies to IP hosts and routers which are also ATM endsystems. It assumes ATM networks that completely implement the ATM Forum UNI Specification Version 3.0.

Note: An erratum to the UNI 3.0 specification has been produced by

the ATM Forum Technical Committee, largely for reasons of alignment with Recommendation Q.2931. The erratum will be published as the UNI 3.1 Specification in the summer of 1994. This memo does not assumes the changes to the specification indicated in the erratum but attempts to point out the relevant incompatibilities with UNI 3.0. Once UNI 3.1 is publicly available, this I-D will be updated to

reflect the changes.

3. Overview

In a Switched Virtual Connection (SVC) environment, ATM virtual channel connections (VCCs) are dynamically established and released as needed. This is accomplished using the ATM call/connection control signaling protocol, which operates between ATM endsystems and the ATM network. The signaling entities use the signaling protocol to establish and release calls (association between ATM endpoints) and connections (VCCs). Signaling procedures include the use of addressing to locate ATM endpoints and allocation of resource in the network for the connection. It also provides indication and negotiation between ATM endpoints for selection of end-to-end protocols and their parameter. This memo describes how the signaling protocol is used in support of IP over ATM, and, in particular, the information exchanged in the signaling protocol to effect this support.

IP address to ATM address resolution and routing issue are not in the scope of this I-D, and is treated as part of IP in figure 1. These issue depend on the subnet and end-to-end networking model being used. A taxonomy of subnet and end-to-end networking models is provided in [COLE94]. The simplest case is the Classical IP over ATM model described in RFC 1577.

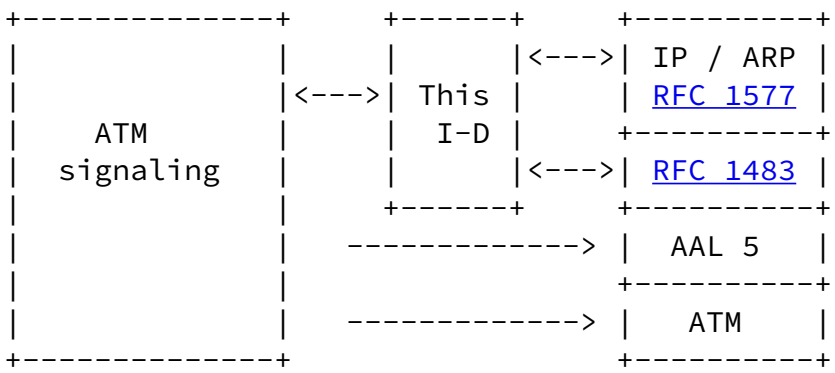

Figure 1.
Relationship of this I-D to IP, RFC 1483,

4. Use of protocol procedures

The following requirements are motivated to provide implementation guidelines on how multiple ATM connections between peer systems should be managed, to prevent connection thrashing and related problems.

The owner of an existing VCC is defined to be the entity within the ATM endsystem that establishes the connection. An ATM endsystem may establish an ATM call when it has a datagram to send and either there is no existing VCC that it can use for this purpose, it chooses not to use an existing VCC, (e.g., for reasons of route optimization or quality of service), or the VCC owner does not allow sharing.

When two ATM endsystems run multiple protocols, an ATM connection may be shared among two or more datagram protocol entities, as long as the VCC owner allows sharing, as well as if the encapsulation allows proper multiplexing and demultiplexing, (i.e., the LLC/SNAP encapsulation or RFC 1490 over FRSSCS). This indication of sharing a VCC MAY be by configuration or via an API. Similarly, the Internet layer supports multiplexing of multiple end-to-end transport session. To properly detect idle connection while sharing a VCC among more than one higher layer protocol entities, the ATM endsystem SHALL monitor the traffic at the lowest multiplexing layer.

An ATMARP server or client may establish an ATM call when it has a datagram to send and either there is no existing VCC that it can use for this purpose, it chooses not to use an existing VCC, or the owner of the VCC does not allow sharing. Note that there might be VCCs to the destination which are used for IP, but an ARP server might prefer to use a separate VCC for ARP only. The ATMARP server or client may maintain or release the call as specified in RFC1577. However, if the VCC is shared among several protocol entities, the ATMARP client or server SHALL not disconnect the call as suggested in RFC1577.

Systems MUST be able to support multiple connections between peer systems (without regard to which peer system initiated each connection). They MAY be configured to only allow one such connection at a time.

If a receiver accepts more than one call from a single source, that receiver MUST then accept incoming PDUs on the additional connection(s), and MAY transmit on the additional connections.

Receivers SHOULD NOT accept the incoming call, only to close the connection or ignore PDUs from the connection.

Because opening multiple connections is specifically allowed, algorithms to prevent connection call collision, such as the one found in section 8.4.3.5 of ISO/IEC 8473 [ISO8473], MUST NOT be implemented.

While allowing multiple connections is specifically desired and allowed, implementations MAY choose (by configuration) to permit only a single connection to some destinations. Only in such a case, if a colliding incoming call is received while a call request is pending, the incoming call shall be rejected. Note that this may result in a failure to establish a connection. In such a case, each system shall wait at least a configurable collision retry time in the range 1 to 10 seconds before retrying. Systems SHOULD add a random increment, with exponential backoff.

Either endsystem MAY close a connection. If the connection is closed or reset while a datagram is being transmitted, the datagram is lost. Systems SHOULD be able to configure a minimum holding time for connections to remain open as long as the endpoints are up. (Note that holding time, the time the connection has been open, differs from idle time.) A suggested default value for the minimum holding time is 60 seconds.

Because some public networks may charge for connection holding time, and connections may be a scarce resource in some networks or endsystems, each system implementing a Public ATM UNI interface MUST support the use of a configurable inactivity timer to clear connections that are idle for some period of time. The timer's range SHOULD include a range from a small number of minutes to "infinite", and the default value SHOULD be "infinite". Systems which only implement a Private ATM UNI interface SHOULD, but are not required to, support the inactivity timer. If implemented, the inactivity timer shall monitor traffic of both receiving and transmitting activities.

5. Brief Overview of UNI Call Setup Signaling Procedures and Messages

This section provides a summary of point-to-point signaling procedures. Readers are referred to [ATMF93] and [Q2931].

UNI signaling messages used for point-to-point call connection control are the following:

Call Setup	Call Release
SETUP	RELEASE
CALL PROCEEDING	RELEASE COMPLETE
CONNECT	
CONNECT ACKNOWLEDGE	

An ATM endpoint initiates a call request by sending a SETUP message to the network. The network processes the call request to determine if the call can be progressed. If so, the network indicates the value of the newly allocated VPCI/VCI in its first response to the the SETUP message, which may either be a CALL PROCEEDING or CONNECT message. If a call cannot be accepted, by the network or destination ATM endpoint, a RELEASE COMPLETE is sent. At the destination ATM endpoint, the network offers the call using the SETUP message. If the destination endpoint is able to accept the call, it responds with a CONNECT message; otherwise, it sends a RELEASE COMPLETE message.

Release can be initiated by either endpoint or (rarely) by the network. When an endpoint wishes to release a call, it sends a RELEASE message to the network. The network responds with a RELEASE COMPLETE message, frees up resources associated with the call, and initiates clearing toward the other endpoint. The network initiates clearing by sending a RELEASE message to the ATM endpoint, which reponds by sending a RELEASE COMPLETE message. Upon receipt of the RELEASE COMPLETE message, the network frees any resources associated with the call.

6. Overview of call establishment message content

Signaling messages are structured to contain mandatory and optional variable length information elements (IEs). IEs are further subdivided into octet groups, which in turn are divided into fields.

IEs contain information related to the call, which may be relevant to the network, the peer endpoint or both. Selection of optional IEs and the content of mandatory and optional IEs in call establishment message determines the parties to and nature of the communication over the ATM connection. For example, the call establishment message for a call which will be used for constant bitrate video over AAL 1 will have different contents than a call which will be used for IP over AAL 5.

A SETUP message which establishes an ATM connection to be used for IP

and multiprotocol interconnection calls SHALL contain the following IE:

AAL Parameters
ATM User Cell Rate (ATM Traffic Descriptor in UNI 3.1 erratum)
Broadband Bearer Capability
Broadband Low Layer Information
QoS Parameter
Called Party Number
Calling Party Number

and may, under certain circumstance contain the following IEs :

Calling Party Subaddress
Called Party Subaddress
Transit Network Selection

In UNI 3.0 the AAL Parameters and the Broadband Low Layer Information IEs are optional in a SETUP message. However, in support of IP over ATM these two IEs MUST be included. Annex A shows an example SETUP message coded in the manner indicated in this draft.

7. Information Elements with Endpoint to Endpoint Significance

This section describes the coding of, and procedures surrounding, information elements in a SETUP message with significance only to the endpoints of an ATM call supporting IP and multiprotocol operation.

7.1. ATM Adaption Layer Parameters

The AAL Parameters IE (see section 5.4.5.5 and Annex F of [ATMF93]) carries information about the ATM Adaption Layer (AAL) to be used on the connection. RFC 1483 specifies encapsulation of IP over AAL 5. Thus, AAL 5 SHALL be indicated in the "AAL type" field.

Coding and procedure related to the 'Forward and Backward Maximum CPCS-SDU Size' fields are discussed in [ATKI94].

The 'mode' field SHOULD be omitted from the AAL Parameters IE. If present it is appropriate to set it to "message" mode, as opposed to "streaming" mode. Nevertheless, it SHALL be ignored by the destination endsystem.

Ordinarily, no Service Specific Convergence Sublayer (SSCS) will be used for multiprotocol interconnect over AAL5. Therefore, the SSCS

The exception will occur in the event that the network provides interworking between ATM and Frame Relay. In this case, the ATM endsystem will receive a SETUP or CONNECT message containing an AAL Parameters IE with the SSCS Type field coded as Frame Relay SSCS. The call SHALL be cleared with cause #93, AAL Parameters not supported unless the ATM endsystem supports RFC 1490 encapsulation over FRSSCS, and a Broadband Low Layer Information IE is coded to indicate RFC 1490 encapsulation (see below).

Format and field values of AAL Parameters IE

aal_parameters		
aal_type	5	(AAL 5)
fwd_max_sdu_size_identifier	140	
fwd_max_sdu_size	9188	(default IP MTU)
bkw_max_sdu_size_identifier	129	
bkw_max_sdu_size	9188	(default IP MTU)
sscs_type identifier	132	
sscs_type	0	(null SSCS)

7.2. Broadband Low Layer Information

Selection of an encapsulation to support IP and multiprotocol interconnection over an ATM VCC is done using the Broadband Low Layer Information (B-LLI) IE, along with the AAL Parameters IE, and the B-LLI negotiation procedure.

Protocol encapsulation for multiprotocol interconnection over ATM ALL 5 is specified in RFC 1483. Three encapsulation are provided; these are:

(a) LLC/SNAP encapsulation
(b) VC-multiplexing (null encapsulation)
(c) Use of RFC 1490 over the Frame Relay Service Specific Convergence Sublayer (FRSSCS)

The example codings for the B-LLI IE provided in Appendix D of the ATM Forum UNI 3.0 specification were selected to correspond to the RFC 1483 encapsulations.

RFC 1577 specifies LLC/SNAP as the default encapsulation. Therefore LLC encapsulation SHOULD be indicated in the B-LLI as shown in figure D.3.1 of [ATMF93]. Signaling indication of other encapsulations is discussed in the next section. Note that in this case only LLC is indicated in the B-LLI. It is up to the LLC layer to look into the encapsulation header of the packet. If the SNAP header indicates IP,

it is the LLC layer's job to hand the packet up to IP.

Format of B-LLI IE indicating LLC/SNAP encapsulation

bb_low_layer_information		
layer_2_id	2	
user_information_layer	12	(lan_llc - ISO 8802/2)

7.2.1. Encapsulation negotiation

The call/connection control signaling protocol includes a mechanism to support negotiation of encapsulation for endsystems that support more than one. This section describes the procedures for negotiation of an encapsulation.

As stated in the previous section, this I-D requires that hosts and router which are ATM endsystems implement LLC/SNAP encapsulation. Nevertheless, RFC 1483 also specifies VC-multiplexing and recognizes use of RFC 1490 over FRSSCS. VC-multiplexing SHOULD be implemented to achieve maximum interoperability. Implementation of RFC 1490 encapsulation over FRSSCS is also recommended for interworking with Frame Relay networks. Such interworking does have its problems however as discussed later.

The B-LLI negotiation procedures (see Annex C of [ATMF93]) are initiated by the calling ATM endsystem by including up to three instance of the B-LLI IE in the SETUP message in descending order of preference (following the rule for repeating IE in section 5.4.5.1 of [ATMF93]).

The following is the list of the three possible combinations that B-LLI IE instances may be included in the SETUP message. Each instance is referred to by its encapsulation name as it appears in RFC 1483, and corresponding section labels from ATM Forum UNI 3.0 specification.

a) LLC/SNAP encapsulation (D.3.1)

In this case, the calling ATM endsystem can only send and receive packets preceded by an LLC/SNAP identification.

b) VC-multiplexing (D.3.2) and LLC/SNAP (D.3.1)

The calling ATM endsystem prefers to use VC multiplexing, but is willing to agree to use LLC/SNAP encapsulation instead, if the called ATM endsytem only supports LLC/SNAP.

c) RFC 1490 encapsulation (MLPID multiplexing) over FRSSCS (D.3.3, omitting octets 7a and 7b and MUST have FR-SSCS in SSCS type of AAL Parameters IE.)

The calling ATM endsystem can only send and receive packets using RFC 1490 encapsulation (NLPID multiplexing) over FRSSCS. Use of RFC 1490 encapsulation presently cannot be negotiated as an alternative to LLC encapsulation or VC-multiplexing (see Appendix B). If the B-LLI IE is encoded to indicate RFC 1490 encapsulation, the SSCS type

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field of the AAL Parameters IE SHALL coded to indicate FRSSCS. Note that the AAL Parameters IE can not be coded to indicate both NULL and FR-SSCS and neither LLC encapsulation nor VC-multiplexing will be interoperable when used over FR-SSCS.

The called ATM endsystem SHALL select the encapsulation method it is able to support from the B-LLI IE present in SETUP message. If it supports more than one of the encapsulations indicated in the SETUP message, it MUST select the one which appears first in the SETUP message. The called ATM endsystem then includes the B-LLI IE content corresponding to the selected encapsulation in the CONNECT message. If the called endsystem does not support any encapsulation indicated in the incoming SETUP message, it SHALL clear the call with cause #88, incompatible destination. If the received SETUP message does not include the B-LLI IE, the call SHALL be cleared with cause #21, "call rejected", with diagnostics indicating rejection reason = information element missing and the B-LLI IE identifier. As described in Annex C of [ATMF93], if the calling ATM endpoint receives a CONNECT message that does not contain a B-LLI IE, it SHALL assume the encapsulation indicated in the first BLLI IE that it included in the SETUP message.

7.2.2. Framework for Protocol Layering

The support of connectionless services from a connection oriented link layer exposes general problems of connection management, specifically the problems of connection acceptance, assignment of quality of service, and connection shutdown. For a connection to be associated with the correct protocol on the called host, it is necessary for information about one or more layers of protocol

identification to be associated with a connection "management entity" or "endpoint". This association is what we call a binding in this draft. In this section we attempt to describe a framework for a usable binding or service architecture given the available IEs in the ATM call control messages.

It is important to distinguish between two basic uses of protocol identification elements present in the UNI setup message. The first is the description of the protocol encapsulation that will be used on the data packet over the virtual connection, the second is the entity that will be responsible for managing the call. All protocols present in various IEs should be used to encapsulate the call, but the most specific, or highest, layer specified should manage the call. This defines a hierarchy of services and provides a framework for applications, including LLC and IP, to terminate calls. The hierarchy provides a clear mechanism for support of higher level protocol and application bindings, when their use and specification is defined in the appropriate standards bodies.

The B-LLI is the only information element currently available in UNI 3.0 for designating the application endpoint. It contains codepoints, which describe layer 2 and layer 3 protocols entities associated with the call. There are other information elements under consideration in the ATM Forum and ITU, which could come to play a significant role in the description of application to connection binding, but their use

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is not currently sanctioned by the Forum, and they are not part of the framework described by RFC1577. They include B-HLI, for containing information for a higher layer protocol, Network Layer Information (NLI) to contain information for the network layer, and UUI, which is meant to carry information for use by the top level application.

In general, it would be desirable to allow data packets to be stored directly into applications address space after connection is established. This is possible only if we have both forward and backward encapsulation indication in the signaling message.

To support multiprotocol encapsulation, the LLC protocol management entity should accept all connections directed specifically to it. For each connection that is terminated at LLC, all protocols that are intended to be supported by this host through that interface should be made available. Termination of the call is at the discretion of the LLC connection management entity, based on the information it has available to it, specifically the perceived packet traffic and administrative policies of the host.

VC-multiplexed IP is specified by using only the layer 3 identifier in B-LLI using an ISO-TR-9577 protocol codepoint. Since no layer 2 is specified, frames produced by AAL processing will be given directly to IP. Since IP is highest specified protocol, it will be responsible for managing the connection.

8. Information Elements with Significance to the ATM Network

This section describes the coding of, and procedures surrounding, information elements with significance to the ATM network, as well as the endpoints of an ATM call supporting multiprotocol operation.

The standards, implementation agreements, research and experience surrounding such issues as traffic management, quality of service and bearer service description are still evolving. Much of this material is cast so as to give the greatest possible latitude to ATM network implementation and service offerings. ATM endsystems need to match the traffic contract and bearer service they request from the network to the capabilities offered by the network. Therefore, this memo can only offer what, at the present time, are the most appropriate and efficient coding rules to follow for setting up IP and ATMARP VCCs.

8.1. ATM User Cell Rate

The ATM Traffic descriptor is contained in the ATM User Cell Rate IE (called ATM Traffic Descriptor in UNI 3.1 erratum). It characterizes the ATM virtual connection in terms of peak cell rate (PCR), sustainable cell rate (SCR), and maximum burst size. This information is used to allocate resources (e.g., bandwidth, buffering) in the network. In general, the ATM traffic descriptor for supporting multiprotocol interconnection over ATM will be driven by factors such as the capacity of the network, conformance definition supported by the network, performance of the ATM endsystem and (for public networks) cost of services.

The most convenient model of IP behavior corresponds to the Best Effort Capability (see section 3.6.2.4 of [ATMF93]). If this capability is offered by the ATM network(s), it SHOULD be requested by including the Best Effort Indicator, the peak cell rate forward (CLP=0+1) and peak cell rate backward (CLP=0+1) fields in the ATM User Cell Rate IE.

Format and field values of ATM User Cell Rate IE

user_cell_rate

fwd_peak_cell_rate_0+1_identifier	132	
fwd_peak_cell_rate_0+1	(link rate)	
bkw_peak_cell_rate_0+1_identifier	133	
bkw_peak_cell_rate_0+1	(link rate)	
best_effort_indication	190	

[ATMF93] does not provide any capability for negotiation of the ATM User Cell Rate. This means that:

a) the calling endsystem SHOULD have a "pretty good idea" as to the traffic contract that will be acceptable to both the called endsystem and the network.

b) if, in response to a SETUP message, a calling endsystem receive a RELEASE COMPLETE message, or a CALL PROCEEDING message followed by a RELEASE COMPLETE message, with cause #51, User cell rate unavailable, it MAY examine the diagnostic field of the Cause IE and reattempt the call after selecting smaller values for the parameter(s) indicated. If the RELEASE COMPLETE or RELEASE message is received with cause #73, Unsupported combination of traffic parameter, it MAY try other combinations from table 5-7 and 5-8 of [ATMF93].

c) the called endsystem SHOULD examine the ATM traffic descriptor IE in the SETUP message. If it is unable to process cells at the Forward PCR indicated, it should clear the call cause #51, User cell rate unavailable.

8.2. Broadband Bearer Capability

Broadband Bearer Connection Oriented Service Type X (BCOB-X) or Type C (BCOB-C) are applicable for multiprotocol interconnection, depending on the service(s) provided by the ATM network and the capabilities (e.g. for traffic shaping) of the ATM endsystem. The example coding of Broadband Bearer Capability in figure D.2.1 of [ATMF93] applies for BCOB-C. When BCOB-X is specified, the "traffic type" and "timing requirements" fields SHALL both be set to "no indication". The susceptibility to clipping and User plane traffic configuration SHALL be set to "not susceptible to clipping" and "point-to-point", respectively.

bb_bearer_capability		
spare	0	
bearer_class	16	(BCOC-X)
spare	0	
traffic_type	0	(no indication)
timing_reqs	0	(no indication)
susceptibility_to_clipping	0	(not suscept)
spare	0	
user_plane_configuration	0	(point_to_point)

[ATMF93] does not provide any capability for negotiation of the broadband bearer capability. This means that:

a) the calling endsystem SHOULD have a "pretty good idea" as to the broadband bearer capability that will be acceptable to both the called endsystem and the network.

b) if, in response to a SETUP message, a calling endsystem receives a RELEASE COMPLETE message, or a CALL PROCEEDING message followed by a RELEASE COMPLETE message, with cause #57, bearer capability not authorized or #58 bearer capability not presently available, it MAY reattempt the call after selecting another bearer capability.

8.3. QoS Parameter

The Unspecified QoS class (Class 0), the Specified QoS Class for Connection Oriented Data Transfer (Class 3) or the Specified QoS Class for Connectionless Data Transfer (Class 4) may be applicable to multiprotocol over ATM. The available combination of QoS parameters with the ATM User Cell Rate and the Broadband Bearer Capability is specific to the ATM network.

Format and field values of QoS Parameters IE

qos_parameter		
qos_class_fwd	0	(class 0)
qos_class_bkw	0	(class 0)

[ATMF93] does not provide any capability for negotiation of Quality of Service parameters. This means that:

a) the calling endsystem SHOULD have a "pretty good idea" as to the QoS classes offered by the ATM network in conjunction with the requested Broadband Bearer Service and traffic descriptor.

b) if, in response to a SETUP message, a calling endsystem receives a RELEASE COMPLETE message, or a CALL PROCEEDING message followed by a RELEASE COMPLETE message, with cause #49, Quality of Service unavailable, it MAY reattempt the call after selecting another QoS class.

Note: In UNI 3.1 a new code point of '00' has been added to the coding standard field in the IE header. This code point has been added for compatibility with Q.2931 and is to be used when indicating the Unspecified QoS class (class 0). Therefore, the coding standard field SHALL be set to '00' when indicating QoS class 0, as is suggested for IP.

8.4. ATM Addressing information

ATM addressing information is carried in the Called Party Number, Calling Party Number, and, under certain circumstance, Called Party Subaddress, and Calling Party Subaddress IE. Section 5.1.3 and Annex A of [ATMF93] describes the syntax and semantics of ATM addressing information, including use of the subaddress IE. Section 5.8 of [ATMF93] provides the procedure for an ATM endsystem to learn its own ATM address from the ATM network, for use in populating the Calling Party Number IE.

Resolution of IP address to an ATM address is required of hosts and router which are ATM endsystems that use ATM SVCs. RFC 1577 provides a mechanism for doing IP to ATM address resolution in the classical IP model.

Format and field values of Called Party Number IE

called_party_number	
type_of_number	(international number / unknown)
addr_plan_ident	(ISDN / ISO NSAPA)
number	(E.164 / OSI NSAPA)

Format and field values of Calling Party Number IE

```
-------------------------------------------------------------
| calling_party_number                                      |
-------------------------------------------------------------
|  type_of_number      (international number / unknown)     |
|  addr_plan_ident     (ISDN / ISO NSAPA)                   |
|  presentation_indic  (presentation allowed)               |
|  spare               0                                    |
|  screening_indic     (user provided verified & passed)    |
|  number              (E.164 / OSI NSAPA)                  |
-------------------------------------------------------------
```


9. Dealing with Failure of Call Establishment

If an ATM call attempt fails with any of the following cause, the situation SHALL be treated as "network unreachable" (if the called ATM endsystem is a router) or "host unreachable" (if the called ATM endsystem is a host).

```
#  1  unallocated (unassigned) number
#  3  no route to destination
# 17  user busy
# 18  no user reponding
# 27  destination out of order
# 38  network out of order
# 41  temporary failure
# 47  resource unavailable, unspecified
```

If an ATM call attempt fails with any of the following causes, the ATM endpoint may retry the call, changing (or adding) the IE(s) indicated by the cause code and diagnostic.

```
#  2  no route to specified transit network
# 21  call rejected
# 22  number changed
# 23  user rejects call with CLIR
# 49  quality of service unavailable
# 51  user cell rate unavailable
# 57  bearer capability not authorized
# 58  bearer capability not presently available
# 65  bearer capability not implemented
# 73  unsupported combination of traffic parameter
# 88  incompatible destination
# 91  invalid transmit network selection
```

93 AAL parameter cannot be supported

Any cause in the protocol error class (value 96 to 111) where the location is either private network serving the local user or public network serving the local user

10. Security Consideration

Security consideration are not addressed in this memo.

11. Acknowledgments

The authors wish to thank the work of their colleagues who attend the IP over ATM working group; the ATM Forum Technical Committee; the ATM Signaling Subworking Group in ANSI-Accredited Technical Subcommittee T1S1; the ATM Access Signaling experts in ITU-T (formerly CCITT) Study Group 11. Rao Cherukuri (IBM) and Jeff Kiel (formerly with Bellcore, presently with BellSouth) were particularly valuable in coordinating among T1S1, ITU-T and the ATM Forum to make sure that the needs of multiprotocol over ATM could be expressed in the ATM signaling protocol.

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Appendix A. Frame Relay Interworking

1. SSCS vs. LLC

Procedures for Frame Relay to ATM signaling interworking have not yet been specified by ITU-T, the ATM Forum, or the Frame Relay Forum. If an ATM endsystem wishes to use FR-SSCS, FR-SSCS and RFC 1490 encapsulation must both be be specified in the SETUP message. Nevertheless, since neither LLC encapsulation nor VC-multiplexing will interoperate when used over FR-SSCS, these two encapsulations cannot be negotiated as alternatives to RFC 1490 encapsulation.

In ATM environments the SSCS layer is part of the AAL functionality.

The SSCS serves to coordinate the needs of a protocol above with the requirements of next lower layer, the Common Part Convergence Sublayer (CPCS). For example, the UNI ATM signaling protocol runs on top of a signaling SSCS which among other things provides an assured transfer service for signaling messages. Since the SSCS is considered part of the AAL, the SSCS type is specified as one of the parameters in the AAL Parameters IE. To date there has not been an SSCS defined for data transmission in ATM and this type field is usually set to 'null'.

The exception occurs when doing FR interworking where an ATM endsystem may choose to use the FR-SSCS over AAL 5 in order to communicate with a FR endsystem. In that case the SSCS type in the AAL Parameters IE of the SETUP message is set to 'FR-SSCS'.

Also included in a SETUP message is an indication in the B-LLI IE of the protocol layers to be used above the AAL. In particular, ATM connections established to carry connectionless network interconnect traffic require a layer above the AAL for multiplexing multiple protocols over a single VC [HEIN 93]. As mentioned above, RFC 1577 defines LLC as default multiplexing layer for IP over AAL5.

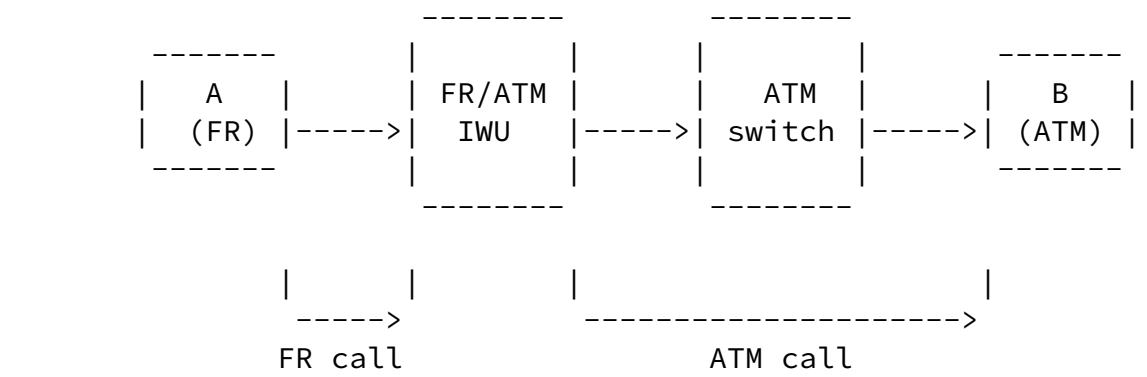
Specification of the SSCS restricts the encapsulation protocol used over it, since RFC 1483 (in addition to applicable ITU standards) requires the use of RFC 1490 encapsulation over the FR-SSCS, and LLC or null encapsulation otherwise. The fact that it is not possible, in the UNI 3.1 signaling specification, to negotiate between the FR-SSCS and null SSCS can result in interoperability restrictions between stations that implement and wish to use the FR-SSCS and those that do not, even though they both are using IP. The guidelines in the following section were developed to decrease the chance that such interoperability restrictions occur.

2. Scenarios for Interworking

The following discussion uses the terms "network interworking" and "service interworking". "Network interworking" uses FR-SSCS over AAL5 between the InterWorking Unit (IWU) and the ATM endsystem, and the ATM endsystem is aware that the other endpoint is a FR/ATM Network IWU. "Service interworking" aims to make the operation transparent to the ATM endsystem by adding encapsulation translation and other payload processing in the FR/ATM Service IWU to allow the

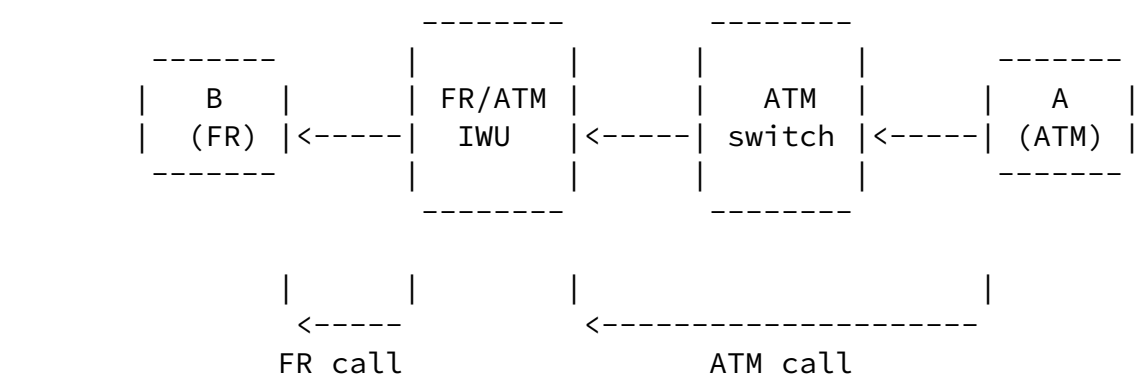
ATM endsystem to operate as if it were talking to another ATM endsystem.

The most common scenario where FR-SSCS could be negotiated is between an ATM endsystem and a FR/ATM network IWU to allow connectivity among an ATM endsystem and a FR endsystem residing behind a FR/ATM network IWU.



A network IWU can place a call to an ATM host (on behalf of a FR host) by signaling for FR-SSCS and assuming that the ATM endsystem supports FR-SSCS. The B-LLI IE SHALL be encoded to indicate RFC 1490 encapsulation and the SSCS type field of the AAL Parameters IE SHALL be coded to indicate FR-SSCS. If the FR-SSCS negotiation fails because the called ATM host does not support FR-SSCS, the IWU can retry the call negotiating for LLC encapsulation or VC-multiplexing. However, the IWU can only attempt the retry if it is able to do FR-ATM service interworking. Such service interworking adds extra processing overhead during the call.

The even more problematic case occurs when a call is requested in the opposite direction, i.e. when an ATM host places a call to a host residing behind an IWU.



Not knowing that the destination resides behind an IWU, the calling host will negotiate for the default LLC encapsulation (possibly requesting VC-multiplexing as an alternative). In this situation the IWU can accept the call and do the necessary service interworking or reject the call specifying 'AAL Parameters not supported'. If the IWU

rejects the call it risks the possibility that calling host does not support FR-SSCS or simply does not retry and the call will never be

established.

3. Possible Alternatives

While Frame Relay interworking is possible, it is not possible to negotiate FR-SSCS with LLC encapsulation or VC-multiplexing, which decreases the chances of completing an ATM call. However, interoperability can be increased using the following alternatives:

1. Maintaining external knowledge that a particular destination uses FR-SSCS. This knowledge can be configured, or in the future added to some network host database.

2. In the absence of such external knowledge, an ATM endsystem is required to negotiate for the default LLC encapsulation (possibly requesting VC-multiplexing as an alternative). There are three subcases:

2a. The IWU supports service interworking and network interworking, and prefers service interworking. The IWU simply accepts the call using LLC encapsulation.

2b. The IWU supports service interworking and network interworking, and prefers network interworking. The IWU simply accepts the call, but attempts to open a parallel connection back to the original ATM endsystem negotiating the FR-SSCS use. If the connection is accepted, the IWU closes the service interworking connection.

2c. The IWU supports network interworking only. The IWU rejects the call specifying 'AAL Parameters not supported', and then attempts to open a connection back to the original ATM endsystem negotiating the FR-SSCS use.

Appendix B. Sample Signaling Messages

This annex shows sample codings of the SETUP and CONNECT signaling messages. The fields in the IE header are not shown.

SETUP

Information Elements/ Fields	Value/(Meaning)	
aal_parameters		
aal_type	5	(AAL 5)
fwd_max_sdu_size_ident	140	
fwd_max_sdu_size	9188	(default, send IP MTU value)
bkw_max_sdu_size_ident	129	
bkw_max_sdu_size	9188	(default, recv IP MTU value)
mode identifier	131 *	
mode	message *	
sscs_type identifier	132	
sscs_type	0	(null SSCS)
user_cell_rate		
fwd_peak_cell_rate_0_1_ident	132	
fwd_peak_cell_rate_0_1	(link rate)	
bkw_peak_cell_rate_0_1_ident	133	
bkw_peak_cell_rate_0_1	(link rate)	
best_effort_indication	190	
bb_bearer_capability		
spare	0	
bearer_class	16	(BCOC-X)
spare	0	
traffic_type	0	(no indication)

```
    timing_reqs                     0       (no indication)
    susceptibility_to_clipping      0       (not susceptible to clipping)
    spare                           0
    user_plane_configuration        0       (point_to_point)

  bb_low_layer_information
    layer_2_id                      2
    user_information_layer          12      (lan_llc (ISO 8802/2)

  qos_parameter
    qos_class_fwd                   0       (class 0)
    qos_class_bkw                   0       (class 0)

  called_party_number
    type_of_number                  (international number / unknown)
    addr_plan_ident                 (ISDN / ISO NSAPA)
    number                          (E.164 / OSI NSAPA)

  calling_party_number
    type_of_number                  (international number / unknown)
    addr_plan_ident                 (ISDN / ISO NSAPA)
    presentation_indic              (presentation allowed)
    spare                           0
    screening_indic                 (user_provided verified and passed)
    number                          (E.164 / OSI NSAPA)
```

Figure 1.
Sample contents of SETUP message

[* : optional, ignored if present]

In IP over ATM environments the inclusion of the "AAL parameters" IE is *mandatory* to allow for MTU size negotiation between the source and destination. The "Broadband Low Layer Information" IE is also mandatory for specifying the IP encapsualtion scheme.

CONNECT

```
  Information Elements/
    Fields                          Value
  --------------------              -----
  aal_parameters
    aal_type                        5       (AAL 5)
```

```
    fwd_max_sdu_size_ident          140
    fwd_max_sdu_size                9188     (default, send IP MTU value)
    bkw_max_sdu_size_ident          129
    bkw_max_sdu_size                9188     (default, recv IP MTU value)
    mode identifier                 131 *
    mode                            message *
    sscs_type identifier            132

  bb_low_layer_information
    layer_2_id                      2
    user_information_layer          12       (lan_llc (ISO 8802/2)

  connection identifier
    spare                           0
    vp_assoc_signaling              1        (explicit indication of VPCI)
    preferred_exclusive             0        (exclusive vpci/vci)
    vpci                            (assigned by network)
    vci                             (assigned by network)
+-------------------------------------------------------------------+
```

Figure 2.
Sample contents of CONNECT message

As in the SETUP message, IP over ATM environments demand the inclusion of the "AAL parameters" IE so that the destination may specify the MTU size that it is willing to receive.