

The ATM Forum
Technical Committee

**Frame-based ATM Transport over Ethernet
(FATE)**

AF-FBATM-0139.001

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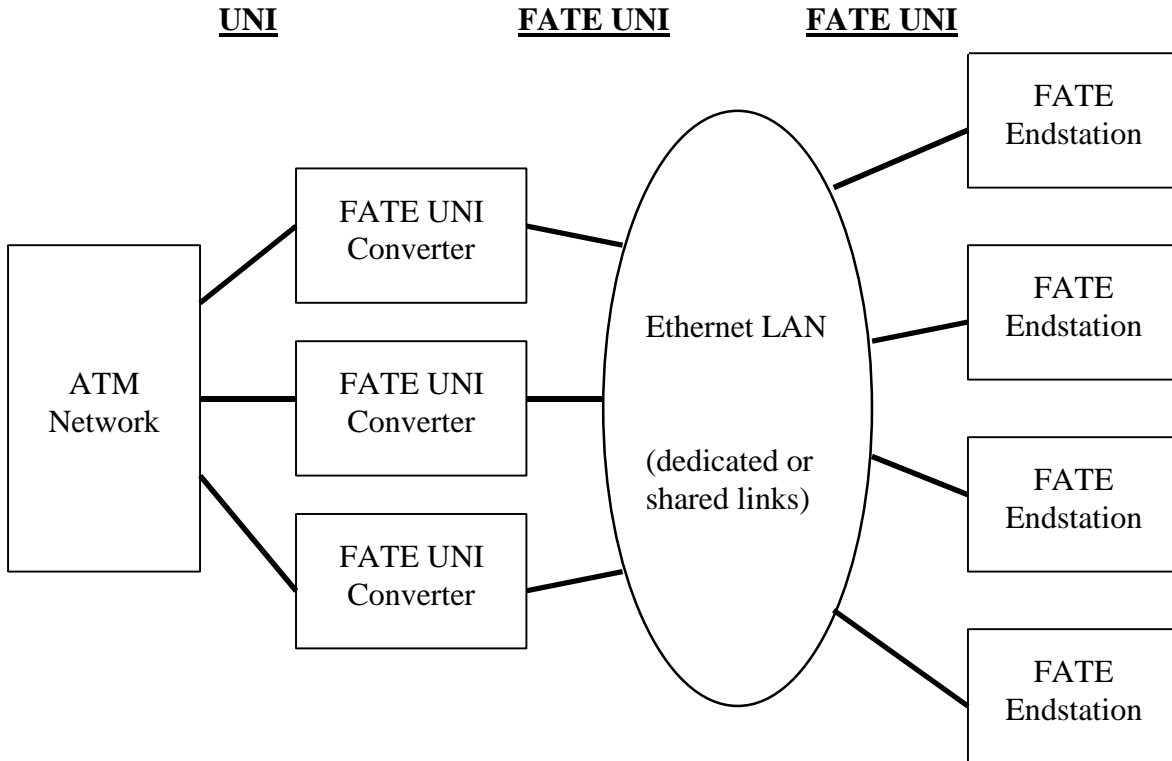
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1. Introduction

The Frame-Based ATM Transport over Ethernet specification (called “FATE” herein) allows ATM services to be provided over Ethernet [1] media. This is accomplished by transporting ATM data within an Ethernet frame. This specification is defined for the UNI only at this time and the FATE for NNI is for further study.

2. Reference Model

The following diagram illustrates the FATE UNI reference model.



2.1 ADSL Customer Premises Environment

In the context of an ADSL customer premises environment [2], the reference model elements are intended to represent the following components:

- **ATM Network** - An ADSL access network that supports the “ATM mode” of ADSL and provides a path into an ATM public network.
- **FATE UNI Converter** - An external ATU-R modem, located on the customer premises.
- **FATE Endstation** - A personal computer (PC) running applications that communicate across the network using either traditional transport/network protocols (e.g. TCP/IP) or native ATM protocols.

2.2 Corporate LAN Environment

In the context of a corporate LAN environment, the reference model elements are intended to represent the following components:

- **ATM Network** – A campus ATM backbone that optionally provides a path into an ATM public network.
- **FATE UNI Converter** - An Ethernet switch/hub with an ATM uplink.
- **FATE Endstation** - A personal computer (PC) running applications that communicate across the network using either traditional transport/network protocols (e.g. TCP/IP) or native ATM protocols.

3. Relationship to Other Protocols

The following table shows the relationship between the protocol defined herein and other protocols, for message flows across the Ethernet media.

Control			User Data	Management		
RM Cells	Q.2931	PVC Mux (2)	AAL-5 payloads	ILMI	xDSL modem management (3)	OAM Cells
	Q.2100			SVC Mux (1)		
	SVC Mux (1)					
Frame-based ATM Transport over Ethernet (FATE) (including DISCOVER messages)						
Ethernet DIX or 802.3						

Notes:

1. "SVC Mux" is an optional method by which a single signaling [3] channel (including the portion of the ILMI [4] MIB required for ATM address registration) provided by the ATM network may be shared across multiple FATE Endstations. In this scheme, each FATE UNI establishes signaling and ILMI channels upon the default VPI/VCI pair.
2. "PVC Mux" is an optional method by which a set of permanent virtual circuits provided by the ATM network may be shared across multiple FATE Endstations. With this protocol, FATE Endstations request (and later release) exclusive use of a given virtual circuit.
3. "xDSL modem management" is an optional method by which command and status information is communicated between a FATE Endstation and a xDSL modem. Protocol messages might contain information about the status (up/down) of the xDSL link, the upstream and downstream link rate, xDSL power management state, and dual latency channel partitioning. This work item is for further study.

4. Taxonomy of FATE UNI Converters

4.1 Support of Single FATE Endstation

A relatively small number of functions are required to be present in a FATE UNI Converter that supports only a single FATE Endstation as shown in Figure 4.1 below. There are three basic requirements:

1. translation between ATM cells flowing across the ATM Network and FATE UNI payloads flowing across the Ethernet media
2. support for discovery messages and procedures, described in sections 5 and 7
3. termination of message flows related to “xDSL modem management” if appropriate, previously identified in section 3

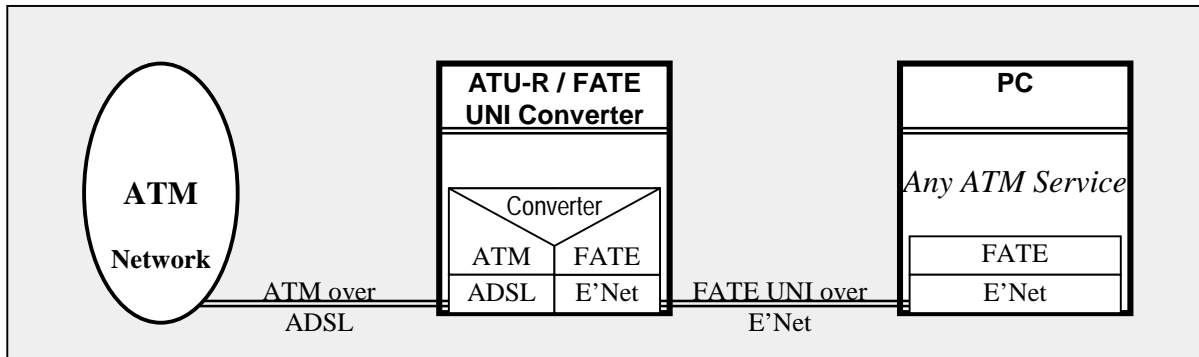


Fig 4.1. Single-PC support with Simple ATU-R

There is no requirement for the “SVC Mux” or “PVC Mux” functions, previously identified in section 3. Since the FATE Endstation terminates the signaling and ILMI links, there is no requirement to implement a complete signaling or ILMI protocol stack; however, some parsing of the signaling and ILMI flows may be required for ATM traffic management.

4.2 Support of Multiple FATE Endstations

In addition to the functions listed in the previous sub-section (to support a single FATE Endstation), support of multiple FATE Endstations requires the ability to multiplex SVC and PVC services among the FATE Endstations as shown in Figure 4.2 below. The “SVC Mux” and “PVC Mux” functions, previously identified in section 3, offer one solution. Another possibility is to add the functionality of an ATM switch to the FATE UNI Converter. Some parsing of the signaling and ILMI flows may be required for ATM traffic management.

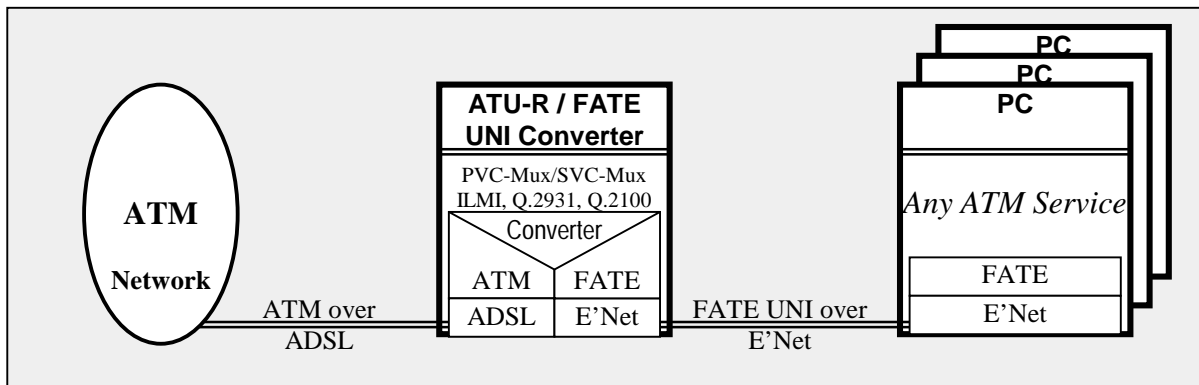


Fig 4.2. Multi-PC support with Intelligent ATU-R

5. Frame Format

5.1 Ethernet Header and Trailer

The general frame format for an Ethernet (DIX) frame is shown below.

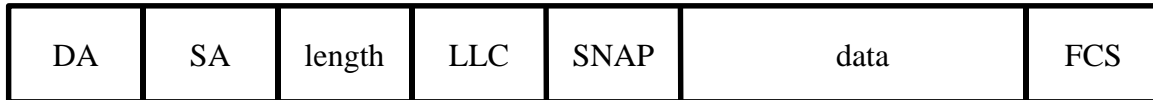


where the following definitions apply:

- **DA** - the destination MAC address (6 octets)
- **SA** - the source MAC address (6 octets)
- **type** - the "Ethertype" that identifies the format of the data field (2 octets)
- **data** - the payload of the Ethernet frame; this could be either:
 1. a FATE UNI header, followed by a FATE payload
 2. a FATE discovery message
- **FCS** - the frame sequence check (4 octets)

Any packet carrying a FATE UNI header and FATE payload shall be distinguished by the use of a new Ethertype value (0x8884) placed in the type field. Any packet carrying a FATE discovery message shall be distinguished by the use of a second Ethertype value (0x884C) placed in the type field. Note that the Ethertype 0x884C is also used by the MPOA protocol, however, it is believed that there is no risk of a conflict in the dual use of this Ethertype.

The general frame format for an 802.3 frame is shown below.



where the following definitions apply:

- **DA** - the destination MAC address (6 octets)
- **SA** - the source MAC address (6 octets)
- **length** - the length of the MAC frame (2 octets)
- **LLC** - the 802.2 header that specifies a SNAP header immediately following (3 octets)
- **SNAP** - the header that identifies the format of the data field (5 octets, including "Ethertype" field)
- **data** - the payload of the Ethernet frame; this could be either:
 1. a FATE UNI header, followed by a FATE payload
 2. a FATE discovery message
- **FCS** - the frame sequence check (4 octets)

Any packet carrying a FATE UNI header and FATE payload shall be distinguished by the use of a new Ethertype value (0x8884) placed in the SNAP field. Any packet carrying a FATE discovery message shall be distinguished by the use of a second Ethertype value (0x884C) placed in the SNAP field. Note that the Ethertype 0x884C is also used by the MPOA protocol, however, it is believed that there is no risk of a conflict in the dual use of this Ethertype.

5.2 FATE UNI Header

The FATE UNI header shall be identical to the first 4 octets of the ATM cell header. Thus, FATE UNI header shall contain the GFC, VPI, VCI, PT, and CLP fields of the ATM cell structure.

5.3 FATE Payload

5.3.1 AAL5 Frames

The FATE payload uses a fragmentation model similar to the one defined by “Multi-Service Extensions to FUNI Specification” [6]. There are several differences however, between the fragmentation model used by FATE and the model used by FUNI:

- In FATE UNI, fragmentation for AAL5 frames is always enabled; whereas, FUNI fragmentation is enabled or disabled on a link via configuration of equipment
- In FATE UNI, the maximum fragment size shall be negotiated via FATE discovery messages

There are several potential limiting factors to consider in the selection of the link maximum fragment size:

- the maximum transmission unit (MTU) size of the Ethernet link
- the transmission latency of a data packet that may result in unacceptable performance degradation of real-time services
- the FATE UNI Converter may limit the number of cells simultaneously undergoing re-assembly; note that in the extreme case, a FATE UNI Converter may limit the link’s maximum fragment size to 48 bytes (of the AAL5 payload) per Ethernet frame, which would result in minimum FATE UNI Converter processing

The FATE payload format for an AAL5 frame is shown below.

B	E	reserved	Sequence # (high 4 bits)
Sequence # (low 8 bits)			
Length (high 8 bits)			
Length (low 8 bits)			
UU			
CPI			
data			

where the following definitions apply:

- **B** - the Beginning fragment bit, identical to the analogous field defined by “Multi-Service FUNI Specification” (1 bit).
- **E** - the Ending fragment bit, identical to the analogous field defined by “Multi-Service FUNI Specification” (1 bit).
- **reserved** - this field is reserved for future use (2 bits).
- **Sequence #** - the fragment sequence number, identical to the analogous field defined by “Multi-Service Extensions to FUNI Specification” (12 bits).

- **Length** - the length, in octets, of the data field (2 octets).
- **UU** - the User-to-User indication field from the AAL5 trailer (1 octet).
- **CPI** - the Common Part Indicator field from the AAL5 trailer (1 octet).
- **data** - the AAL5 SSCS PDU.

Note that the AAL5 CRC field is not included in the FATE payload. The AAL5 CRC is not needed because data integrity is provided by the Ethernet FCS field. Also, inclusion of the AAL5 CRC would in practice require the FATE Endstation to perform AAL5 CRC generation and checking in software. The FATE UNI Converter must generate and check CRC for AAL5 frames sent or received across the ATM network; thus the FATE UNI Converter performs proxy AAL5 CRC generation and checking on behalf of the FATE Endstation.

5.3.2 OAM Cells

The FATE payload shall be identical to ATM cell payload of an OAM cell. In other words, the FATE payload shall be identical to octets 6-53 of the analogous ATM OAM cell.

5.3.3 RM Cells

The FATE payload shall be identical to ATM cell payload of a RM cell. In other words, the FATE payload shall be identical to octets 6-53 of the analogous ATM RM cell.

5.4 FATE Discovery Messages

5.4.1 DISCOVER-REQ

The DISCOVER-REQ message is sent from the FATE Endstation to the FATE UNI Converter. Its purpose is to request that the FATE UNI Converter respond with a DISCOVER-ACK message.

0	1	2	3
0 1 2 3 4 5 6 7	8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3	4 5 6 7 8 9 0 1
Version = 1	Message Type = 1	reserved	Message Length = 8
Reserved		Maximum Fragment Size	

- **Maximum Fragment Size** – the maximum size, in octets, of AAL-5 fragments across the FATE UNI, as suggested by the Endstation. This value specifies the length of the “data” field within the FATE payload for AAL5 frames.

5.4.2 DISCOVER-ACK

The DISCOVER-ACK message is sent from the FATE UNI Converter to the FATE Endstation. Its purpose is to advertise the MAC address and service capabilities of the FATE UNI Converter.

0								1					2				3														
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Version = 1								Message Type = 2					reserved				Message Length = 20														
reserved				MX				reserved		Loading			Maximum Fragment Size																		
Link Status								Link Type					reserved																		
Upstream Link Data Rate																															
Downstream Link Data Rate																															

where the following definitions apply:

- **MX** – the PVC multiplexing capability of the FATE UNI Converter. These two bits are encoded in the following manner:
 - 0 = no multiplexing; only a single FATE Endstation is supported
 - 1 = PVC multiplexing; any FATE Endstation must request PVC resources before sending or receiving user data on that PVC
- **Loading** – the perceived loading of the FATE UNI Converter. These four bits are encoded in the following manner:
 - 0 = the FATE UNI Converter is idle
 - 1 – 10 = the FATE UNI Converter is available, but is currently servicing requests from other FATE Endstations; an increasing value of this field represents increased loading at the FATE UNI
 - 15 = the FATE UNI Converter is unavailable for servicing additional FATE Endstations
- **Maximum Fragment Size** – the maximum size, in octets, of AAL-5 fragments across the FATE UNI, as negotiated for this FATE UNI Converter/Endstation pair. This field’s value shall be the minimum of that suggested by the Endstation (within the DISCOVER-REQ message) and the maximum fragment size supported by the FB_UNI Converter. This value specifies the length of the “data” field within the FATE payload for AAL5 frames.
- **Link Status** - the status of the link connecting the FATE UNI Converter to the ATM Network, encoded in the following manner:
 - 0 = link is down
 - 1 = link is in power-saving mode
 - 2 = link is up
- **Link Type** - the type of the link connecting the FATE UNI Converter to the ATM Network, encoded in the following manner:
 - 0 = ATM physical layer, non-SONET (e.g. 25 Mbps ATM)
 - 1 = ATM physical layer, SONET (e.g. 155 Mbps ATM)
 - 2 = ADSL
- **Upstream Link Data Rate** - the data rate, in bits per second, of the link connecting the FATE UNI Converter to the ATM Network, in the direction towards the ATM Network. If the link is modeled as multiple physical ATM links (e.g. ADSL "fast path" versus "interleaved path"), then this number is the aggregate throughput.
- **Downstream Link Data Rate** - the data rate, in bits per second, of the link connecting the FATE UNI Converter to the ATM Network, in the direction towards the FATE UNI Converter. If the link is modeled as multiple physical ATM links (e.g. ADSL "fast path" versus "interleaved path"), then this number is the aggregate throughput.

6. Traffic Management Considerations

It can be difficult to achieve the guaranteed quality of service (QoS) normally associated with ATM, because the underlying Ethernet media does not guarantee QoS. With careful traffic engineering, however, a level of QoS that satisfies many applications can be obtained. Rather than specify an exact network configuration, the table below identifies factors that serve to either enhance or degrade the ability to achieve QoS across the Ethernet link.

Factor	Enhances QoS	Degrades QoS
Ethernet link access (1)	dedicated	shared
Ethernet link access (2)	full-duplex	half-duplex
802.1 bridge (s) with flooding enabled between FATE UNI converter and FATE Endstation	no	yes
maximum fragment size	small	large
ratio between bandwidth of Ethernet link and bandwidth of traffic from FATE UNI Converter to ATM Network (assumes FATE Endstation shapes traffic to UNI between ATM Network and FATE UNI Converter)	large	small
ratio between bandwidth of Ethernet link and bandwidth of traffic from ATM Network to FATE UNI Converter	large	small

7. Discovery Procedures

7.1 FATE Endstation

The FATE Endstation initiates the discovery process by sending a DISCOVER-REQ message to the FATE UNI Converter. The DA field of the Ethernet header contains a unique group (multicast) MAC address (01-A0-3E-00-00-01) that distinguishes FATE DISCOVER-REQ messages. The SA field of the Ethernet header contains the FATE Endstation's MAC address. The Maximum Fragment Size field contains the value suggested by the FATE Endstation.

In the event that a corresponding DISCOVER-ACK message is not received, the FATE Endstation may retry the process by sending additional DISCOVER-REQ messages. The FATE Endstation may send a maximum of three DISCOVER-REQ messages per minute, and must allow an interval of at least one second between each transmitted DISCOVER-REQ message.

The FATE Endstation expects to receive DISCOVER-ACK messages from any FATE UNI Converter on the Ethernet segment. The FATE Endstation observes the frame's SA field of the Ethernet header to learn the MAC address of the FATE UNI Converter. By examining various fields of the DISCOVER-ACK message, the FATE Endstation can determine whether or not the capabilities of the FATE UNI Converter meet the FATE Endstation's service requirements. Note that the Maximum Fragment Size field may contain a value different than that suggested by the FATE Endstation; this occurs when the FATE UNI Converter does not support the previously suggested value. In any case, the value of the maximum fragment size appearing in the DISCOVER-ACK message is the value that shall be used for FATE UNI communication between the Endstation and Converter.

In the scenario where many FATE UNI Converters exist within the Ethernet segment, the FATE Endstation receives DISCOVER-ACK messages from each of the FATE UNI Converters. By examining and comparing various fields of the DISCOVER-ACK messages, the FATE Endstation can intelligently select which FATE UNI Converter to use for communication across the ATM Network.

7.2 FATE UNI Converter

Upon receiving a DISCOVER-REQ message, the FATE UNI Converter responds via a DISCOVER-ACK message. Within the DISCOVER-ACK message, the SA field of the Ethernet header contains the MAC address of the FATE UNI Converter and the DA field contains the MAC address of the FATE Endstation. If the FATE UNI Converter does not support the maximum fragment size suggested within the DISCOVER-REQ message, then the FATE UNI Converter negotiates a lower value by placing the Converter's maximum supported fragment size within the DISCOVER-ACK message.

8 References

- [1] IEEE, 802.3 Ethernet
- [2] ADSL Forum, CPE Architectures Recommendation, WT-32
- [3] ATM Forum, ATM UNI Signaling Specification v4.0, af-sig-0061.000
- [4] ATM Forum, Integrated Local Management Interface (ILMI) Specification v4.0, af-ilmi-0065.000
- [6] ATM Forum, Multi-service Extensions to FUNI v2.0 Specification, af-saa-0109-000