

IP Tunnel MIB

Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The Internet Society (1999). All Rights Reserved.

1. Abstract

This memo defines a Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects used for managing tunnels of any type over IPv4 networks. Extension MIBs may be designed for managing protocol-specific objects. Likewise, extension MIBs may be designed for managing security-specific objects. This MIB does not support tunnels over non-IPv4 networks (including IPv6 networks). Management of such tunnels may be supported by other MIBs.

Table of Contents

1 Abstract .....	1
2 Introduction .....	2
3 The SNMP Network Management Framework .....	2
4 Overview .....	3
4.1 Relationship to the Interfaces MIB .....	3
4.1.1 Layering Model .....	3
4.1.2 ifRcvAddressTable .....	4
4.1.3 ifEntry .....	4
5 Definitions .....	4
6 Security Considerations .....	12
7 Acknowledgements .....	12
8 Author's Address .....	12
9 References .....	13
10 Intellectual Property Notice .....	15
11 Full Copyright Statement .....	16

## 2. Introduction

Over the past several years, there have been a number of "tunneling" protocols specified by the IETF (see [28] for an early discussion of the model and examples). This document describes a Management Information Base (MIB) used for managing tunnels of any type over IPv4 networks, including GRE [16,17], IP-in-IP [18], Minimal Encapsulation [19], L2TP [20], PPTP [21], L2F [25], UDP (e.g., [26]), ATMP [22], and IPv6-in-IPv4 [27] tunnels.

Extension MIBs may be designed for managing protocol-specific objects. Likewise, extension MIBs may be designed for managing security-specific objects (e.g., IPSEC [24]), and traffic conditioner [29] objects. Finally, this MIB does not support tunnels over non-IPv4 networks (including IPv6 networks). Management of such tunnels may be supported by other MIBs.

## 3. The SNMP Network Management Framework

The SNMP Management Framework presently consists of five major components:

- o An overall architecture, described in RFC 2571 [1].
- o Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIV1 and described in STD 16, RFC 1155 [2], STD 16, RFC 1212 [3] and RFC 1215 [4]. The second version, called SMIV2, is described in STD 58, RFC 2578 [5], STD 58, RFC 2579 [6] and STD 58, RFC 2580 [7].
- o Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157 [8]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [9] and RFC 1906 [10]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [10], RFC 2572 [11] and RFC 2574 [12].
- o Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157 [8]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [13].

- o A set of fundamental applications described in RFC 2573 [14] and the view-based access control mechanism described in RFC 2575 [15].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI.

This memo specifies a MIB module that is compliant to the SMIV2. A MIB conforming to the SMIV1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIV2 will be converted into textual descriptions in SMIV1 during the translation process. However, this loss of machine readable information is not considered to change the semantics of the MIB.

#### 4. Overview

This MIB module contains two tables:

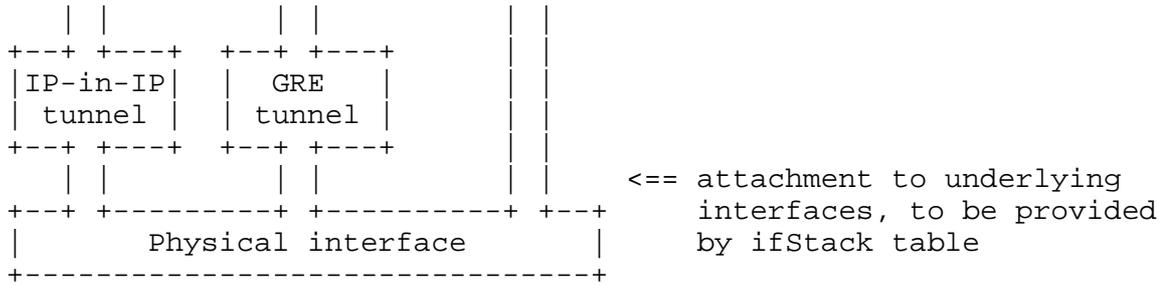
- o the Tunnel Interface Table, containing information on the tunnels known to a router; and
- o the Tunnel Config Table, which can be used for dynamic creation of tunnels, and also provides a mapping from endpoint addresses to the current interface index value.

##### 4.1. Relationship to the Interfaces MIB

This section clarifies the relationship of this MIB to the Interfaces MIB [23]. Several areas of correlation are addressed in the following subsections. The implementor is referred to the Interfaces MIB document in order to understand the general intent of these areas.

###### 4.1.1. Layering Model

Each logical interface (physical or virtual) has an ifEntry in the Interfaces MIB [23]. Tunnels are handled by creating a logical interface (ifEntry) for each tunnel. These are then correlated, using the ifStack table of the Interfaces MIB, to those interfaces on which the local IPv4 addresses of the tunnels are configured. The basic model, therefore, looks something like this (for example):



4.1.2. ifRcvAddressTable

The ifRcvAddressTable usage is defined in the MIBs defining the encapsulation below the network layer. For example, if IP-in-IP encapsulation is being used, the ifRcvAddressTable is defined by IP-in-IP.

4.1.3. ifEntry

IfEntries are defined in the MIBs defining the encapsulation below the network layer. For example, if IP-in-IP encapsulation [20] is being used, the ifEntry is defined by IP-in-IP.

The ifType of a tunnel should be set to "tunnel" (131). An entry in the IP Tunnel MIB will exist for every ifEntry with this ifType. An implementation of the IP Tunnel MIB may allow ifEntries to be created via the tunnelConfigTable. Creating a tunnel will also add an entry in the ifTable and in the tunnelIfTable, and deleting a tunnel will likewise delete the entry in the ifTable and the tunnelIfTable.

The use of two different tables in this MIB was an important design decision. Traditionally, ifIndex values are chosen by agents, and are permitted to change across restarts. Allowing row creation directly in the Tunnel Interface Table, indexed by ifIndex, would complicate row creation and/or cause interoperability problems (if each agent had special restrictions on ifIndex). Instead, a separate table is used which is indexed only by objects over which the manager has control. Namely, these are the addresses of the tunnel endpoints and the encapsulation protocol. Finally, an additional manager-chosen ID is used in the index to support protocols such as L2F which allow multiple tunnels between the same endpoints.

## 5. Definitions

```
TUNNEL-MIB DEFINITIONS ::= BEGIN
```

```
IMPORTS
```

```
    MODULE-IDENTITY, OBJECT-TYPE, transmission,
    Integer32, IpAddress          FROM SNMPv2-SMI
    RowStatus                    FROM SNMPv2-TC
    MODULE-COMPLIANCE, OBJECT-GROUP FROM SNMPv2-CONF
    ifIndex, InterfaceIndexOrZero FROM IF-MIB;
```

```
tunnelMIB MODULE-IDENTITY
```

```
    LAST-UPDATED "9908241200Z" -- August 24, 1999
    ORGANIZATION "IETF Interfaces MIB Working Group"
    CONTACT-INFO
        " Dave Thaler
          Microsoft Corporation
          One Microsoft Way
          Redmond, WA 98052-6399
          EMail: dthaler@dthaler.microsoft.com"
```

```
DESCRIPTION
```

```
    "The MIB module for management of IP Tunnels, independent of
    the specific encapsulation scheme in use."
```

```
REVISION    "9908241200Z" -- August 24, 1999
```

```
DESCRIPTION
```

```
    "Initial version, published as RFC 2667."
```

```
::= { transmission 131 }
```

```
tunnelMIBObjects OBJECT IDENTIFIER ::= { tunnelMIB 1 }
```

```
tunnel          OBJECT IDENTIFIER ::= { tunnelMIBObjects 1 }
```

```
-- the IP Tunnel MIB-Group
```

```
--
```

```
-- a collection of objects providing information about
```

```
-- IP Tunnels
```

```
tunnelIfTable OBJECT-TYPE
```

```
SYNTAX      SEQUENCE OF TunnelIfEntry
```

```
MAX-ACCESS not-accessible
```

```
STATUS      current
```

```
DESCRIPTION
```

```
    "The (conceptual) table containing information on configured
    tunnels."
```

```
::= { tunnel 1 }
```

```
tunnelIfEntry OBJECT-TYPE
```

```
SYNTAX      TunnelIfEntry
```

```

MAX-ACCESS not-accessible
STATUS      current
DESCRIPTION
    "An entry (conceptual row) containing the information on a
    particular configured tunnel."
INDEX       { ifIndex }
 ::= { tunnelIfTable 1 }

```

```

TunnelIfEntry ::= SEQUENCE {
    tunnelIfLocalAddress      IpAddress,
    tunnelIfRemoteAddress    IpAddress,
    tunnelIfEncapsMethod     INTEGER,
    tunnelIfHopLimit         Integer32,
    tunnelIfSecurity         INTEGER,
    tunnelIfTOS              Integer32
}

```

```

tunnelIfLocalAddress OBJECT-TYPE
SYNTAX      IpAddress
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The address of the local endpoint of the tunnel (i.e., the
    source address used in the outer IP header), or 0.0.0.0 if
    unknown."
 ::= { tunnelIfEntry 1 }

```

```

tunnelIfRemoteAddress OBJECT-TYPE
SYNTAX      IpAddress
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The address of the remote endpoint of the tunnel (i.e., the
    destination address used in the outer IP header), or 0.0.0.0
    if unknown."
 ::= { tunnelIfEntry 2 }

```

```

tunnelIfEncapsMethod OBJECT-TYPE
SYNTAX      INTEGER {
    other(1),      -- none of the following
    direct(2),    -- no intermediate header
    gre(3),        -- GRE encapsulation
    minimal(4),   -- Minimal encapsulation
    l2tp(5),      -- L2TP encapsulation
    pptp(6),      -- PPTP encapsulation
    l2f(7),       -- L2F encapsulation
    udp(8),       -- UDP encapsulation
    atmp(9)       -- ATMP encapsulation
}

```

```

    }
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The encapsulation method used by the tunnel. The value
    direct indicates that the packet is encapsulated directly
    within a normal IPv4 header, with no intermediate header,
    and unicast to the remote tunnel endpoint (e.g., an RFC 2003
    IP-in-IP tunnel, or an RFC 1933 IPv6-in-IPv4 tunnel). The
    value minimal indicates that a Minimal Forwarding Header
    (RFC 2004) is inserted between the outer header and the
    payload packet. The value UDP indicates that the payload
    packet is encapsulated within a normal UDP packet (e.g., RFC
    1234). The remaining protocol-specific values indicate that
    a header of the protocol of that name is inserted between
    the outer header and the payload header."
 ::= { tunnelIfEntry 3 }

```

```

tunnelIfHopLimit OBJECT-TYPE
SYNTAX Integer32 (0..255)
MAX-ACCESS read-write
STATUS current
DESCRIPTION
    "The TTL to use in the outer IP header. A value of 0
    indicates that the value is copied from the payload's
    header."
 ::= { tunnelIfEntry 4 }

```

```

tunnelIfSecurity OBJECT-TYPE
SYNTAX INTEGER {
    none(1), -- no security
    ipsec(2), -- IPSEC security
    other(3)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The method used by the tunnel to secure the outer IP
    header. The value ipsec indicates that IPsec is used
    between the tunnel endpoints for authentication or
    encryption or both. More specific security-related
    information may be available in a MIB for the security
    protocol in use."
 ::= { tunnelIfEntry 5 }

```

```

tunnelIfTOS OBJECT-TYPE
SYNTAX Integer32 (-2..63)
MAX-ACCESS read-write

```

STATUS current

DESCRIPTION

"The method used to set the high 6 bits of the TOS in the outer IP header. A value of -1 indicates that the bits are copied from the payload's header. A value of -2 indicates that a traffic conditioner is invoked and more information may be available in a traffic conditioner MIB. A value between 0 and 63 inclusive indicates that the bit field is set to the indicated value."

::= { tunnelIfEntry 6 }

tunnelConfigTable OBJECT-TYPE

SYNTAX SEQUENCE OF TunnelConfigEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table containing information on configured tunnels. This table can be used to map a set of tunnel endpoints to the associated ifIndex value. It can also be used for row creation. Note that every row in the tunnelIfTable with a fixed destination address should have a corresponding row in the tunnelConfigTable, regardless of whether it was created via SNMP."

::= { tunnel 2 }

tunnelConfigEntry OBJECT-TYPE

SYNTAX TunnelConfigEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry (conceptual row) containing the information on a particular configured tunnel."

INDEX { tunnelConfigLocalAddress,  
tunnelConfigRemoteAddress,  
tunnelConfigEncapsMethod,  
tunnelConfigID }

::= { tunnelConfigTable 1 }

TunnelConfigEntry ::= SEQUENCE {

tunnelConfigLocalAddress	IpAddress,
tunnelConfigRemoteAddress	IpAddress,
tunnelConfigEncapsMethod	INTEGER,
tunnelConfigID	Integer32,
tunnelConfigIfIndex	InterfaceIndexOrZero,
tunnelConfigStatus	RowStatus

}

tunnelConfigLocalAddress OBJECT-TYPE

```
SYNTAX      IPAddress
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
    "The address of the local endpoint of the tunnel, or 0.0.0.0
    if the device is free to choose any of its addresses at
    tunnel establishment time."
 ::= { tunnelConfigEntry 1 }
```

tunnelConfigRemoteAddress OBJECT-TYPE

```
SYNTAX      IPAddress
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
    "The address of the remote endpoint of the tunnel."
 ::= { tunnelConfigEntry 2 }
```

tunnelConfigEncapsMethod OBJECT-TYPE

```
SYNTAX      INTEGER {
                other(1),      -- none of the following
                direct(2),    -- no intermediate header
                gre(3),        -- GRE encapsulation
                minimal(4),    -- Minimal encapsulation
                l2tp(5),       -- L2TP encapsulation
                pptp(6),       -- PPTP encapsulation
                l2f(7),        -- L2F encapsulation
                udp(8),        -- UDP encapsulation
                atmp(9)
            }
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
    "The encapsulation method used by the tunnel."
 ::= { tunnelConfigEntry 3 }
```

tunnelConfigID OBJECT-TYPE

```
SYNTAX      Integer32 (1..2147483647)
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
    "An identifier used to distinguish between multiple tunnels
    of the same encapsulation method, with the same endpoints.
    If the encapsulation protocol only allows one tunnel per set
    of endpoint addresses (such as for GRE or IP-in-IP), the
    value of this object is 1. For encapsulation methods (such
    as L2F) which allow multiple parallel tunnels, the manager
    is responsible for choosing any ID which does not conflict
    with an existing row, such as choosing a random number."
```

```
::= { tunnelConfigEntry 4 }
```

```
tunnelConfigIfIndex OBJECT-TYPE
```

```
SYNTAX      InterfaceIndexOrZero
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

```
DESCRIPTION
```

"If the value of tunnelConfigStatus for this row is active, then this object contains the value of ifIndex corresponding to the tunnel interface. A value of 0 is not legal in the active state, and means that the interface index has not yet been assigned."

```
::= { tunnelConfigEntry 5 }
```

```
tunnelConfigStatus OBJECT-TYPE
```

```
SYNTAX      RowStatus
```

```
MAX-ACCESS  read-create
```

```
STATUS      current
```

```
DESCRIPTION
```

"The status of this row, by which new entries may be created, or old entries deleted from this table. The agent need not support setting this object to createAndWait or notInService since there are no other writable objects in this table, and writable objects in rows of corresponding tables such as the tunnelIfTable may be modified while this row is active.

To create a row in this table for an encapsulation method which does not support multiple parallel tunnels with the same endpoints, the management station should simply use a tunnelConfigID of 1, and set tunnelConfigStatus to createAndGo. For encapsulation methods such as L2F which allow multiple parallel tunnels, the management station may select a pseudo-random number to use as the tunnelConfigID and set tunnelConfigStatus to createAndGo. In the event that this ID is already in use and an inconsistentValue is returned in response to the set operation, the management station should simply select a new pseudo-random number and retry the operation.

Creating a row in this table will cause an interface index to be assigned by the agent in an implementation-dependent manner, and corresponding rows will be instantiated in the ifTable and the tunnelIfTable. The status of this row will become active as soon as the agent assigns the interface index, regardless of whether the interface is operationally up.

Deleting a row in this table will likewise delete the corresponding row in the ifTable and in the tunnelIfTable."  
 ::= { tunnelConfigEntry 6 }

-- conformance information

tunnelMIBConformance

OBJECT IDENTIFIER ::= { tunnelMIB 2 }

tunnelMIBCompliances

OBJECT IDENTIFIER ::= { tunnelMIBConformance 1 }

tunnelMIBGroups OBJECT IDENTIFIER ::= { tunnelMIBConformance 2 }

-- compliance statements

tunnelMIBCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"The compliance statement for the IP Tunnel MIB."

MODULE -- this module

MANDATORY-GROUPS { tunnelMIBBasicGroup }

OBJECT tunnelIfHopLimit

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT tunnelIfTOS

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT tunnelConfigStatus

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

::= { tunnelMIBCompliances 1 }

-- units of conformance

tunnelMIBBasicGroup OBJECT-GROUP

OBJECTS { tunnelIfLocalAddress, tunnelIfRemoteAddress,  
 tunnelIfEncapsMethod, tunnelIfHopLimit, tunnelIfTOS,  
 tunnelIfSecurity, tunnelConfigIfIndex, tunnelConfigStatus }

STATUS current

DESCRIPTION

"A collection of objects to support basic management of IP  
 Tunnels."

::= { tunnelMIBGroups 1 }

END

## 6. Security Considerations

This MIB contains readable objects whose values provide information related to IP tunnel interfaces. There are also a number of objects that have a MAX-ACCESS clause of read-write and/or read-create, such as those which allow an administrator to dynamically configure tunnels.

While unauthorized access to the readable objects is relatively innocuous, unauthorized access to the write-able objects could cause a denial of service, or could cause unauthorized creation and/or manipulation of tunnels. Hence, the support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations.

SNMPv1 by itself is such an insecure environment. Even if the network itself is secure (for example by using IPSec [24]), even then, there is no control as to who on the secure network is allowed to access and SET (change/create/delete) the objects in this MIB.

It is recommended that the implementers consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model RFC 2574 [12] and the View-based Access Control Model RFC 2575 [15] is recommended.

It is then a customer/user responsibility to ensure that the SNMP entity giving access to this MIB, is properly configured to give access to those objects only to those principals (users) that have legitimate rights to access them.

## 7. Acknowledgements

This MIB module was updated based on feedback from the IETF's Interfaces MIB (IF-MIB) and Point-to-Point Protocol Extensions (PPPEXT) Working Groups.

## 8. Author's Address

Dave Thaler  
Microsoft Corporation  
One Microsoft Way  
Redmond, WA 98052-6399

Phone: +1 425 703 8835  
EMail: dthaler@microsoft.com

## 9. References

- [1] Wijnen, B., Harrington, D. and R. Presuhn, "An Architecture for Describing SNMP Management Frameworks", RFC 2571, April 1999.
- [2] Rose, M. and K. McCloghrie, "Structure and Identification of Management Information for TCP/IP-based Internets", STD 16, RFC 1155, May 1990.
- [3] Rose, M. and K. McCloghrie, "Concise MIB Definitions", STD 16, RFC 1212, March 1991.
- [4] Rose, M., "A Convention for Defining Traps for use with the SNMP", RFC 1215, March 1991.
- [5] McCloghrie, K., Perkins, D. and J. Schoenwaelder, "Structure of Management Information Version 2 (SMIV2)", STD 58, RFC 2578, April 1999.
- [6] McCloghrie, K., Perkins, D. and J. Schoenwaelder, "Textual Conventions for SMIV2", STD 58, RFC 2579, April 1999.
- [7] McCloghrie, K., Perkins, D. and J. Schoenwaelder, "Conformance Statements for SMIV2", STD 58, RFC 2580, April 1999.
- [8] Case, J., Fedor, M., Schoffstall, M. and J. Davin, "Simple Network Management Protocol", STD 15, RFC 1157, May 1990.
- [9] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Introduction to Community-based SNMPv2", RFC 1901, January 1996.
- [10] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1906, January 1996.
- [11] Case, J., Harrington D., Presuhn R. and B. Wijnen, "Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)", RFC 2572, April 1999.
- [12] Blumenthal, U. and B. Wijnen, "User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)", RFC 2574, April 1999.
- [13] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1905, January 1996.

- [14] Levi, D., Meyer, P. and B. Stewart, "SNMPv3 Applications", RFC 2573, April 1999.
- [15] Wijnen, B., Presuhn, R. and K. McCloghrie, "View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)", RFC 2575, April 1999.
- [16] Hanks, S., Li, T., Farinacci, D. and P. Traina, "Generic Routing Encapsulation (GRE)", RFC 1701, October 1994.
- [17] Hanks, S., Li, T., Farinacci, D. and P. Traina, "Generic Routing Encapsulation over IPv4 networks", RFC 1702, October 1994.
- [18] Perkins, C., "IP Encapsulation within IP", RFC 2003, October 1996.
- [19] Perkins, C., "Minimal Encapsulation within IP", RFC 2004, October 1996.
- [20] Townsley, W., Valencia, A., Rubens, A., Pall, G., Zorn, G. and B. Palter, "Layer Two Tunneling Protocol "L2TP"", RFC 2661, August 1999.
- [21] Hamzeh, K., Pall, G., Verthein, W. Taarud, J., Little, W. and G. Zorn, "Point-to-Point Tunneling Protocol", RFC 2637, July 1999.
- [22] Hamzeh, K., "Ascend Tunnel Management Protocol - ATMP", RFC 2107, February 1997.
- [23] McCloghrie, K. and F. Kastenholz. "The Interfaces Group MIB using SMIV2", RFC 2233, November 1997.
- [24] R. Atkinson, "Security architecture for the internet protocol", RFC 2401, November 1998.
- [25] Valencia, A., Littlewood, M. and T. Kolar. "Cisco Layer Two Forwarding (Protocol) "L2F"", RFC 2341, May 1998.
- [26] D. Provan, "Tunneling IPX Traffic through IP Networks", RFC 1234, June 1991.
- [27] Gilligan, R. and E. Nordmark. "Transition Mechanisms for IPv6 Hosts and Routers", RFC 1933, April 1996.
- [28] Woodburn, R. and D. Mills, "A Scheme for an Internet Encapsulation Protocol: Version 1", RFC 1241, July 1991.

- [29] Nichols, K., Blake, S., Baker, F. and D. Black. "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers", RFC 2474, December 1998.

## 10. Intellectual Property Notice

The IETF takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Information on the IETF's procedures with respect to rights in standards-track and standards-related documentation can be found in BCP-11. Copies of claims of rights made available for publication and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF Secretariat."

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights which may cover technology that may be required to practice this standard. Please address the information to the IETF Executive Director.

## 11. Full Copyright Statement

Copyright (C) The Internet Society (1999). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the Internet Society or other Internet organizations, except as needed for the purpose of developing Internet standards in which case the procedures for copyrights defined in the Internet Standards process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the Internet Society or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

## Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.

