

Network Working Group
Internet-Draft
Expires: August 23, 2012

Alia Atlas
Juniper Networks
A S Kiran Koushik(Ed.)
Cisco Systems Inc.
John Flick(Ed.)
Hewlett-Packard Company

March 2012

IP MIB for IP Fast-Reroute

[draft-ietf-rtgwg-ipfrr-ip-mib-02](#)

Status of this Memo

This Internet-Draft is submitted to IETF in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/1id-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

This Internet-Draft will expire on August 23, 2012.

Abstract

This draft defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects relevant for IP routes using IP Fast-Reroute [[RFC5714](#)].

Table of Contents

1.	Introduction	3
1.1.	The SNMP Management Framework	3
2.	Brief Description of MIB Objects	4
2.1.	ipFrrProtectStats Group	4
2.2.	ipFrrAltTable	4
2.3.	ipFrrNoAltTable	4
3.	IP Fast-Reroute MIB Module Definitions	5
4.	Security Considerations	16
5.	References	16
	Authors' Addresses	18
	Full Copyright Statements	19

1. Introduction

This document defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it defines the managed objects used for IP routes and interfaces in relation to IP Fast-Reroute. This document uses terminology from [[RFC5714](#)] and [[RFC5286](#)].

Current work is underway to define mechanisms for determining alternate paths for traffic to use when the original path becomes unavailable due to a local failure. The alternate next-hops can be computed in the context of any IGP.

There are certain configuration attributes for IP Fast-Reroute that should be configured to enable IP Fast Reroute in the context of the IGP. These configuration attributes of IP Fast-Reroute are not covered by this MIB module. Examples include whether IP Fast-Reroute is enabled on a network region (i.e. an OSPF area or IS-IS level) and the desired local hold-down timer[[RFC5286](#)], whose proper value is dependent upon the size of the network region.

It is possible for traffic other than IP to depend upon and use the alternate next-hops computed by IP Fast-Reroute. An example would be MPLS traffic whose path is configured via LDP[[RFC5036](#)]. The additional details (for example, outgoing MPLS label) pertaining to alternate next-hops that are required by such traffic are not covered by this MIB module.

An IP route may be reachable via multiple primary next-hops which provide equal-cost paths. Where IP Fast-Reroute is enabled, each primary next-hop will be protected by one or more alternate next-hops. Such an alternate next-hop may itself be a primary next-hop.

1.1. The SNMP Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to [section 7 of RFC 3410](#) [[RFC3410](#)].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIV2, which is described in STD 58, [RFC 2578](#) [[RFC2578](#)], STD 58, [RFC 2579](#) [[RFC2579](#)] and STD 58, [RFC 2580](#) [[RFC2580](#)].

2. Brief Description of MIB Objects

This MIB module consists of five global objects, organized into the ipFrrProtectStats group, and two tables.

2.1. ipFrrProtectStats Group

The global objects in this group provide summary information related to protection for all IP routes. The information available includes counts of all routes, of all protected routes, of all unprotected routes, of all routes which are protected against a link failure, and of all routes which are protected against a node failure.

2.2. ipFrrAltTable

The ipFrrAltTable extends the inetCidrRouteTable[RFC4292] to provide information about each alternate next-hop associated with a primary next-hop used by a route. Statically configured alternate next-hops associated with primary next-hops can be created.

2.3. ipFrrNoAltTable

The ipFrrNoAltTable extends the inetCidrRouteTable[RFC4292] to provide information about the routes which do not have an alternate next-hop associated with any of the route's primary next-hop. The entry provides an explanation for the lack of protection.

3. IP Fast-Reroute MIB Module Definitions

```
IPFRR-MIB DEFINITIONS ::= BEGIN
```

```
IMPORTS
```

```
    MODULE-IDENTITY,
    OBJECT-TYPE,
    Gauge32,
    Integer32                FROM SNMPv2-SMI                -- [RFC2578]

    RowStatus                FROM SNMPv2-TC                -- [RFC2579]

    MODULE-COMPLIANCE,
    OBJECT-GROUP             FROM SNMPv2-CONF              -- [RFC2580]

    InetAddressType,
    InetAddress              FROM INET-ADDRESS-MIB         -- [RFC4001]

    InterfaceIndex           FROM IF-MIB                   -- [RFC2863]

    ip                       FROM IP-MIB                   -- [RFC4293]

    inetCidrRouteDestType,
    inetCidrRouteDest,
    inetCidrRoutePfxLen,
    inetCidrRoutePolicy,
    inetCidrRouteNextHopType,
    inetCidrRouteNextHop FROM IP-FORWARD-MIB
                                -- [RFC4292]
;
```

```
ipFrrMIB MODULE-IDENTITY
```

```
    LAST-UPDATED "201203131200Z" -- Mar 13, 2012
    ORGANIZATION "draft-ietf-ipfrr-ip-mib-02.txt"
    CONTACT-INFO
        "
```

```
            A S Kiran Koushik
            Cisco Systems Inc.
            EMail: kkoushik@cisco.com
```

```
            John W Flick
            Hewlett Packard Company
            EMail: john.flick@hp.com
```

```
            Alia Atlas
            Juniper Networks
```


Email: akatlas@juniper.net

Atlas, et al.

Expires August 23, 2012

[Page 5]

```
"
DESCRIPTION
    "IP MIB module for management of IP Fast-Reroute.

    Copyright (C) The Internet Society (date).
    This version of this MIB module is part of
    draft-ietf-rtgwg-ipfrr-ip-mib-00.txt"
REVISION      "201203131200Z" -- Mar 13, 2012
DESCRIPTION
    "Editorial changes. Added new type to ipFrrAltType."
REVISION      "200502181200Z" -- February 18, 2005
DESCRIPTION
    "Add Set operations on ipFrrAltTable"
REVISION      "200502131200Z" -- February 13, 2005
DESCRIPTION
    "Initial version."
 ::= { ip ZZZ } -- To be assigned by IANA
-- RFC Ed.: replace 999 with actual RFC number
-- & remove this note

-- Top level components of this MIB module.

ipFrrMIBObjects OBJECT IDENTIFIER ::= { ipFrrMIB 1 }

ipFrrProtectStats OBJECT IDENTIFIER ::= { ipFrrMIBObjects 1 }

-- the IP FRR MIB-Group

-- A collection of objects providing summarized information
-- about the protection availability and type of alternate paths
-- provided by IP Fast-Reroute mechanisms.

ipFrrTotalRoutes    OBJECT-TYPE
    SYNTAX      Gauge32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of valid routes known by this entity."
    ::= { ipFrrProtectStats 1 }

ipFrrUnprotectedRoutes    OBJECT-TYPE
    SYNTAX      Gauge32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of valid routes known by this entity"
```

```
        which do not have an alternate next-hop associated
        with any primary next-hop."
 ::= { ipFrrProtectStats 2 }
```

```
ipFrrProtectedRoutes    OBJECT-TYPE
    SYNTAX      Gauge32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of routes known by this entity
        which have at least one alternate next-hop."
 ::= { ipFrrProtectStats 3 }
```

```
ipFrrLinkProtectedRoutes OBJECT-TYPE
    SYNTAX      Gauge32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of routes known by this entity
        for which all alternate next-hops provide link
        protection for their associated primary next-hops."
 ::= { ipFrrProtectStats 4 }
```

```
ipFrrNodeProtectedRoutes OBJECT-TYPE
    SYNTAX      Gauge32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The number of routes known by this entity
        for which all alternate next-hops provide node
        protection for their associated primary next-hops."
 ::= { ipFrrProtectStats 5 }
```

```
-- the IP FRR Alternate MIB-Group
```

```
--
```

```
-- The ipFrrAltTable extends the inetCidrRouteTable to indicate
-- the alternate next-hop(s) associated with each primary
-- next-hop. The additional indices (ipFrrAltNextHopType and
-- ipFrrAltNextHop ) allow for multiple alternate paths for a
-- given primary next-hop.
```

```
ipFrrAltTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF IpFrrAltEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "This entity's IP Fast Reroute Alternates table."
 ::= { ipFrrMIBObjects 2 }
```

ipFrrAltEntry OBJECT-TYPE
SYNTAX IpFrrAltEntry
MAX-ACCESS not-accessible

Atlas, et al.

Expires August 23, 2012

[Page 7]

STATUS current

DESCRIPTION

"An entry containing information on a particular route, one of its particular (primary) next-hops and one of the associated alternate next-hops.

Implementers need to be aware that if the total number of elements (octets or sub-identifiers) in inetCidrRouteDest, inetCidrRoutePolicy, inetCidrRouteNextHop, and ipFrrAltNextHop exceeds 107 then OIDs of column instances in this table will have more than 128 sub-identifiers and cannot be accessed using SNMPv1, SNMPv2c, or SNMPv3."

```
INDEX { inetCidrRouteDestType,
        inetCidrRouteDest,
        inetCidrRoutePfxLen,
        inetCidrRoutePolicy,
        inetCidrRouteNextHopType,
        inetCidrRouteNextHop,
        ipFrrAltNextHopType,
        ipFrrAltNextHop
      }
```

```
::= { ipFrrAltTable 1 }
```

```
IpFrrAltEntry ::= SEQUENCE {
    ipFrrAltNextHopType      InetAddressType,
    ipFrrAltNextHop          InetAddress,
    ipFrrAltIfIndex          InterfaceIndex,
    ipFrrAltType              INTEGER,
    ipFrrAltProtectionAvailable BITS,
    ipFrrAltMetric1          Integer32,
    ipFrrAltStatus            RowStatus
}
```

ipFrrAltNextHopType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The type of the ipFrrNextHop address, as defined in the InetAddress MIB.

Only those address types that may appear in an actual routing table are allowed as values of this object."

REFERENCE "[RFC 4001](#)"

```
::= { ipFrrAltEntry 1 }
```


ipFrrAltNextHop OBJECT-TYPE

SYNTAX InetAddress
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"The address of the next system along the alternate route.

The type of this address is determined by the value of the ipFrrAltNextHopType."

::= { ipFrrAltEntry 2 }

ipFrrAltIfIndex OBJECT-TYPE

SYNTAX InterfaceIndex
MAX-ACCESS read-create
STATUS current
DESCRIPTION

"The ifIndex value which identifies the local interface through which the next hop of this alternate route should be reached."

::= { ipFrrAltEntry 3 }

ipFrrAltType OBJECT-TYPE

SYNTAX INTEGER {
 other (1), -- type not defined
 equalCost (2), -- primary path
 loopFree (3), -- loop free alternate
 MRT (4) -- Maximally Redundant Trees
 }
MAX-ACCESS read-create
STATUS current
DESCRIPTION

"The type of alternate which is provided by the alternate next-hop. The supported types are as follows:

equalCost : The alternate next-hop is another primary next-hop.

loopFree : The shortest route to the destination IP address from the alternate next-hop does not traverse this system. See [draft-ietf-rtgwg-ipfrr-spec-base-04](#).

other : The mechanism by which the alternate next-hop can be used is not specified.

MRT : Maximally Redundant Trees, where each destination has two MRTs associated with it. These two trees are referred as blue and red MRTs.
See [draft-ietf-rtgwg-mrt-frr-architecture-00](#).

"

::= { ipFrrAltEntry 4 }

ipFrrAltProtectionAvailable OBJECT-TYPE

SYNTAX BITS {
 nodeProtect(0),
 linkProtect(1),
 unknownProtection(2)
}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object specifies the scope of protection for which this alternate next-hop can provide failure protection. The alternate next-hop should provide one or more of node-protection and link-protection. If the protection provided by the alternate next-hop is unknown, then only unknownProtection should be specified. Specifying unknownProtection with any other type of protection is not supported. "

::= { ipFrrAltEntry 5 }

ipFrrAltMetric1 OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This is the primary routing metric for this alternate path to the destination IP address. If the alternate path metric is unknown, the value should be set to -1."

::= { ipFrrAltEntry 6 }

ipFrrAltStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The row status variable, used according to


```
row installation and removal conventions."  
::= { ipFrrAltEntry 7 }
```

```
-- the IP FRR No Alternate MIB-Group
--
-- The ipFrrNoAltTable extends the inetCidrRouteTable
-- to indicate which routes are unprotected and the reason
-- why. The indices do not include the primary next-hop because
-- the lack of protection is for the route. This allows easy
-- access to the set of unprotected routes that would be
-- affected by a local failure of their primary next-hop.
```

ipFrrNoAltTable OBJECT-TYPE

SYNTAX SEQUENCE OF IpFrrNoAltEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This entity's IP Fast Reroute Unprotected Routes
table."

::= { ipFrrMIBObjects 3 }

ipFrrNoAltEntry OBJECT-TYPE

SYNTAX IpFrrNoAltEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry containing the reason why a route does not
have an alternate next-hop. The existence of an
entry for a route indicates that there is no
alternate next-hop."

INDEX { inetCidrRouteDestType,
inetCidrRouteDest,
inetCidrRoutePfxLen
}

::= { ipFrrNoAltTable 1 }

IpFrrNoAltEntry ::= SEQUENCE {

ipFrrNoAltCause INTEGER

}

ipFrrNoAltCause OBJECT-TYPE

SYNTAX INTEGER {

ipFrrUnavailable (1), -- No valid alternate(s)

localAddress (2), -- local/internal address

ipFrrDisabled (3), -- Protection not enabled

other (4) -- unknown or other cause

}

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"For valid routes without an alternate next-hop, this object enumerates the reason why no protection is available. The possibilities are as follows.

ipFrrUnavailable : The supported IP Fast-Reroute mechanisms could not find a safe alternate next-hop.

localAddress : The route represents a local address. This system is the destination so no alternate path is possible or necessary.

ipFrrDisabled : Finding of alternate next-hops is operationally disabled.

other : The reason is unknown or different from those specifically enumerated possible causes."

::= { ipFrrNoAltEntry 1 }

-- conformance information

ipFrrMIBConformance

OBJECT IDENTIFIER ::= { ipFrrMIB 2 }

ipFrrMIBCompliances

OBJECT IDENTIFIER ::= { ipFrrMIBConformance 1 }

ipFrrMIBGroups

OBJECT IDENTIFIER ::= { ipFrrMIBConformance 2 }

-- compliance statements

ipFrrMIBCompliance MODULE-COMPLIANCE

STATUS deprecated

DESCRIPTION

"Minimum requirements to state conformity to this MIB. Supporting only IP v4 addresses
This is deprecated in favor of
ipFrrMIBInetCompliance

There are a number of INDEX objects that cannot be represented in the form of OBJECT clauses in SMIV2,

but for which there are compliance requirements,
expressed in OBJECT clause form in this description:

```
OBJECT      inetCidrRouteDestType
SYNTAX      InetAddressType { ipv4(1), ipv4z(3) }
MIN-ACCESS  read-only
DESCRIPTION
    A (deprecated) complying implementation at this
    level is required to support IPv4 addresses only.
    This compliance level is defined so an
    implementation only needs to support the addresses
    it actually supports on the device.

OBJECT      inetCidrRouteNextHopType
SYNTAX      InetAddressType { ipv4(1), ipv4z(3) }
MIN-ACCESS  read-only
DESCRIPTION
    A (deprecated) complying implementation at this
    level is required to support IPv4 addresses only.
    This compliance level is defined so an
    implementation only needs to support the addresses
    it actually supports on the device.

OBJECT      ipFrrAltNextHopType
SYNTAX      InetAddressType { ipv4(1), ipv4z(3) }
MIN-ACCESS  read-only
DESCRIPTION
    A (deprecated) complying implementation at this
    level is required to support IPv4 addresses only.
    This compliance level is defined so an
    implementation only needs to support the
    addresses it actually supports on the device.
"

MODULE -- this module
MANDATORY-GROUPS { ipFrrBasicGroup }

::= { ipFrrMIBCompliances 1 }

ipFrrMIBInetCompliance MODULE-COMPLIANCE
STATUS current
DESCRIPTION
    "Full conformity to this MIB."
MODULE -- this module
MANDATORY-GROUPS { ipFrrBasicGroup }

OBJECT ipFrrAltStatus
SYNTAX INTEGER { active(1) }
```



```
WRITE-SYNTAX INTEGER { createAndGo(4), destroy(6) }
```

```
DESCRIPTION
```

```
"Support for createAndWait and notInService is not
required."
```

```
::= { ipFrrMIBCompliances 2 }
```

```
ipFrrReadOnlyCompliance MODULE-COMPLIANCE
```

```
STATUS current
```

```
DESCRIPTION
```

```
"When this MIB is implemented without support for
read-create (i.e. in read-only mode), then that
implementation can claim read-only compliance. In that
case, ipFrrAlt group can be monitored but cannot be
configured with this MIB."
```

```
MODULE
```

```
MANDATORY-GROUPS { ipFrrBasicGroup }
```

```
OBJECT ipFrrAltIfIndex
```

```
MIN-ACCESS read-only
```

```
DESCRIPTION
```

```
"Write access is not required."
```

```
OBJECT ipFrrAltType
```

```
MIN-ACCESS read-only
```

```
DESCRIPTION
```

```
"Write access is not required."
```

```
OBJECT ipFrrAltProtectionAvailable
```

```
MIN-ACCESS read-only
```

```
DESCRIPTION
```

```
"Write access is not required."
```

```
OBJECT ipFrrAltMetric1
```

```
MIN-ACCESS read-only
```

```
DESCRIPTION
```

```
"Write access is not required."
```

```
OBJECT ipFrrAltStatus
```

```
MIN-ACCESS read-only
```

```
DESCRIPTION
```

```
"Write access is not required."
```

```
::= { ipFrrMIBCompliances 3 }
```

```
-- units of conformance
```



```
ipFrrBasicGroup OBJECT-GROUP
  OBJECTS {ipFrrTotalRoutes,
            ipFrrUnprotectedRoutes,
            ipFrrProtectedRoutes,
            ipFrrLinkProtectedRoutes,
            ipFrrNodeProtectedRoutes,
            ipFrrAltIfIndex,
            ipFrrAltType,
            ipFrrAltProtectionAvailable,
            ipFrrAltMetric1,
            ipFrrAltStatus,
            ipFrrNoAltCause
  }
  STATUS current
  DESCRIPTION
    "The entire collection of objects defined in
     this MIB for management of IP Fast Reroute ."
  ::= { ipFrrMIBGroups 1 }

END
```


4. Security Considerations

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. The ipFrrAltTable contains routing and forwarding information that is critical to the operation of the network in the event of a local failure. Allowing unauthenticated write access to this table can compromise the validity of the alternate forwarding information.

Some of the readable objects in this MIB module (i.e. objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), even then, there is no control as to who on the secure network is allowed to access and GET the objects in this MIB module.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [\[RFC3410\]](#), [section 8](#)), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET them.

5. References

5.1 Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", [RFC 2863](#), June 2000.
- [RFC4001] Daniele, M., Haberman, B., Routhier, S., and J. Schoenwaelder, "Textual Conventions for Internet Network Addresses", [RFC 4001](#), February 2005.
- [RFC4292] Haberman, B., "IP Forwarding Table MIB", [RFC 4292](#), April 2006.
- [RFC4293] Routhier, S., "Management Information Base for the Internet Protocol (IP)", [RFC 4293](#), April 2006.
- [RFC5286] Atlas, A. and A. Zinin, "Basic Specification for IP Fast Reroute: Loop-Free Alternates", [RFC 5286](#), September 2008.

[5.2](#) Informative References

- [RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, [RFC 2578](#), April 1999.
- [RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, [RFC 2579](#), April 1999.
- [RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, [RFC 2580](#), April 1999.
- [RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", [RFC 3410](#), December 2002.
- [RFC5036] Andersson, L., Ed., Minei, I., Ed., and B. Thomas, Ed., "LDP Specification", [RFC 5036](#), October 2007.
- [RFC5714] Shand, M. and S. Bryant, "IP Fast Reroute Framework", [RFC 5714](#), January 2010.

6. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the SMI Numbers registry.

The IANA is requested to assign { ip ZZZ } to the IPFRR-MIB MIB module specified in this document.

Editor's Note (to be removed prior to publication): the IANA is requested to assign a value for "ZZZ" under the ip subtree and to record the assignments in the SMI Numbers registry. When the assignments have been made, the RFC Editor is asked to replace "ZZZ" (here and in the MIB modules) with the assigned value and to remove this note.

Authors' Addresses

Alia Atlas
Juniper Networks
10 Technology Park Drive
Westford, MA 01886
USA

Email: akatlas@juniper.net

A S Kiran Koushik (Ed.)
Cisco Systems Inc.
12515 Research Blvd, Bldg 4,
Austin, TX 78759
USA

Email: kkoushik@cisco.com

John Flick (Ed.)
Hewlett-Packard Company
8000 Foothills Blvd.
Roseville, CA 95747-5557
USA
Email: john.flick@hp.com

Acknowledgements

The authors would like to acknowledge contributions made by Bill Anderson and Don Fedyk and thank them.

Full Copyright Statement

Copyright (c) 2012 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

This document may contain material from IETF Documents or IETF Contributions published or made publicly available before November 10, 2008. The person(s) controlling the copyright in some of this material may not have granted the IETF Trust the right to allow modifications of such material outside the IETF Standards Process. Without obtaining an adequate license from the person(s) controlling the copyright in such materials, this document may not be modified outside the IETF Standards Process, and derivative works of it may not be created outside the IETF Standards Process, except to format it for publication as an RFC or to translate it into languages other than English.

Acknowledgment

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