          The Transmission of IP Datagrams over the SMDS Service

Status of this Memo

   This memo defines a protocol for the transmission of IP and ARP
   packets over a Switched Multi-megabit Data Service Network configured
   as a logical IP subnetwork. This RFC specifies an IAB standards
   track protocol for the Internet community, and requests discussion
   and suggestions for improvements. Please refer to the current
   edition of the "IAB Official Protocol Standards" for the
   standardization state and status of this protocol. Distribution of
   this memo is unlimited.

Abstract

   This memo describes an initial use of IP and ARP in an SMDS service
   environment configured as a logical IP subnetwork, LIS (described
   below). The encapsulation method used is described, as well as
   various service-specific issues. This memo does not preclude
   subsequent treatment of the SMDS Service in configurations other than
   LIS; specifically, public or inter-company, inter-enterprise
   configurations may be treated differently and will be described in
   future documents. This document considers only directly connected IP
   end-stations or routers; issues raised by MAC level bridging are
   beyond the scope of this paper.

Acknowledgment

   This memo draws heavily in both concept and text from [4], written by
   Jon Postel and Joyce K. Reynolds of ISI and [5], written by David
   Katz of Merit, Inc. The authors would also like to acknowledge the
   contributions of the IP Over SMDS Service working group of the
   Internet Engineering Task Force.

Conventions

   The following language conventions are used in the items of
   specification in this document:

      o MUST, SHALL, or MANDATORY -- the item is an absolute
        requirement of the specification.

o SHOULD or RECOMMENDED -- the item should generally be followed
   for all but exceptional circumstances.

o MAY or OPTIONAL -- the item is truly optional and may be
   followed or ignored according to the needs of the implementor.

Introduction

   The goal of this specification is to allow compatible and
   interoperable implementations for transmitting IP datagrams and ARP
   requests and replies.

   The characteristics of the SMDS Service and the SMDS Interface
   Protocol (SIP) are presented in [3], [6], and in [7]. Briefly, the
   SMDS Service is a connectionless, public, packet-switched data
   service. The operation and features of the SMDS Service are similar
   to those found in high-speed data networks such as LANs:

      o The SMDS Service provides a datagram packet transfer, where each
         data unit is handled and switched separately without the prior
         establishment of a network connection.

      o The SMDS Service exhibits high throughput and low delay, and
         provides the transparent transport and delivery of up to 9188
         octets of user information in a single transmission.

      o No explicit flow control mechanisms are provided; instead, the
         rate of information transfer on the access paths is controlled
         both in the subscriber-to-network direction and in the network-
         to-subscriber direction through the use of an access class
         enforcement mechanism.

      o Both individually and group-addressed (multicast) packets can
         be transferred.

      o In addition to these LAN-like features, a set of addressing-
         related service features (source address validation, source and
         destination address screening) are provided to enable a
         subscriber or set of subscribers to create a logical private
         network, or closed user group, over the SMDS Service. The
         access control provided by the closed user group mechanism is
         supplied by the SMDS provider according to the specifications
         stated in [3].

      o SMDS addresses are 60 bits plus a 4 bit Address Type. The
         Address Type subfield occupies the 4 most significant bits of
         the destination and source address fields of the SIP Level 3
         Protocol Data Unit (PDU). It contains the value 1100 to

indicate an individual address and the value 1110 for a 60-bit
group address.

The SMDS Interface Protocol is based on the IEEE Standard 802.6,
Distributed Queue Dual Bus (DQDB) Connectionless MAC protocol [8].
The SMDS service layer corresponds to the IEEE 802 MAC sublayer. The
remainder of the Data Link Service is provided by the IEEE 802.2
Logical Link Control (LLC) service [9]. The resulting stack of
services is illustrated in Figure 1:

```
+--------------------+
|       IP/ARP       |
+--------------------+
|IEEE 802.2 LLC/SNAP |
+--------------------+
| SIP LEVEL 3 (MAC)  |
+--------------------+
| SIP LEVELS 1 & 2   |
+--------------------+
```
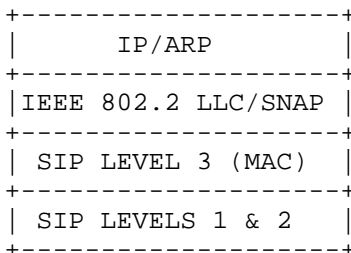
         Figure 1. Protocol stack for IP over SMDS Service

This memo describes an initial use of IP and ARP in an SMDS Service
environment configured as a logical IP subnetwork (described below).
It does not preclude subsequent treatment of SMDS Service in
configurations other than logical IP subnetworks; specifically,
public or inter-company, inter-enterprise configurations may be
treated differently and will be described in future documents. This
document does not address issues related to transparent data link
layer interoperability.

Logical IP Subnetwork Configuration

This section describes the scenario for an SMDS Service that is
configured with multiple logical IP subnetworks, LIS (described
below). The scenario considers only directly connected IP end-
stations or routers; issues raised by MAC level bridging are beyond
the scope of this paper.

In the LIS scenario, each separate administrative entity configures
its hosts within a closed logical IP subnetwork. Each LIS operates
and communicates independently of other LISs over the same network
providing SMDS. Hosts connected to SMDS communicate directly to
other hosts within the same LIS. Communication to hosts outside of
an individual LIS is provided via an IP router. This router would
simply be a station attached to the SMDS Service that has been
configured to be a member of both logical IP subnetworks. This
configuration results in a number of disjoint LISs operating over the

same network supporting the SMDS Service. It is recognized that with
this configuration, hosts of differing IP networks would communicate
via an intermediate router even though a direct path over the SMDS
Service may be possible.

It is envisioned that the service will evolve to provide a more
public interconnection, allowing machines directly connected to the
SMDS Service to communicate without an intermediate router. However,
the issues raised by such a large public interconnection, such as
scalability of address resolution or propagation of routing updates,
are beyond the scope of this paper. We anticipate that future RFCs
 will address these issues.

The following is a list of the requirements for a LIS configuration:

    o All members have the same IP network/subnet number.

    o All stations within a LIS are accessed directly over SMDS.

    o All stations outside of the LIS are accessed via a router.

    o For each LIS a single SMDS group address has been configured
      that identifies all members of the LIS. Any packet transmitted
      with this address is delivered by SMDS Service to all members
      of the LIS.

The following list identifies a set of SMDS Service specific
parameters that MUST be implemented in each IP station which would
connect to the SMDS Service. The parameter values will be determined
at SMDS subscription time and will be different for each LIS. Thus
these parameters MUST be user configurable.

    o SMDS Hardware Address (smds$ha). The SMDS Individual address
      of the IP station as determined at subscription time. Each
      host MUST be configured to accept datagrams destined for this
      address.

    o SMDS LIS Group Address(smds$lis-ga). The SMDS Group address
      that has been configured at subscription time to identify the
      SMDS Subscriber Network Interfaces (SNI) of all members of the
      LIS connected to the SMDS Service. All members of the LIS MUST
      be prepared to accept datagrams addressed to smds$lis-ga.

    o SMDS Arp Request Address (smds$arp-req). The SMDS address
      (individual or group) to which arp requests are to be sent. In
      the initial LIS configuration this value is set to smds$lis-ga.
      It is conceivable that in other configurations this value would
      be set to some address other than that of smds$lis-ga (see

section on Address Resolution).

It is RECOMMENDED that routers providing LIS functionality over the
SMDS service also support the ability to interconnect differing LISs.
Routers that wish to provide interconnection of differing LISs MUST
be able to support multiple sets of these parameters (one set for
each connected LIS) and be able to associate each set of parameters
with a specific IP network/subnet number. In addition, it is
RECOMMENDED that a router be able to provide this multiple LIS
support with a single physical SMDS interface that may have one or
more individual SMDS addresses.

The following list identifies LIS specific parameters that MUST be
configured in the network supporting the SMDS Service. For each LIS,
the IP network administrator MUST request the configuration of these
parameters at subscription time. The administrator of each LIS MUST
update these parameters as each new station is added to the LIS.

   o SMDS LIS Group Address(smds$lis-ga). An SMDS Group address MUST
     be configured at subscription time to identify the SMDS
     Subscriber Network Interfaces (SNI) of all members of the LIS
     connected to the SMDS Service.

   o SMDS Address Screening Tables (Source and Destination). The use
     of SMDS screening tables is not necessary for the operation of
     IP over SMDS Service. If the SMDS screening tables are to be
     used, both source and destination tables for each SNI MUST be
     configured to allow, at minimum, both the direct communication
     between all hosts in the same LIS and the use of the SMDS LIS
     Group Address.

Packet Format

   Service SHALL be encapsulated within the IEEE 802.2 LLC and IEEE
   802.1A Sub-Network Access Protocol (SNAP) [10] Data Link layers
   and the 3-level SIP. The SNAP MUST be used with an
   Organizationally Unique Identifier Code indicating that the SNAP
   header contains the EtherType code as listed in Assigned Numbers
   [11] (see Figure 2). Note that values specified in this document
   follow Internet conventions: multi-byte fields are described in
   big-endian order and bits within bytes are described as most
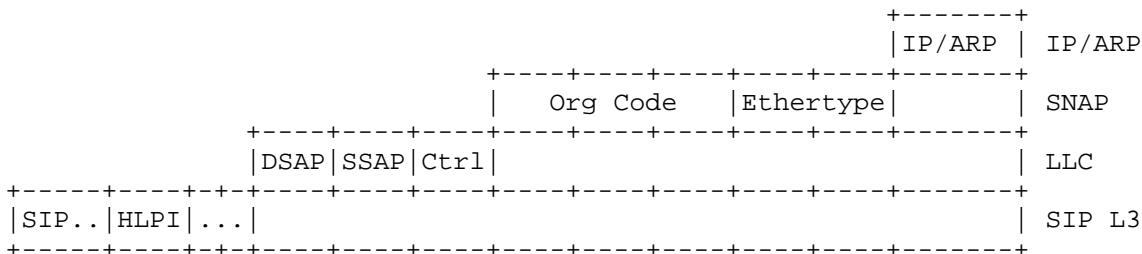   significant first [11].

```
                                          +-------+
                                          |IP/ARP |  IP/ARP
                            +----+----+----+----+----+-------+
                            |   Org Code   |Ethertype|      |  SNAP
                       +----+----+----+----+----+----+----+-------+
                       |DSAP|SSAP|Ctrl|                     |  LLC
   +-----+----+-+-+----+----+----+----+----+----+----+-------+
   |SIP..|HLPI|...|                                    |  SIP L3
   +-----+----+-+-+----+----+----+----+----+----+----+-------+
```

                   Figure 2. Data Link Encapsulation

        o The value of HLPI in the SIP L3 Header is 1.

        o The total length of the LLC Header and the SNAP header is 8
          octets.

        o The value of DSAP and SSAP in the LLC header is 170 (decimal),
          AA (Internet hexadecimal).

        o The Ctrl (Control) value in the LLC header is 3 (Indicates Type
          One Unnumbered Information).

        o The Org Code in the SNAP header is zero (000000 Internet
          hexadecimal).

        o The EtherType for IP is 2048 (decimal), 0800 (Internet
          hexadecimal). The EtherType for ARP is 2054 (decimal), 0806
          (Internet hexadecimal).

   IEEE 802.2 LLC Type One Unnumbered Information (UI) communication
   (which must be implemented by all conforming IEEE 802.2 stations) is
   used exclusively. The Higher Layer Protocol Id (HLPI) field in the
   SIP L3_PDU header MUST be set to the IEEE 802.6 assigned Protocol Id
   value for LLC (decimal 1) [8]. All frames MUST be transmitted in
   standard IEEE 802.2 LLC Type 1 Unnumbered Information format, with
   the DSAP and the SSAP fields of the IEEE 802.2 header set to the
   assigned global SAP value for SNAP (decimal 170) [10]. The 24-bit
   Org Code (Organizationally Unique Identifier Code) in the SNAP MUST
   be set to a value of zero, and the remaining 16 bits are set to the
   EtherType value from Assigned Numbers [11] (2048 for IP, 2054 for
   ARP).

   The data link encapsulation for IP packets is shown in Figure 3 and
   for ARP in Figure 4. All values shown are in Internet hexadecimal
   format.

```
+--------------+------------------------------------+-------+
|      SIP     |             LLC / SNAP             |  IP   |
|              |                                    |       |
|SIP..|HLPI|...|DSAP|SSAP|Ctrl|   Org Code   |Ethertype|    |
+-----+----+-+-+----+----+----+----+----+----+----+----+-------+
|SIP..| 01 |...| AA | AA | 03 |    000000    |  0800  | IP... |
+-----+----+-+-+----+----+----+----+----+----+----+----+-------+
```

                Figure 3. IP Data Link Encapsulation and Values

```
+--------------+------------------------------------+-------+
|      SIP     |             LLC / SNAP             |  ARP  |
|              |                                    |       |
|SIP..|HLPI|...|DSAP|SSAP|Ctrl|   Org Code   |Ethertype|    |
+-----+----+-+-+----+----+----+----+----+----+----+----+-------+
|SIP..| 01 |...| AA | AA | 03 |    000000    |  0806  | ARP...|
+-----+----+-+-+----+----+----+----+----+----+----+----+-------+
```

                Figure 4. ARP Data Link Encapsulation and Values

Address Resolution

   The dynamic mapping of 32-bit Internet addresses to SMDS addresses
   SHALL be done via the dynamic discovery procedure of the Address
   Resolution Protocol (ARP) [2].

   Internet addresses are assigned independent of SMDS addresses. Each
   host implementation MUST know its own Internet address and SMDS
   address and respond to Address Resolution requests appropriately.
   Hosts MUST also use ARP to map Internet addresses to SMDS addresses
   when needed.

   The ARP protocol has several fields that parameterize its use in any
   specific context [2]. These fields are:

           ar$hrd   16 - bits   The Hardware Type Code
           ar$pro   16 - bits   The Protocol Type Code
           ar$hln   8 - bits   Octets in each hardware address
           ar$pln   8 - bits   Octets in each protocol address
           ar$op   16 - bits   Operation Code

     o The hardware type code assigned to SMDS addresses is 14
       (decimal), 0E (Internet hexadecimal) [11].

     o The protocol type code for IP is 2048 (decimal), 0800
       (Internet hexadecimal) [11].

o The hardware address length for SMDS is 8.

o The protocol address length for IP is 4.

o The operation code is 1 for request and 2 for reply.

The SMDS hardware addresses in ARP packets (arsha, artha) MUST be
carried in SMDS native address format, with the most significant bit
of the Address Type sub-field as the high order bit of the first
octet. Although outside the scope of this document, it is
RECOMMENDED that SMDS addresses be represented in this format in all
higher layer Internet protocols (e.g., SNMP).

Traditionally, ARP requests are broadcast to all directly connected
stations. For the SMDS Service, the ARP request packet is
transmitted to the smds$arp-req hardware address. In the LIS
configuration, the smds$arp-req address is set to smds$lis-ga, (the
SMDS group address that identifies all members of the LIS). It is
conceivable that in a larger scale, public configuration, the
smds$arp-req address would be configured to the address of some ARP-
server(s) instead of the group address that identifies the entire
LIS.

IP Broadcast Address

There is no facility for complete hardware broadcast addressing over
the SMDS Service. As discussed in the "LIS Configuration" section,
an SMDS group address (smds$lis-ga) SHALL be configured to include
all stations in the same LIS. The broadcast Internet address (the
address on that network with a host part of all binary ones) MUST be
mapped to smds$lis-ga (see also [12]).

IP Multicast Support

A method of supporting IP multicasting is specified in [13]. It
would be desirable to fully utilize the SMDS group address
capabilities to support IP multicasting. However, the method in [13]
requires a Network Service Interface which provides multicast-like
ability to provide dynamic access to the local network service
interface operations:

o JoinLocalGroup (group-address)

o LeaveLocalGroup (group-address)

The SMDS group address ability does not currently support dynamic
subscription and removal from group address lists. Therefore, it is
RECOMMENDED that in the LIS configuration, if IP multicasting is to

be supported, the method of IP multicasting described for pure
broadcast media, such as the Experimental Ethernet, be used. For
this method, all Multicast IP addresses are mapped to the same SMDS
address which the broadcast Internet address is mapped for a given
LIS. Thus all Multicast IP addresses are mapped to smds$lis-ga.
Filtering of multicast packets MUST be performed in the destination
host.

Trailer Formats

   Some versions of Unix 4.x BSD use a different encapsulation method in
   order to get better network performance with the VAX virtual memory
   architecture. Trailers SHALL not be used over the SMDS Service.

Byte Order

   As described in Appendix B of the Internet Protocol specification
   [1], the IP datagram is transmitted over the SMDS Service as a series
   of 8-bit bytes. The byte order of the IP datagram shall be mapped
   directly onto the native SMDS byte order.

MAC Sublayer Details

Packet Size

   The SMDS Service defines a maximum service data unit size of 9188
   information octets. This leaves 9180 octets for user data after the
   LLC/SNAP header is taken into account. Therefore, the MTU for IP
   stations operating over the network supporting the SMDS Service SHALL
   be 9180 octets.

   There is no minimum packet size restriction defined for the SMDS
   Service.

Other MAC Sublayer Issues

   The SMDS Service requires that the publicly administered 60-bit
   address plus 4-bit type field format SHALL be used in both source and
   destination address fields of the SIP L3_PDU [3].

IEEE 802.2 Details

   While not necessary for supporting IP and ARP, all implementations
   MUST support IEEE 802.2 standard Class I service in order to be
   compliant with IEEE 802.2. Some of the functions are not related
   directly to the support of the SNAP SAP (e.g., responding to XID and
   TEST commands directed to the null or global SAP addresses), but are
   part of a general LLC implementation. Both [4] and [5] describe the

minimum functionality necessary for a conformant station.
Implementors should also consult IEEE Std. 802.2 [14] for details.

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Security Considerations

    Security issues are not discussed in this memo.

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