         The PPP Internetwork Packet Exchange Control Protocol (IPXCP)

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.

Abstract

   The Point-to-Point Protocol (PPP) [1] provides a method for
   transmitting multi-protocol datagrams over point-to-point links. PPP
   defines an extensible Link Control Protocol, and proposes a family of
   Network Control Protocols for establishing and configuring different
   network-layer protocols.

   The IPX protocol was originally used in Novell's NetWare products
   [3], and is now supported by numerous other vendors. This document
   defines the Network Control Protocol for establishing and configuring
   the IPX protocol over PPP.

   This memo is the product of the Point-to-Point Protocol Working Group
   of the IETF. Comments should be submitted to the ietf-
   ppp@ucdavis.edu mailing list.

Table of Contents

1. Introduction

   PPP has three main components:

      1. A method for encapsulating multi-protocol datagrams.

      2. A Link Control Protocol (LCP) for establishing, configuring,
         and testing the data-link connection.

      3. A family of Network Control Protocols for establishing and
         configuring different network-layer protocols.

   In order to establish communications over a point-to-point link, each
   end of the PPP link must first send LCP packets to configure and test
   the data link. After the link has been established and optional
   facilities have been negotiated as needed by the LCP, PPP must send
   IPXCP packets to choose and configure the IPX network-layer protocol.
   Once IPXCP has reached the Opened state, IPX datagrams can be sent
   over the link.

   The link will remain configured for communications until explicit LCP
   or IPXCP packets close the link down, or until some external event
   occurs (an inactivity timer expires or network administrator
   intervention).

1.1 Specification of Requirements

In this document, several words are used to signify the requirements of the specification. These words are often capitalized.

MUST

This word, or the adjective "required", means that the definition is an absolute requirement of the specification.

MUST NOT

This phrase means that the definition is an absolute prohibition of the specification.

SHOULD

This word, or the adjective "recommended", means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and carefully weighed before choosing a different course.

MAY

This word, or the adjective "optional", means that this item is one of an allowed set of alternatives. An implementation which does not include this option MUST be prepared to interoperate with another implementation which does include the option.

1.2 Terminology

This document frequently uses the following terms:

peer

The other end of the point-to-point link.

silently discard

This means the implementation discards the packet without further processing. The implementation SHOULD provide the capability of logging the error, including the contents of the silently discarded packet, and SHOULD record the event in a statistics counter.

   end-system

      A user's machine. It only sends packets to servers and other
      end-systems. It doesn't pass any packets through itself.

   router

      Allows packets to pass through, usually from one ethernet segment
      to another. Sometimes these are called "intermediate-systems".

   half-router

      Two normal routers, with an unnumbered link between them. Each
      looks like a router to the local users, but Netware doesn't
      understand unnumbered links, so each router is made to look like
      they both are a single machine.

2. A PPP Network Control Protocol for IPX

   The IPX Control Protocol (IPXCP) is responsible for configuring,
   enabling, and disabling the IPX protocol modules on both ends of the
   point-to-point link. IPXCP uses the same packet exchange mechanism
   as the Link Control Protocol. IPXCP packets may not be exchanged
   until PPP has reached the Network-Layer Protocol phase. IPXCP
   packets received before this phase is reached should be silently
   discarded.

   The IPX Control Protocol is exactly the same as the Link Control
   Protocol [1] with the following exceptions:

    Frame Modifications

      The packet may utilize any modifications to the basic frame format
      which have been negotiated during the Link Establishment phase.

    Data Link Layer Protocol Field

      Exactly one IPXCP packet is encapsulated in the Information field
      of a PPP Data Link Layer frame where the Protocol field indicates
      type hex 802B (IPX Control Protocol).

    Code field

      Only Codes 1 through 7 (Configure-Request, Configure-Ack,
      Configure-Nak, Configure-Reject, Terminate-Request, Terminate-Ack
      and Code-Reject) are used. Other Codes should be treated as
      unrecognized and should result in Code-Rejects.

Timeouts

   IPXCP packets may not be exchanged until PPP has reached the
   Network-Layer Protocol phase. An implementation should be
   prepared to wait for Authentication and Link Quality Determination
   to finish before timing out waiting for a Configure-Ack or other
   response. It is suggested that an implementation give up only
   after user intervention or a configurable amount of time.

 Configuration Option Types

   IPXCP has a distinct set of Configuration Options.

2.1 Sending IPX Datagrams

  Before any IPX packets may be communicated, PPP must reach the
  Network-Layer Protocol phase, and the IPX Control Protocol must reach
  the Opened state.

  Exactly one IPX packet is encapsulated in the Information field of a
  PPP Data Link Layer frame where the Protocol field indicates type hex
  002B (IPX datagram).

  The maximum length of an IPX datagram transmitted over a PPP link is
  the same as the maximum length of the Information field of a PPP data
  link layer frame. Since there is no standard method for fragmenting
  and reassembling IPX datagrams, PPP links supporting IPX MUST allow
  at least 576 octets in the information field of a data link layer
  frame.

2.2 IPX-WAN protocol

  A Novell specification called IPX-WAN [4] is intended to provide
  mechanisms similar to IPXCP negotiation over wide area links. As
  viewed by PPP, IPX-WAN is a part of IPX, and IPX-WAN packets are
  indistinguishable from other IPX packets.

  Currently, Novell has implemented IPXCP without any Configuration
  Options, and requires successful IPX-WAN completion, even when all
  required parameters have been hand configured. This makes it
  impossible for the current Novell products to interoperate with other
  IPXCP implementations which do not already include support for IPX-
  WAN.

2.3 Desired Parameters

  To resolve the possible conflict between the two configuration
  methods, this specification defines the concept of "Desired

Parameters". Where applicable, each Configuration Option indicates
the environment where the parameter which is negotiated MAY be
required by the implementation for proper operation.

This determination is highly implementation dependent. For example,
a particular implementation might require that all links have
addresses, while another implementation might not need such
addresses. The configuration negotiation is intended to discover
that this pair of implementations will never converge.

2.4 Co-existence with IPX-WAN

An IPXCP implementation which includes support for IPX-WAN SHOULD
always reach Opened state, even when unable to negotiate some
"Desired Parameter", and when no Configuration Options are
successfully negotiated. This allows IPX-WAN the opportunity to
finish the negotiation.

If an implementation does not include support for IPX-WAN, it SHOULD
NOT reach Opened state when unable to negotiate some "Desired
Parameter".

IPX-WAN uses a "Timer Request" packet to set up the link. These MUST
NOT be sent until IPXCP has Opened the link.

An implementation which provides both IPX-WAN and IPXCP Configuration
Options capability SHOULD only send a Timer Request packet when a
Timer Request packet is received, or upon failure to successfully
negotiate a "Desired Parameter".

If unable to complete IPX-WAN setup when a "Desired Parameter" is
unknown, by default IPXCP SHOULD terminate the link.

However, some implementations might be capable of operating without
all indicated "Desired Parameters", in which case the termination
MUST be configurable.

3. IPXCP Configuration Options

IPXCP Configuration Options allow modifications to the standard
characteristics of the network-layer protocol to be negotiated. If a
Configuration Option is not included in a Configure-Request packet,
the default value for that Configuration Option is assumed.

IPXCP uses the same Configuration Option format defined for LCP [1],
with a separate set of Options.

Up-to-date values of the IPXCP Option Type field are specified in the

most recent "Assigned Numbers" RFC [2]. Current values are assigned
as follows:

    1   IPX-Network-Number
    2   IPX-Node-Number
    3   IPX-Compression-Protocol
    4   IPX-Routing-Protocol
    5   IPX-Router-Name
    6   IPX-Configuration-Complete

3.1 IPX-Network-Number

   Description

      This Configuration Option provides a way to negotiate the IPX
      network number to be used for the link. This allows an
      implementation to learn the network number, or to ensure agreement
      on the network number.

      The network number MUST be unique within the routing domain, or
      zero to indicate that it is not used for routing.

      The sender of the Configure-Request states which network number is
      desired. A network number specified as zero in a Configure-
      Request shall be interpreted as requesting the peer to specify
      another value in a Configure-Nak. A network number specified as
      zero in a Configure-Ack shall be interpreted as agreement that no
      value exists.

      Both ends of the link MUST have the same network number. When a
      Configure-Request is received which has a lower network number
      than locally configured, a Configure-Nak MUST be returned with the
      highest network number.

      When the peer did not provide the option in its Configure-Request,
      the option SHOULD NOT be appended to a Configure-Nak.

      By default, no network number is assigned to the link (the network
      number is zero). There is no need for a network number if the
      interface is not used by a routing protocol.

      This is a Desired Parameter when the implementation is operating
      as a router. It MUST be negotiated if the network number is non-
      zero, and has been derived from another interface.

      Any IPX-WAN packets received MUST supercede information negotiated
      in this option.

A summary of the IPX-Network-Number Configuration Option format is
shown below. The fields are transmitted from left to right.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type     |     Length    |        IPX-Network-Number     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   IPX-Network-Number (cont.)  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type

   1

Length

   6

IPX-Network-Number

The four octet IPX-Network-Number is the desired local IPX network
number of the sender of the Configure-Request. This number may be
zero, which is interpreted as being a local network of unknown
number that is not used by the routing protocol.

3.2 IPX-Node-Number

 Description

This Configuration Option provides a way to negotiate the IPX node
number to be used for the local end of the link. This allows an
implementation to learn its node number, or to inform the peer of
its node number.

The node number MUST be unique for the network number.

The sender of the Configure-Request states which node number is
desired. A node number specified as zero in a Configure-Request
shall be interpreted as requesting the peer to specify another
value in a Configure-Nak. A node number specified as zero in a
Configure-Ack shall be interpreted as agreement that no value
exists.

If negotiation about the peer node number is required, and the
peer did not provide the option in its Configure-Request, the
option can be appended to a Configure-Nak. The value of the node
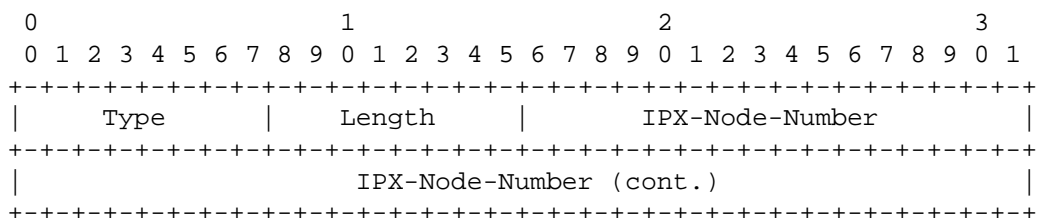number given MUST be acceptable as the peer IPX-Node-Number, or

indicate with a zero value that the peer provide the information.

By default, no node number is assigned to the link (the node
number is zero). There is no need for a node number if the
interface is not used by a routing protocol.

This is a Desired Parameter when the implementation is operating
as an end-system. However, when the node number has been
statically configured, this option SHOULD NOT be negotiated unless
requested by the peer.

Any IPX-WAN packets received MUST supercede information negotiated
in this option.

A summary of the IPX-Node-Number Configuration Option format is
shown below. The fields are transmitted from left to right.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type     |     Length    |        IPX-Node-Number        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     IPX-Node-Number (cont.)                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type

   2

Length

   8

IPX-Node-Number

The six octet IPX-Node-Number is the desired local IPX node number
of the sender of the Configure-Request.

3.3 IPX-Compression-Protocol

Description

This Configuration Option provides a way to negotiate the use of a
specific compression protocol. By default, compression is not
enabled.

The sender of this Configuration Option indicates that it can
receive packets with the specified compression technique. A

      Configure-Ack MAY obligate the peer to send such packets,
      depending on the protocol negotiated.

      Information negotiated in this option MUST supercede any IPX-WAN
      packets received, since IPX-WAN packets could be affected by the
      compression technique.

   A summary of the IPX-Compression-Protocol Configuration Option
   format is shown below. The fields are transmitted from left to
   right.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |    Length     |   IPX-Compression-Protocol    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Data ...
   +-+-+-+-+
```

      Type

         3

      Length

         >= 4

      IPX-Compression-Protocol

   The IPX-Compression-Protocol field is two octets and indicates the
   compression protocol desired. Odd values for this field are always
   the same as the PPP Data Link Layer Protocol field values for that
   same compression protocol. Even values are used when the compression
   protocol is interleaved with IPX packets.

   Up-to-date values of the IPX-Compression-Protocol field are specified
   in the most recent "Assigned Numbers" RFC [2]. Current values are
   assigned as follows:

           Value (in hex) Protocol

           0002   Telebit Compressed IPX
           0235   Shiva Compressed NCP/IPX

   Data

      The Data field is zero or more octets and contains additional data
      as determined by the particular compression protocol.

IPX-Routing-Protocol

   Description

      This Configuration Option provides a way to negotiate the use of a
      specific routing protocol (or no routing protocol, if desired).
      The sender of this option is specifying that it wishes to receive
      information of the specified routing protocol. Multiple protocols
      MAY be requested by sending multiple IPX-Routing-Protocol
      Configuration Options. The "no routing protocol required" value
      is mutually exclusive with other values.

      By default, Novell's combination of Routing Information Protocol
      (RIP) and Server Advertising Protocol (SAP) is expected.

      This is a Desired Parameter when the implementation is operating
      as an end-system, to indicate that no routing protocol is
      necessary.

      Any IPX-WAN packets received MAY add to information negotiated in
      this option.

    A summary of the IPX-Routing-Protocol Configuration Option format is
    shown below. The fields are transmitted from left to right.

       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
      +-+
      | Type | Length | IPX-Routing-Protocol |
      +-+
      | Data ...
      +-+-+-+-+

      Type

         4

      Length

         >= 4

      IPX-Routing-Protocol

      The IPX-Routing-Protocol field is two octets and indicates the
      type of Routing-Protocol desired. This two octet quantity is sent
      most significant octet first.

      Up-to-date values of the IPX-Routing-Protocol field are specified

in the most recent "Assigned Numbers" RFC [2]. Current values are
assigned as follows:

      Value   Protocol

       0   No routing protocol required
       1   RESERVED
       2   Novell RIP/SAP required
       4   Novell NLSP required

   Data

      The Data field is zero or more octets and contains additional data
      as determined by the routing protocol indicated in the Routing-
      Protocol field.

3.5 IPX-Router-Name

   Description

      This Configuration Option provides a way to convey information
      about the IPX server name.

      The nature of this option is advisory only. It is provided as a
      means of improving the end system's ability to provide a simple
      user interface. This option MUST NOT be included in a Configure-
      Nak.

    A summary of the IPX-Router-Name Option format is shown below. The
    fields are transmitted from left to right.

```
        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
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |     Type      |    Length     |          Name...              |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Type

       5

   Length

       >= 3

   Name

      This field contains the name of the IPX entity on this end of the
      link. The symbolic name should be between 1 and 47 ASCII
      characters in length, containing the characters 'A' through 'Z',
      underscore (_), hyphen (-) and "at" sign (@). The length of the
      name is bounded by the option length.

      On reception, the name SHOULD be padded to 48 characters using the
      NUL character. Those readers familiar with NetWare 3.x servers
      will realize that this is equivalent to the file server name.

3.6 IPX-Configuration-Complete

   Description

      This Configuration Option provides a way to indicate that all
      implementation-dependent Desired Parameters are satisfied. It is
      provided as a means of detecting when convergence will occur in a
      heterogeneous environment.

      This option SHOULD be included in a Configure-Request when the
      combination of statically configured parameters and offered
      Configuration Options will result in successful configuration.

      The nature of this option is advisory only. This option MUST NOT
      be included in a Configure-Nak.

      Implementation Note: An implementation which does not support
      IPX-WAN can immediately detect that link setup will not be
      successful when a Desired Parameter is unknown, if this option is
      not present in the peer's Configure-Request or is Rejected by the
      peer. This avoids timeout delays.

      An implementation which supports IPX-WAN may improve link setup
      time by skipping IPX-WAN entirely when this option has been Ack'd
      in both directions.

      However, it is perfectly acceptable to complete configuration
      without including this option. An implementation which includes
      the entire panoply of configuration options and IPX- WAN SHOULD
      interoperate with an implementation which does not support IPX-WAN
      nor any configuration options (including this one), as long as the
      Desired Parameters are satisfied by default or hand configuration.

   A summary of the IPX-Configuration-Complete Option format is shown
   below. The fields are transmitted from left to right.

```
 0                   1
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type      |     Length     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type

     6

Length

     2

APPENDIX A. Link Delay and Throughput

   There has been some concern over correctly estimating the link delay
   (in 55 millisecond ticks) used by Novell routing protocols.

   IPX-WAN uses its Timer Request and Reply for this purpose. The
   measured delay is multiplied by a factor of 6, because the
   measurement is done during initialization of the link, and does not
   reflect actual loading.

   The delay is better measured using the PPP LCP Echo facility, by
   inserting a timestamp in the data part of the Request, and comparing
   it with the same timer when the reply returns. This method could be
   used to periodically re-evaluate the actual round trip delay as link
   and system loads change. The echo packet size SHOULD be 576, to
   match the default IPX packet size.

   In the absence of such dynamic measurements, empirical evidence has
   shown the following to be sufficient:

                  2,400 bps   134 ticks
                 14,400 bps   21 ticks
                 57,600 bps   5 ticks
                 > 1 Mbps   1 tick

Security Considerations

   Security issues are not discussed in this memo.

References

   [1] Simpson, W., "The Point-to-Point Protocol (PPP)", RFC 1548,
       Daydreamer, December 1993.

   [2] Reynolds, J., and J. Postel, "Assigned Numbers", STD 2, RFC 1340,
       USC/Information Sciences Institute, July 1992.

   [3] Novell Inc., "NetWare System Interface Technical Overview",
       Novell Part Number 883-001143-001.

   [4] Allen, M., "Novell IPX Over Various WAN Media", RFC 1551,
       Novell Inc., December 1993.

   [5] Mathu, S., and M. Lewis, "Compressing IPX Headers Over WAN
       Media (CIPX)", RFC 1553, Telebit Corporation, December 1993.

Acknowledgments

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