Network Working Group
Request for Comments: 1553
Category: Standards Track

S. Mathur
M. Lewis
Telebit Corporation

December 1993

Compressing IPX Headers Over WAN Media (CIPX)

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

This document describes a method for compressing the headers of IPX datagrams (CIPX). With this method, it is possible to significantly improve performance over lower speed wide area network (WAN) media. For normal IPX packet traffic, CIPX can provide a compression ratio of approximately 2:1 including both IPX header and data. This method can be used on various type of WAN media, including those supporting PPP and X.25.

This memo ia a product of the Point-to-Point Protocol Extensions (PPPEXT) Working Group of the IETF. Comments should be sent to the authors and the ietf-ppp@ucdavis.edu mailing list.

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.

Introduction

Internetwork Packet Exchange (IPX) is a protocol defined by the Novell Corporation [1]. It is derived from the Internet Datagram Protocol (IDP) protocol of the Xerox Network Systems (XNS) family of protocols. IPX is a datagram, connectionless protocol that does not require an acknowledgment for each packet sent. The IPX protocol corresponds to the network layer of the ISO model.

Usually, there is a transport layer protocol above IPX. The most common transport protocol is the Netware Core Protocol (NCP), which is used for file server access. The Sequenced Packet Exchange (SPX) is the reliable connection-based transport protocol commonly used by applications.

The IPX packet consists of a 30 octet IPX header, usually followed by the transport layer protocol header. The NCP header is 6 octets in length. The SPX header is 12 octets in length.

Two strategies are described below for compressing IPX headers. This specification requires that implementations of CIPX support both IPX header compression strategies. These header compression algorithms are based on those Van Jacobson described [2] for TCP/IP packets.
The first strategy is to compress only the IPX header. This compression algorithm can be used to compress any IPX packet, without affecting the transport protocol. This algorithm compresses a 30 octet IPX header into a one to seven octet header.

The second strategy is to compress the combined IPX and NCP headers. This algorithm compresses only NCP packets with NCP type of 0x2222 and 0x3333. This algorithm compresses a 36 octet NCP/IPX

header into a one to eight octet header.

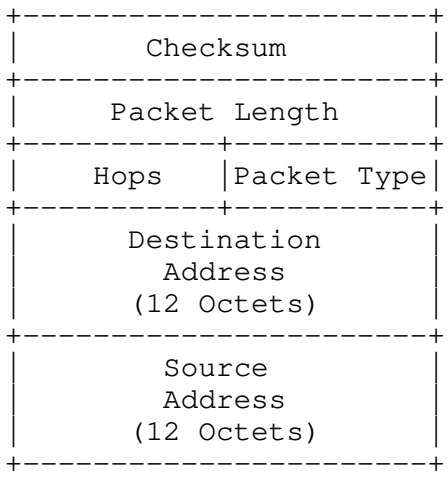
Lastly, it is possible and many times desirable, to use this type of header compression in conjunction with some type of data compression.

Data compression technology takes many forms. Link bit stream compression is a common approach over very low speed asynchronous links, normally performed by modems transparently. Transparent bit stream compression is also offered in some DSUs, routers and bridges. Data compression can be provided using protocols such as CCITT V.42bis[3], MNP 5, Lempel-Ziv, or LAPB[4].

When using both header and data compression, the sequence of compression is important. When sending packets, data compression MUST be done after header compression. Conversely when receiving packets, data decompression MUST be done before header decompression.

IPX Compression Algorithm

The normal IPX header consists of the following fields: checksum, packet length, transport control (hop count), packet type, destination and source address fields.



IPX PACKET HEADER

The IPX header diagram above is shown without the field alignment details. Consider each field of the IPX header separately, and how it typically changes.

Historically, Novell has not used the Checksum field in the IPX

header, and has required that this field be set to 0xFFFF. Since the Checksum field remains constant, it is clear that the value can be compressed.

Where Checksums are implemented (not 0xFFFF), the Checksum MUST be included in the compressed packet. Recalculating the checksum would destroy the end-to-end reliability of the connection. Note that Checksums are now implemented in the Fault Tolerant Servers.

For most links, the Packet Length can be determined from the MAC layer. There are cases in which the length cannot be determined from the MAC layer. For example, some hardware devices pad packets to a required minimum length. For links where it is not possible to determine the IPX packet length from the MAC layer, packet length needs to be included in the compressed packet.

The Transport Control (Hops) field usually does not change between two end-points. For the purposes of compression, we will assume that it never changes, and will not examine this field when determining a connection.

The Packet Type field is constant for any connection.

The Destination and Source Address fields are each made up of 12 octets: Network (4 octets), Node (6 octets), and Socket (2 octets) fields. An IPX connection is the logical association between two endpoints known by a given source and destination address pair. For any specific IPX connection, the Destination and Source Address fields are constant.

Hence, the fields that may need to be included in the compressed IPX header are the Checksum and the Packet Length.

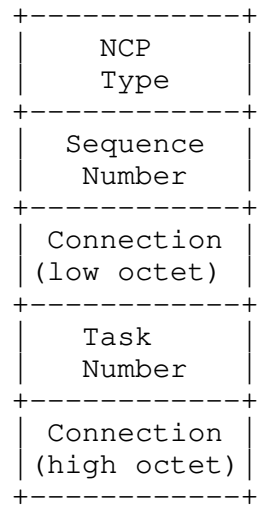
While using this IPX header compression algorithm, packets can be lost. The loss of an Initial packet presents a problem. In this case, if the sender later tries to send a compressed packet, the receiving end cannot decompress the packet correctly.

Sufficient information is not available in the IPX header to determine when a re-transmission has occured. For this reason, it is necessary that the sender of an Initial packet be guaranteed that the packet has been received. Therefore, we provide a mechanism for Confirmation of an Initial packet.

NCP/IPX Header Compression

Since most IPX packets are Netware Core Protocol packets (packet type 17), compressing the NCP header will give us added performance. A

minimal CIPX implementation MUST also implement NCP/IPX compression.



NCP HEADER

The NCP header is 6 octets in length consisting of the following fields: NCP type, sequence number, connection number and task number.

The NCP type field values that are currently defined are:

1111	Create Connection
2222	NCP request from workstation
3333	NCP reply from file server
5555	Destroy Connection
7777	Burst Mode Packet
9999	Server Busy Packet

This NCP header compression algorithm only compresses packets that have a type field value of 0x2222 or 0x3333. If the NCP type is 0x2222, this packet is a request from the client to the server. Conversely if the NCP type is 0x3333, this is a response from the server to the client. All other types of NCP packets are not compressed at the NCP level, but are compressed at the IPX level. The Create Connection (0x111), Destroy Connection (0x5555) and Server Busy (0x9999) packets are not exchanged frequently enough to justify special NCP compression. The Burst Mode (0x7777) packet is discussed below.

The connection number is a constant for a given connection.

The sequence number is increased by one for each new request. Hence the sequence number can be determined implicitly. The decompressor

increments the sequence number for each compressed packet it receives for a connection.

The task number can change unpredictably, although it might remain constant for several packets. If the NCP task number is different from the last one for this connection, the NCP task number must be included.

If the NCP packet is lost, it will be retransmitted through the normal transport layer mechanisms. The Initial NCP packet does not require confirmation, as a re-transmitted packet can be easily identified. This is accomplished by comparing the sequence number of the packet to the sequence number of the previous packet. If the sequence number is not exactly one greater than the previous packet, a new Initial packet must be sent, although the same connection slot may be used.

In the event of compressed packet loss, the sequence number will be too small. When the IPX Checksum is present, the loss can be determined at the destination system by an incorrect checksum. When there is no checksum present, the loss is more likely to be detected upon receiving a later retransmission.

NCP Burst Mode Packets

The burst mode protocol uses the NCP type value of 0x7777. This type of packet does not have the normal NCP header described above. Instead, it has a 36 octet burst header. The above NCP header compression algorithm should not be used to compress this packet. The IPX header in this packet is still compressible with the IPX header compression algorithm described.

SPX Packets

SPX packets are typically used by applications which require reliable service such as print servers. It is possible to apply a similar NCP/IPX technique to SPX/IPX packets. At this time, we have not described such a mechanism. The IPX header in this packet is still compressible with the IPX header compression algorithm described.

Compression Header

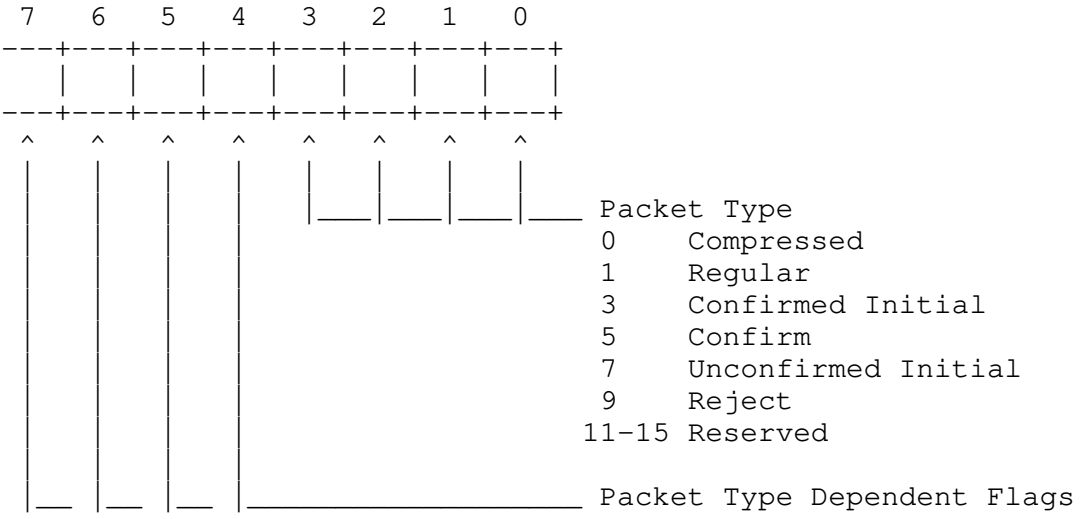
IPX compression should be negotiated by some means (eg. IPXCP or IPXWAN). Each end must negotiate the desired options, such as the maximum number of concurrent connections which will be maintained in each direction. Once IPX compression is negotiated, all IPX packets sent over that link have a CIPX header added to the

beginning of the packet. The CIPX header is variable in length.

The one octet CIPX header is added even when a regular IPX packet is sent over the link. By including the CIPX header on every packet, we support the ability to run CIPX over various WAN links as if it were a normal IPX packet. It does not rely on any new link specific packet demultiplexing.

Implementations of this compression protocol must maintain send and receive tables indicating the state of each connection. The original header for each connection is stored in a "slot". Typically, each client-server connection will use a separate slot. Both sides keep a copy of the full IPX header corresponding to each slot. The sending side (compressor) uses this information to determine the fields that have changed. The receiving side (decompressor) uses this information to reconstruct the original packet header.

The CIPX packet header specifies the type of the packet and any options for that packet. The minimum CIPX header is one octet in length.



FLAGS OCTET

As can be seen above, the low order bits specify the packet type. All Compressed packets have a lowest bit of zero. The other packet types are odd numbers.

Note that the Flags octet MUST NOT contain the value 0xFF. This is necessary to distinguish the CIPX flags octet from a normal IPX header with a 0xFFFF checksum field. It is important to be able

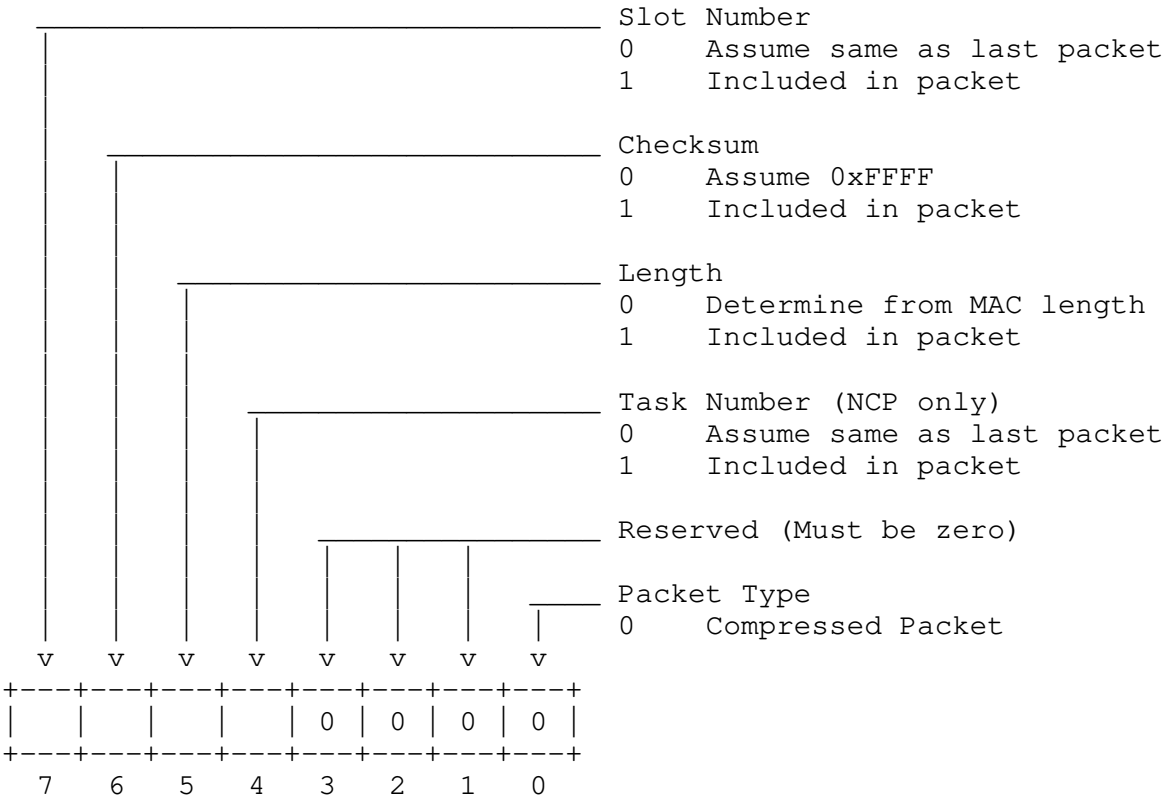
to recognize a normal IPX header regardless of the state of compression. It is possible with some link layer protocols such as X.25 Permanent Virtual Circuits that one end of the link may fail and start sending regular IPX packets without the CIPX header. CIPX implementations MUST recognize this situation and renegotiate the use of CIPX.

Each packet type has associated flag bits, which are called Packet Type Dependent Flags. Different packet types have different Packet Type Dependent Flags. All bits that are reserved or are not specified must be set to zero.

Since none of the packet types other than Compressed currently uses any of the flag bits, the packet type field could easily be expanded. Any future expansion must ensure that at least one of the bits in the Flags octet remains zero so the value cannot be 0xFF.

Compressed Packet

This type of packet does not contain a packet header (either 30 byte IPX, or 36 byte NCP). A slot number indicates to the receiver which saved header to use to formulate the original packet header before passing the packet up to IPX.



Consider each flag in the flags octet, looking at the high order bits working toward the lower order bits. Each of the fields is optional, but if present will be found in the same order in the compressed packet header.

Slot Number

The slot number flag indicates the slot number field is included in the compressed packet. The slot number field is one octet in length and specifies the number of the slot which corresponds to the Initial packet header. Slots are numbered starting at zero and continue to the maximum number of slots minus one.

By default, slot compression is disabled. If negotiated, slot compression can be enabled for those slots which were created by the Unconfirmed Initial packet. When set to one (1), the slot number flag indicates the inclusion of the the slot number in the compressed packet. When set to zero (0), the slot number flag indicates the omission of the the slot number and specifies the use of the same slot number as for the last packet.

Implementation Note:

Slot compression MUST only be enabled in a receiver which can account for all erroneous and discarded packets. When a packet has been discarded, the slot number is indeterminate for future packets. The decompressor MUST discard all further packets until a slot number is received.

Checksum

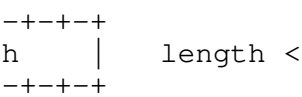
When set to one (1), the checksum flag indicates the compressed packet will include the 2 octet checksum. When set to zero (0), this flag indicates the omission of the checksum and the decompressor is to assume the checksum is 0xFFFF. Note that meaningful checksums must be included in the packet with the checksum flag set to one (1).

Length

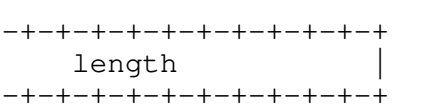
When set to one (1), the length flag indicates the inclusion of the IPX data length field in the compressed packet. When set to zero (0), the length flag indicates the omission of the IPX data length field in the compressed packet.

This is the Length field from the original IPX packet header. It specifies the length of IPX header and data in the packet prior to compression. It does not include the CIPX compression field such as flags, slot number, checksum, length field, or the NCP task number. Note that it is preferable to determine the length field from the MAC layer whenever possible, by subtracting the length of the compression header fields and adding the length of the saved packet header.

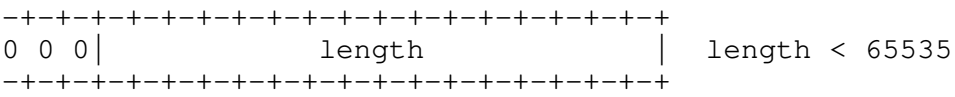
Since every octet is significant over lower speed WAN links, an optimization is used in the specification of the length. It can be specified as a one, two or three octet field. If the length is in the range 0 to 127, then it is specified as a one octet field. If the length is in the range 128 to 16383, it is specified as a two octet field in high to low order, with the first octet in the range 128 to 191. Otherwise, if the length is greater than 16383, the first octet contains 192, and the second and third octets contain the full length. (This scheme is extensible to 8 octets, but currently is not required in the IPX protocol suite.)



ONE OCTET LENGTH FIELD



TWO OCTET LENGTH FIELD

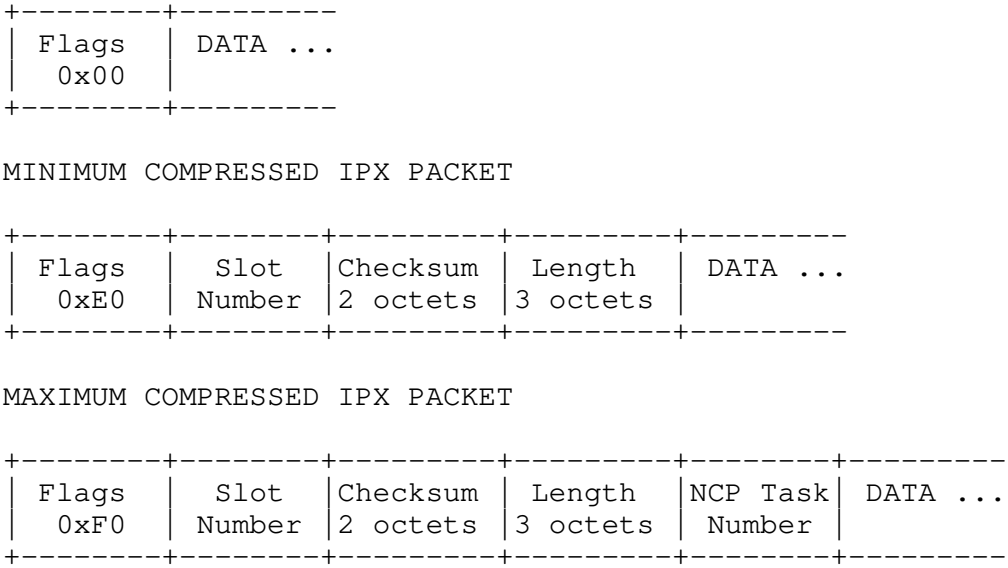


THREE OCTET LENGTH FIELD

Task Number

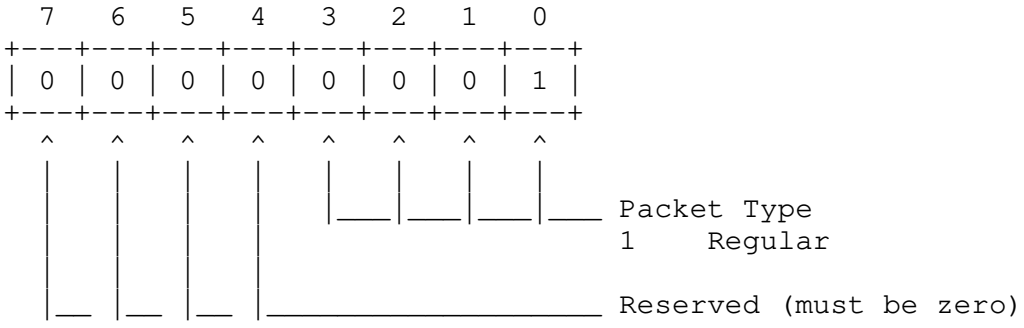
When set to one (1), the NCP task number flag indicates the NCP task number is included in the compressed packet (see NCP/IPX compression above). When set to zero (0), the NCP task number flag indicates the omission of the NCP task number in the compressed packet. When the NCP task number is not included in the compressed packet, we use the same NCP task number as that of last packet.

Based upon the bits set in the flags octet, optional portions are included in the compressed IPX header. The minimum compressed IPX header contains only the Flags octet. All fields in the original IPX header have been compressed out of the header. The maximum compressed IPX header can include up to 7 octets, the Flags, Slot, Checksum (2 octets), and Length (3 octets) fields, or 8 octets if the NCP Task Number is included. The minimum and maximum compressed IPX packets are shown below. Header fields are one octet in length except where noted.



Regular Packet

The Regular packet type designates an IPX packet for which no compression is desired. This type of packet is sent when a packet cannot be compressed, or a decision is made not to compress it.



The Regular packet is rarely sent. Usually, the Regular packet is sent when there is not enough memory for the overhead of a new compression slot. Also, this type is included for future unforeseen changes to the IPX protocol which defeat the effectiveness of compression.

Implementation Note:

The Regular Packet can be used for packets that are sporadic, which are not worth setting-up a compression slot. This may be

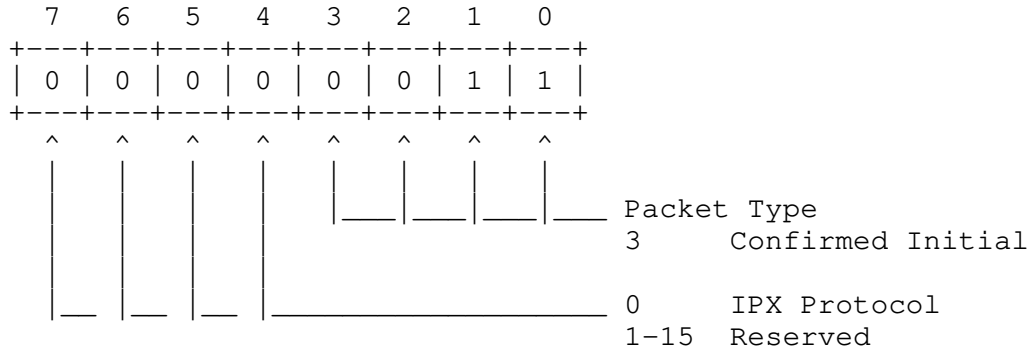
hard to determine for specific protocols. Various methods such as hold-down and least-recently-used timers are currently being used.

On receipt, the 1 octet header is simply removed and the packet passed up to IPX.

The entire IPX packet follows the single Flags octet. Note for a Regular Packet (not compressed or uncompressed), the slot number field is not included.

Confirmed Initial Packet

The Confirmed Initial packet type is used by the compressor to inform the decompressor of the original packet header which will be used for subsequent compression, and to request Confirmation. The high order 4 bits are reserved for expansion to support additional protocols.



This type of packet is sent to inform the receiver to associate the IPX packet header with a slot number. This packet is sent each time a different header format is sent for a given slot, or when the sender has not received a Confirmation Packet from the receiver.

The Flags octet lower 4 bits indicate the Confirmed Initial CIPX packet type. The high order 4 bits are reserved for expansion to support additional protocols. The Flags octet is always followed by the Slot Number and an ID field. The ID field is one octet in length.

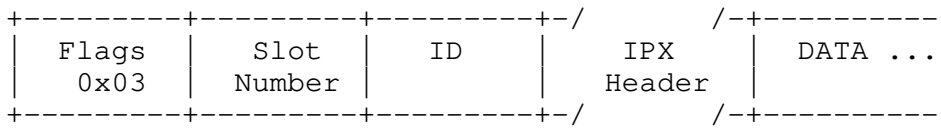
For each slot, the ID will increment with every new header sent. Different slots may have the same ID. The combination of slot and ID uniquely identify a header. In practice, the ID octet can be any number which is unique for a "reasonably long period" of time. A reasonably long period is a function of transmission speed, round trip delays, and network load. There must be very little chance of duplicate slot and ID combinations within this period. Otherwise,

there is ambiguity as to which header is being identified.

Implementation Note:

There is no requirement to hold or resend the Confirmed Initial packet until confirmation. When a new packet with the same IPX header is to be sent, another Confirmed Initial packet should be sent using the same slot, the same ID, and the new packet data.

When a new packet with a different IPX header is to be sent, it may be sent using a slot which has not received confirmation. A Confirmed Initial packet is sent with the same slot, an incremented ID, and the new packet data. Assuming a least-recently-used policy for selecting a slot for a new IPX header, this provides the ability to reuse slots when a Confirmed Initial packet has been sent but not confirmed.



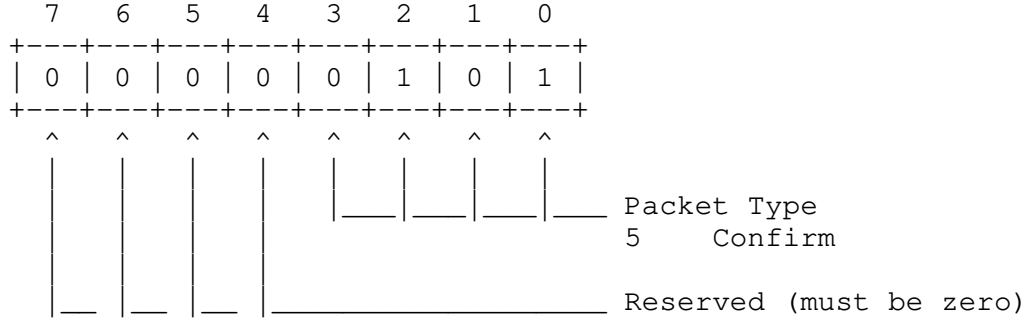
CONFIRMED INITIAL PACKET

Note that a Confirmed Initial header is followed by a complete IPX packet.

Confirm Packet

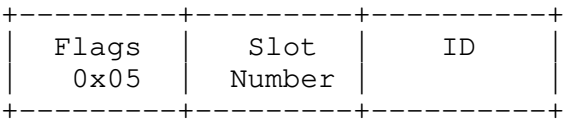
The Confirm packet type is used by the decompressor to tell the compressor that it has received the Confirmed Initial packet.

When the compressor receives this, it can start sending Compressed frames.



A Confirm Packet is exactly 3 octets in length. It consists of the

Flags, Slot Number and ID fields. The Slot Number field contains the number of the slot which is being acknowledged. The ID field contains the ID of the Confirmed Initial Packet which is being acknowledged.

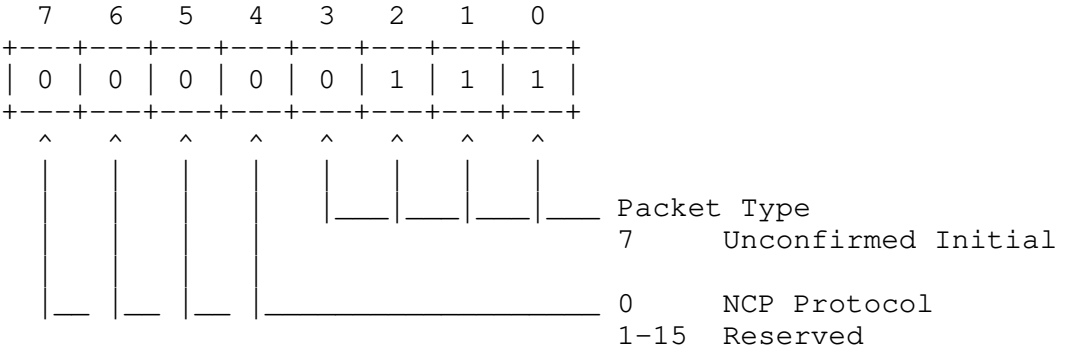


CONFIRM PACKET

Unconfirmed Initial Packet

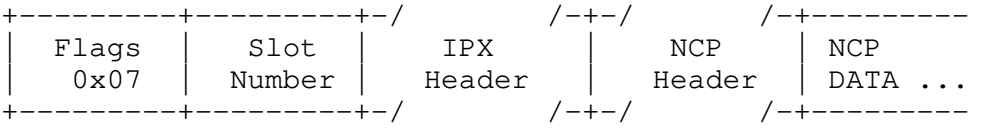
The Unconfirmed Initial packet type is used by the compressor to inform the decompressor of the original packet header which will be used for subsequent compression while not requesting confirmation.

After sending an Unconfirmed Initial packet, the compressor may immediately send Compressed packets without confirmation.



This type of packet is sent to inform the receiver to associate the IPX packet header with a slot number. This packet is sent each time a different header format is sent for a given slot.

The Flags octet lower 4 bits indicate the Unconfirmed Initial CIPX packet type. The high order 4 bits are reserved for expansion to support additional protocols. The Flags octet is always followed by the Slot Number.

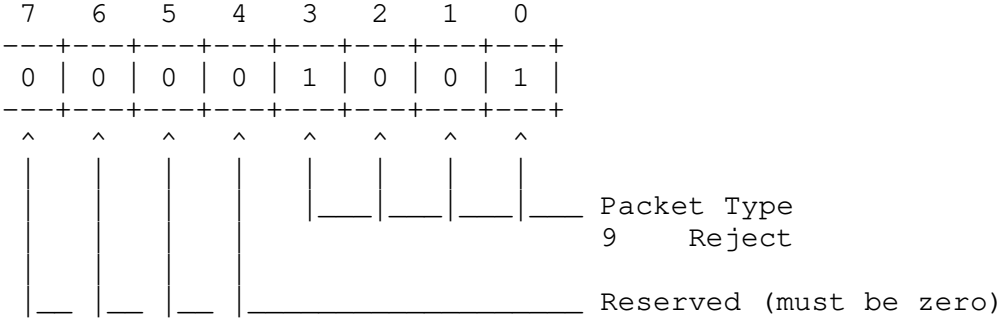


UNCONFIRMED INITIAL PACKET

Note that an Unconfirmed Initial header is followed by a complete IPX packet.

Reject Packet

The Reject packet type is used by the decompressor to tell the compressor that it has received a CIPX packet with a header which it does not support. This is provided to regulate future extensions to CIPX.



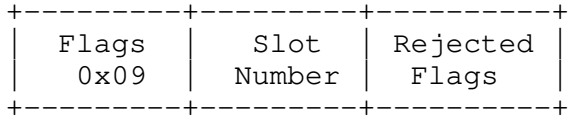
A Reject Packet is exactly 3 octets in length. It consists of the Flags, Slot Number and Rejected Flags fields.

The Slot Number field contains the number of the slot of the packet which is being rejected. Since the actual packet type may be unknown or misunderstood, this field actually contains the second octet of the rejected packet. In the normal case of a known CIPX packet type, this will be the slot number of an initial packet.

The Rejected Flags field contains the first octet of the packet being rejected. The packet type field is left untouched. Any flags which are correctly recognized should be cleared. The remaining flags indicate specific features that are being rejected. This information should be sufficient for implementations to adjust the use of certain packet types or dependent flags.

Implementation Note:

The Flags value of 0xFF is not a valid CIPX packet type. Hence, such a packet type should be recognized as a standard IPX header and forwarded without CIPX processing to the appropriate routines. Under no circumstances should a Flags value of 0xFF be rejected in a Reject Packet.



REJECT PACKET

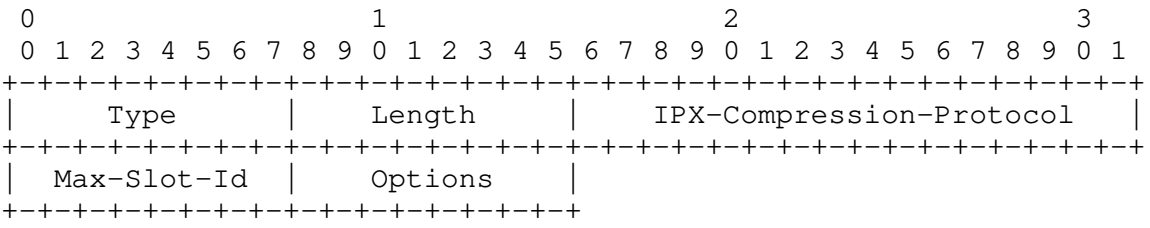
Compression Negotiation over PPP Links

For PPP links [5], the use of header compression can be negotiated by IPXCP [6]. By default, no compression is enabled.

The IPX-Compression-Protocol Configuration Option is used to indicate the ability to receive compressed packets. Each end of the link must separately request this option if bi-directional compression is desired.

The PPP Protocol field is set to the same value as the usual IPX packets, and all IPX packets sent over the link MUST conform to the compressed format.

A summary of the IPX-Compression-Protocol Configuration Option format to negotiate Telebit IPX header compression (CIPX) is shown below. The fields are transmitted from left to right.



Type

3

Length

6

IPX-Compression-Protocol

0002 (hex) for Telebit Compressed IPX headers (CIPX).

Max-Slot-Id

The Max-Slot-Id field is one octet and indicates the maximum

slot identifier. This is one less than the actual number of slots; the slot identifier has values from zero to Max-Slot-Id.

Options

The Options field is one octet, and is comprised of the "logical or" of the following values:

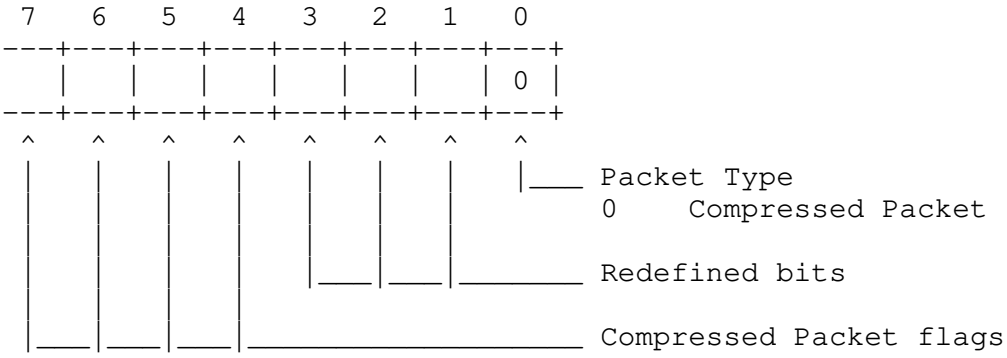
0 No options.

1 The slot identifer may be compressed.

The slot identifier must not be compressed if there is no ability for the PPP link level to indicate an error in reception to the decompression module. Synchronization after errors depends on receiving a packet with the slot identifier.

2 Redefine Compressed Packet type bits 1-3.

It was noted earlier that packet types have been chosen such that only the Compressed Packet type is an even number value with the lowest order bit of zero. All other packet types are odd values with a lowest order bit of one. The reason for this assignment was to make it possible to determine the Compressed Packet type by examining only one bit. This make it possible to use all the other 7 bits to indicate status in the Compressed Packet. The 7 bits are composed of the upper 4 bits which are permanently defined to indicate packet dependent flags, plus bits 1-3 which are otherwise part of the Packet Type. The upper 4 bits are defined above. The redefinition of bits 1-3 of the Compressed Packet type is left for future expansion.



By default, this feature in not enabled and this flag is set to zero. When this flag is set to one, it indicates

the desire to use this feature.

Compression Negotiation over IPXWAN Links

"IPXWAN" is the protocol Novell uses to exchange necessary router to router information prior to exchanging standard IPX routing information and traffic over WAN datalinks [7]. To negotiate the Telebit compression option, we use Novell's allocated option number for CIPX (00) in the IPXWAN timer request/response packet.

The Timer Request packet contains the following Telebit compression option:

```
WOption Number       80        - Define compression type
WAccept Option       01        - 0=No, 1=Yes, 3=N/A
WOption Data Len     00 03     - Length of option
WOption Data         00        - Telebit's compression (CIPX)
WOption Data         XX        - Compression options
WOption Data         NN        - Compression slots
```

Where the WOption Data fields are:

00 Telebit's compression option described in this document (CIPX).

XX Compression options as defined below:

```
0x01   Compress slot ID when possible
0x02   Redefine Compressed Packet type bits 1-3.
```

NN The requested # of compression slots.

Accept Option (for compression type) must be set to YES if the option is supported and NO if the option is not supported. A Timer Response must respond with only one header compression type set to YES.

The Timer Response packet that accepts the option will look like this:

```
WOption Number       80        - Define compression type
WAccept Option       01        - 0=No, 1=Yes, 3=N/A
WOption Data Len     00 03     - Length of option
WOption Data         00        - Telebit's compression (CIPX)
WOption Data         XX        - Compression options
WOption Data         NN        - Compression slots
```

Where the WOption Data fields are:

00 Telebit's compression option described in this document (CIPX).

XX Compression options as defined below:

0x01 Compress slot ID when possible
0x02 Redefine Compressed Packet type bits 1-3.

NN The negotiated # of slots (The lower of each side's requested number of slots)

IPX packets (except of course IPXWAN packets) are not sent over the link until the IPXWAN negotiations are completed. Once IPXWAN negotiations are completed, regular IPX packets can be sent over the link.

If both ends of the link agree on the compression options, then the IPX packets are sent using the specified options. If either end of the link does not accept a compression option, then this compression option will not be used. Compression will be done using any remaining options. Options, by definition, are not required. Implementations MUST support CIPX without any options.

It is the responsibility of the router sending the IPXWAN Timer Response to inform the other router of the options that will be used. The Timer Response MUST contain a subset of the options received in a Timer Request.

To be clear, IPXWAN is used to set up a symmetrical compression link. Compression is configured identically in both directions. Each end will use the same number of slots and same compression options. It is illegal for link ends to use different number of slots or different options.

IPX Compression Performance

The performance of this algorithm will depend on the number of active connections and the number of slots negotiated. If the number of slots is greater than the number of connections, the hit rate should be very high giving a very high compression ratio. The performance also depends on the average size of the IPX packets. If the average size of packets is small, then compression will result in a more noticeable performance improvement.

$$\text{Compression ratio} = \frac{\text{avg\_data\_len} + \text{uncomp\_header\_len}}{\text{avg\_data\_len} + \text{avg\_comp\_header\_len}}$$

Where 'avg_data_len' is the average length of data in the IPX packet, and 'uncomp_head_len' is the uncompressed header length which is fixed at 30 octets. Where 'avg_comp_header_len' is the average length of the compressed IPX header. The length of the minimum compressed IPX header is 1 octet. The length of the maximum compressed NCP/IPX header is 8 octets (including the NCP task number), but since no implementation yet sends packets with a length greater than 16K, 7 octets is the commonly encountered maximum. Perhaps a reasonable 'avg_comp_header_len' is 2, assuming the inclusion of the flag and slot number octets.

The maximum length of the data in an IPX packet is 546 octets (576 octets - 30 octet IPX header), although newer implementations may send packets of up to 4096 octets. The minimum length of the data in an IPX packet is 1 octet. Within the normal distribution of small NCP packets, perhaps a reasonable 'avg_data_len' is 26 octets.

$$\text{Minimal Compression} = \frac{546 + 30}{546 + 6} = 1.04$$

$$\text{Maximal Compression} = \frac{1 + 30}{1 + 1} = 15.50$$

$$\text{Likely Compression} = \frac{26 + 30}{26 + 2} = 2.00$$

Security Considerations

IPX provides some security features, which are fully applicable to CIPX. CIPX does not significantly alter the basic security of IPX.

References

[1] Novell Inc., "IPX Router Specification", September 1992, Part Number: 107-000029-001

[2] Jacobson, Van, "Compressing TCP/IP Headers for Low-Speed Serial Links", RFC 1144, February 1990

[3] CCITT Recommendation V.42bis Error Correcting Procedures for DCEs using Error Correction Procedures

[4] ISO 7776, Information Processing Systems - Data Communication - High Level Data Link Control Procedures - Description of the X.25 LAPB-Compatible DTE Data Link Procedures

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

[6] Simpson, W. A., "The PPP Internet Packet Exchange Control Protocol (IPXCP)", RFC 1552, December 1993

[7] Allen, Michael, "Novell IPX Over Various WAN Media [IPXWAN]", RFC 1551, December 1993

Acknowledgements

This compression algorithm incorporates many ideas from the Van Jacobson TCP/IP header compression algorithm.

Michael Allen from Novell provided a lot of valuable feedback in the design of this algorithm. David Piscitello from Bellcore and Marty Del Vecchio at Shiva Corp. made several good suggestions. Bill Simpson was very helpful in driving PPP, and specifically IPXCP, on the standards course.

Chair's Address

Fred Baker
Advanced Computer Communications
315 Bollay Drive
Santa Barbara, California 93117

EMail: fbaker@acc.com

Authors' Addresses

Saroop Mathur
Telebit Corp.
1315 Chesapeake Terrace
Sunnyvale, CA 94089-1100

EMail: mathur@telebit.com

Mark S. Lewis
Telebit Corp.
1315 Chesapeake Terrace
Sunnyvale, CA 94089-1100

EMail: Mark.S.Lewis@telebit.com