smb_dscnt	Number of data bytes being sent in this buffer.
smb_dsoff	Offset from the start of an SMB header to the data bytes.
smb_dsdisp	Byte displacement for these data bytes.
smb_fid	Value = 0xffff. No FID in this request.
smb_bcc	Total bytes following including pad bytes.
smb_data[ ]	Data bytes (size = *smb_dscnt*).

Response Format

smb_wct	Value = 10.
smb_tprcnt	Value = 2.
smb_tdrcnt	Value = 0. No data bytes.
smb_rsvd	Reserved. Must be zero.
smb_prcnt	Value = 2. Parameter bytes being returned.
smb_proff	Offset from the start of an SMB header to the parameter bytes.
smb_prdisp	Value = 0. Byte displacement for these parameter bytes.
smb_bcc	Total bytes following including pad bytes.
smb_param[ ]	The parameter block for the *TRANSACT2_MKDIR* function response is the mkdir-specific return information in the following format:

Location	Name	Meaning
smb_param[0-1]	*mkdir_offerror*	Offset into FEALIST data of first error which occurred while setting the extended attributes.

Appendix A

SMB Transmission Analysis

A.1 Introduction

This appendix describes the mapping between DOS and OS/2 system calls on an SMB redirector, and the associated SMB requests sent from the SMB redirector to an LMX server. The DOS SMB redirector is assumed to be using the core SMB protocols, and the OS/2 SMB redirector is assumed to be using the LAN Manager extended SMB protocols. While an OS/2 SMB redirector will use core SMB requests to communicate with a core LMX server, and a DOS LAN Manager client will use extended SMB requests to communicate with an OS/2 server, these situations will not be considered here.

The mappings given here do not completely describe the behaviour of all SMB redirectors; they do not take into account various optimisations which SMB redirectors may do which will result in behaviour which differs from that described here. In particular, the extended SMB protocol contains a number of facilities which allow a redirector to improve performance. These include: SMB chaining, opportunistic locking, caching and various specialised SMB requests, such as Read Block Multiplex, Write Block Multiplex, Read Block Raw and Write Block Raw. Redirectors which make use of these facilities may not behave exactly as described here.

It should also be noted that the OS/2 SMB redirector and file system make extensive use of internal buffers and heuristics that make it difficult to determine an exact mapping between OS/2 API calls and SMB emissions. The listed API calls give an indication of which SMBs are sent when invoked, and where possible, an explanation is given regarding any special circumstances.

DOS and OS/2 system calls which are not listed here will not normally result in SMB requests being transmitted.

A.2 DOS Functions

Function Number	DOS Function
0x00	Terminate Programme
0x05	Print Character
0x0d	Reset Disk
0x0f	Open File (FCB I/O)
0x10	Close File (FCB I/O)
0x11	Search For First Entry
0x12	Search For Next Entry
0x13	Delete File (FCB I/O)
0x14	Sequential Read (FCB I/O)
0x15	Sequential Write (FCB I/O)
0x16	Create File (FCB I/O)
0x17	Rename File (FCB I/O)
0x1b	Get Default Drive Data
0x1c	Get Drive Data
0x21	Random Read (FCB I/O)
0x22	Random Write (FCB I/O)
0x23	Get File Size (FCB I/O)
0x27	Random Block Read (FCB I/O)
0x28	Random Block Write (FCB I/O)
0x36	Get Disk Free Space
0x39	Create Directory
0x3a	Remove Directory
0x3b	Change Current Directory
0x3c	Create File Handle
0x3d	Open File Handle
0x3e	Close File Handle
0x3f	Read Via File Handle
0x40	Write Via File Handle
0x41	Delete Directory Entry
0x42	Move File Pointer
0x43	Set/Get File Attributes
0x4b	Load and Execute Programme/Load Overlay
0x4c	End Process
0x4e	Find First File
0x4f	Find Next File
0x56	Change Directory Entry
0x57	Set/Get Date/Time of File
0x5a	Create Temporary File Handle
0x5b	Create New File
0x5c	Unlock/Lock File
0x5f	Get Assign List Entry
0x68	Flush Buffer

Change Current Directory

Function number	0x3b.
SMB sent	*SMBchkpth.*
Reason	Change directory.

Change Directory Entry

Function number	0x56.
SMB sent	*SMBmv.*
Reason	Rename file.

Close File (FCB I/O)

Function number	0x10.
SMB sent	*SMBclose.*
Reason	Close file (FCB I/O).

Close File Handle

Function number	0x3e.
SMB sent	*SMBclose*, *SMBsplclose* (printer device).
Reason	Close file.

Create Directory

Function number	0x39.
SMB sent	*SMBmkdir.*
Reason	Make directory.

Create File (FCB I/O)

Function number	0x16.
SMB sent	*SMBcreate.*
Reason	Create file.

Create File Handle

Function number	0x3c.
SMB sent	*SMBcreate.*
Reason	Create file.

Create New File

Function number	0x5b.
SMB sent	*SMBmknew.*
Reason	Create file.

Delete Directory Entry

Function number	0x41.
SMB sent	*SMBunlink.*
Reason	Delete file.

Delete File (FCB I/O)

Function number	0x13.
SMB sent	*SMBunlink.*
Reason	Delete file (FCB I/O).

End Process

Function number	0x4c.
SMB sent	*SMBexit.*
Reason	Exit programme.

Find First File

Function number	0x4e.
SMB sent	*SMBsearch.*
Reason	Find first matching filename.

Find Next File

Function number	0x4f.
SMB sent	*SMBsearch.*
Reason	Find next matching filename.

Flush Buffer

Function number	0x68.
SMB sent	*SMBflush.*
Reason	Commit file.

Get Assign List Entry

Function number	0x5f.
SMB sent	*SMBtcon, SMBtdis.*
Reason	Redirect device, cancel redirection.

Get Default Drive Data

Function number	0x1b.
SMB sent	*SMBdskattr.*
Reason	Get data on the default drive.

Get Disk Free Space

Function number	0x36.
SMB sent	*SMBdskattr.*
Reason	Get free space on disk.

Get Drive data

Function number	0x1c.
SMB sent	*SMBdskattr.*
Reason	Get data on a drive.

Get File Size (FCB I/O)

Function number	0x23.
SMB sent	*SMBsearch.*
Reason	File size in records.

Load and Execute Programme /Load Overlay

Function number	0x4b.
SMB sent	*SMBopen, SMBread, SMBclose.*
Reason	Load/execute programme.

Move File Pointer

Function number	0x42.
SMB sent	*SMBlseek.*
Reason	Set position in file.

Open File (FCB I/O)

Function number	0x0f.
SMB sent	*SMBopen* (read/write/share set to 0xff).
Reason	Open file (FCB I/O).

Open File Handle

Function number	0x3d.
SMB sent	*SMBopen, SMBsplopen* (printer device).
Reason	Open file.

Print Character

Function number	0x05.
SMB sent	*SMBsplopen, SMBsplwr, SMBsplclose.*
Reason	Printer output.

Random Block Read (FCB I/O)

Function number	0x27.
SMB sent	*SMBread.*
Reason	Random block read (FCB I/O).

Random Block Write (FCB I/O)

Function number	0x28.
SMB sent	*SMBwrite.*
Reason	Random block write (FCB I/O).

Random Read (FCB I/O)

Function number	0x21.
SMB sent	*SMBread.*
Reason	Random read (FCB I/O).

Random Write (FCB I/O)

Function number	0x22.
SMB sent	*SMBwrite.*
Reason	Random write.

Read Via File Handle

Function number	0x3f.
SMB sent	*SMBread.*
Reason	Read file.

Remove Directory

Function number	0x3a.
SMB sent	*SMBrmdir.*
Reason	Remove directory.

Rename File (FCB I/O)

Function number	0x17.
SMB sent	*SMBmv.*
Reason	Rename file.

Reset Disk

Function number	0x0d.
SMB sent	*SMBflush.*
Reason	Disk reset (flush file buffers).

Search For First Entry

Function number	0x11.
SMB sent	*SMBsearch.*
Reason	Search first matching entry.

Search For Next Entry

Function number	0x12.
SMB sent	*SMBsearch.*
Reason	Search next matching entry.

Sequential Read (FCB I/O)

Function number	0x14.
SMB sent	*SMBread.*
Reason	Sequential read (FCB I/O).

Sequential Write (FCB I/O)

Function number 0x15.

SMB sent *SMBwrite.*

Reason Sequential write (FCB I/O).

Set/Get Date/Time of File

Function number 0x57.

SMB sent *SMBsearch, SMBsetatr.*

Reason Get/set file date and time.

Set/Get File Attributes

Function number 0x43.

SMB sent *SMBsetatr.*

Reason Change file attributes.

Terminate Programme

Function number 0x00.

SMB sent *SMBexit.*

Reason Programme terminate.

Unlock/Lock File

Function number 0x5c.

SMB sent *SMBlock, SMBunlock.*

Reason Lock/Unlock file.

Write Via File Handle

Function number 0x40.

SMB sent *SMBwrite, SMBsplwr* (printer device).

Reason Write file.

A.3 OS/2 Functions

The SMB requests generated from OS/2 redirectors will vary based on the protocol dialect negotiated. This variation is highlighted in the sequences below by listing the SMB request that will be sent if the extended 1.0 dialect was negotiated first followed by the SMB request for the extended 2.0 dialect.

DosBufReset

SMB sent	*SMBflush.*
Reason	Flush file buffer.

DosChDir

SMB sent	*SMBchkpth.*
Reason	Change the current working directory.

DosClose

SMB sent	*SMBclose, SMBwriteclose, SMBwrite.*
Reason	Close FID. If the file I/O is buffered, a *DosClose* will cause the data in the buffers to be flushed. This type of situation may cause an *SMBwriteclose* or *SMBwrite* to be sent.

DosDelete

SMB sent	*SMBunlink.*
Reason	Delete a file.

DosDevIOCtl

SMB sent	*SMBioctl, SMBioctls.*
Reason	Pass a device-specific I/O control request to a driver.

DosExecPgm

SMB sent	*SMBopen, SMBread, SMBclose. SMBtrans2(TRANSACT2_OPEN)* may be used for the open function instead of *SMBopen* for the extended 2.0 dialect.
Reason	Start a programme as a child process. *DosExecPgm* makes use of OS/2's standard file I/O functions.

DosFileLocks

SMB sent	*SMBlock SMBlockingX, SMBlockread, SMBunlock, SMBwriteunlock.*
Reason	Set or reset a byte lock range in an open file. An *SMBwriteunlock* is sent after unlocking bytes which were just written out. *SMBlockread* is used to lock and then read ahead.

DosFindClose

SMB sent *SMBfclose* and possibly *SMBfindnclose*.

Reason Close an active directory search handle. If change notification was involved, the *SMBfindnclose* will be sent to cancel further notifications.

DosFindFirst

SMB sent *SMBffirst* or *SMBtrans2*(*TRANSACT2_FINDFIRST*).

Reason Find the first file in a directory matching the search pattern.

DosFindFirst2

SMB sent *SMBtrans2*(*TRANSACT2_FINDFIRST*). An *SMBfindclose* may follow.

Reason Find the first file in a directory matching the search pattern. If no additional searchs are desired the *SMBfindclose* will be used to allow the server to free resources associated with the find.

DosFindNext

SMB sent *SMBffirst* or *SMBtrans2*(*TRANSACT2_FINDNEXT*).

Reason Get the next file from the search pattern.

If this function is used on a sufficiently large directory it will eventually send an *SMBfind* request.

DosFindNotifyClose

SMB sent *SMBfindnclose*.

Reason To indicate to the LMX server that directory search requests are complete.

DosMkDir

SMB sent *SMBmkdir SMBtrans2*(*TRANSACT2_MKDIR*).

Reason Create a new directory.

DosMove

SMB sent *SMBmv*.

Reason Rename or move a file.

DosOpen

SMB sent *SMBopenX, SMBopen, SMBcreate, SMBreadX* or *SMBtrans2*(*TRANSACT2_OPEN*).

Reason Open a device/file for I/O.

DosOpen may send an *SMBreadX* read ahead. *DosOpen* will send an *SMBopenX* instead of an *SMBopen* when in protected mode. *SMBopen* has no capabilities for creating a file when opening, so *DosOpen* may send an *SMBcreate*.

DosQCurDir

SMB sent	*SMBchkpth.*
Reason	Determine the current directory of a logical drive.

DosQFSInfo

SMB sent	*SMBdskattr* or *SMBtrans2*(*TRANSACT2_QFSINFO*).
Reason	Retrieve file system information data.

DosQFileInfo

SMB sent	*SMBgetattrE* or *SMBtrans2*(*TRANSACT2_QFILEINFO*).
Reason	Retrieve a file information record.

DosQFileMode

SMB sent	*SMBgetatr.*
Reason	Get a file's attribute byte.

DosRead

SMB sent	*SMBread, SMBreadX, SMBreadbraw, SMBreadbmpx.*
Reason	Read characters from an FID. *SMBreadbraw* is used to send a block of data which is larger than the data size which was negotiated.

DosReadAsync

SMB sent	*SMBread, SMBreadX, SMBreadbraw, SMBreadbmpx.*
Reason	Read characters from an FID asynchronously. Same behaviour as *DosRead.*

DosRmDir

SMB sent	*SMBrmdir.*
Reason	Delete a subdirectory.

DosSetFileInfo

SMB sent	*SMBsetattrE.*
Reason	Change a file's directory information.

DosSetFileMode

SMB sent	*SMBsetatr.*
Reason	Change a file's attribute.

DosWrite

SMB sent	*SMBwrite, SMBwriteX, SMBwritebraw, SMBwritebmpx.*
Reason	Write characters to an FID.
	SMBwritebraw is used to send a block of data which is larger than the data size which was negotiated.

DosWriteAsync

SMB sent	*SMBwrite, SMBwriteX, SMBwritebraw, SMBwritebmpx.*
Reason	Write characters to an FID asynchronously.
	Same behaviour as *DosWrite.*

Appendix B

LAN Manager Remote Administration Protocol

B.1 Overview

This section describes the mechanism used by LAN Manager to implement remote administration functions and access control lists. The protocols described here are those which are provided by the extended dialects. They are included here so that an implementor can build an LMX server which can handle this class of SMB redirector requests. However, their inclusion in this specification does not imply any X/Open endorsement of these mechanisms as the basis for future X/Open network management functionality.

All administrative functions in the LAN Manager are provided by a set of shared library routines, often referred to as LAN Manager API routines. Many of these routines have a servername argument which the caller uses to distinguish a local administrative operation (one which applies to the LMX server on the local machine) from a remote operation (one which applies to the server on another machine).

In the case of a remote operation the SMB redirector packages up its arguments, and sends them to the appropriate LMX server. The LMX server then calls the corresponding LAN Manager API routine locally, packages the results, and sends them back to the SMB redirector. The mechanism resembles a specialised, private, remote procedure call facility between the SMB redirector and the LMX server.

B.2 Remote API Protocol

1. All remote API operations are done using the share name IPC$. The SMB redirector will automatically connect to that share if necessary in order to do a remote API call.
2. All remote API operations are done using the Transaction SMB *SMBtrans*.
3. The *smb_name* field of the Transaction SMB is always \PIPE\LANMAN. The server uses this to identify a remote API request. The SMB resembles a normal named pipe operation, which is also done using a Transaction SMB. However, the *smb_setup*[0] field, which would normally contain the desired named pipe operation, is ignored; the \PIPE\LANMAN name field is sufficient to identify a remote API operation.

The arguments for the remote API call are encapsulated in the Transaction request SMB; return values are encapsulated in the Transaction response SMB. In both the request and the response, all binary values are stored in little-endian order, least significant byte first. There are no pad bytes other than those explicitly specified in descriptor strings; therefore, items may be located at an arbitrary byte boundary - there are no alignment restrictions.

The request and response Transaction SMBs contain a parameter section and a data section. The arguments for a remote API call are split into two parts, and placed in these sections of the request Transaction. The Transaction response message contains the results of the call, split between the parameter and data sections of the Transaction response. A number of fields in the Transaction SMB identify the size and location of these sections within the SMB, and also allow a single Transaction request or response to be split into several messages (refer to X/Open CAE Specification, IPC Mechanisms for SMB).

B.3 LMX Access Control Lists Mapping

Access control lists (ACLs) are used by LMX servers running in user-level security mode. Though the implementation of ACLs is outside the scope of the specification the following list is a set of possible access permissions, which is used by LAN Manager implementations.

User-level security allows access permissions to be set for each shared resource (for example, file system subtree, individual file, spooler, device, etc.). Each shared resource has a list of users and groups, with the permissions allowed for each user or group on that resource.

ACL Permissions		
R	read	Permission to read data from a resource and, by default, execute the resource.
W	write	Permission to write data to the resource.
X	execute	Permission to execute the resource.
C	create	Permission to create an instance of the resource (for example, a file); data can be written to the resource when creating it.
D	delete	Permission to delete the resource.
A	change attributes	Permission to modify the resource's attributes (for example, the date and time a file was last modified).
P	change permissions	Permission to modify the permissions (read, write, create, execute and delete) assigned to a resource for a user, group or application.
N	deny access	No permissions.
Y	allow spool requests	

Since the X/Open CAE does not provide an access control list (ACL) mechanism, the usual CAE access control mechanisms should be used instead. Following the principle of least surprise, a mapping is defined for access mechanisms which cannot easily be provided under CAE systems. The CAE access control mechanisms are used to permit interoperability for applications which reside on both PCs and on CAE hosts.

A mapping from (SMB) UID and username/password supplied by the client to CAE User ID (*uid*) and Group ID(s) (*gid*) is established by the *SMBsesssetupX* and will be maintained by the LMX server. The mapped-to CAE User ID and one or more Group IDs are used for all accesses on the CAE system in the usual manner.

The differences between the functionality provided by ACLs and the access control mechanisms for LMX servers described above include:

1. ACL permissions apply to shared resources. This includes file system directories as well as individual files. CAE permissions apply to individual files and directories but are not extended to subtrees.
2. For each resource, ACL permissions can be listed for any number of individual users, for any number of groups, and for anyone else. A CAE file or directory specifies permissions for the owner, one group and everyone else.

The following table shows the mapping between the ACL permissions and CAE permissions:

SMB Permissions		Equivalent CAE Permission	
R	read	r	read
W	write	w	write
X	execute	r	read (**Note 1**)
C	create	w	write on parent dir
D	delete	w	write on parent dir
A	change attributes		not supportable
P	change permissions		(**Note 2**)
N	deny access	-	no permissions (**Note 3**)
Y	allow spool requests		not supportable

Notes:

1. Execute permission for LMX servers requires only read permission, as the client need only be able to read the file before it can execute it.
2. Not an assignable access right. The owner of a file and users with appropriate privileges always have P access and cannot relinquish it; no other user can acquire P access.
3. Not a specific right, but the absence of rights. Note that the privileged user always has all rights and can relinquish none of them.

ACLs could be partially implemented for LMX servers by placing the required checks into the LMX server itself. The list would be used to further restrict (but not grant) access to files and directories beyond the restrictions imposed by the usual CAE access control mechanisms. A client may have access to a resource only if it does not conflict with CAE permissions and if it is specified in the ACL. There may be cases where the ACL indicates that a user should have access, but the CAE security would have to be circumvented to honour it. The access will be denied in accordance with the CAE in these cases. This permits access security to be maintained on both the server and client system equivalently; if a user local on the CAE system is denied access, access should be denied for the user on a client system as well.

X/Open-compliant system implementations which support native ACLs as an enhancement may use that mechanism instead of the normal CAE access control mechanisms if desired, as long as the ACLs do not grant permission where the expected CAE access mechanisms would have denied it.

B.4 Transaction API Request Format

B.4.1 Parameter Section

The parameter section (*smb_param*) of the Transaction request contains the following:

- API number: 16-bit integer
- parameter descriptor string: null-terminated ASCII string
- data descriptor string: null-terminated ASCII string
- parms: subroutine arguments, as described by the parameter descriptor string
- auxiliary data descriptor string: optional null-terminated ASCII string

The API number identifies which API routine the SMB redirector wishes the LMX server to call on its behalf. A list of API numbers is given in Section B.8 on page 275.

The parameter descriptor string describes the types of the arguments in the data section (*smb_data*), as given in the original call to the routine on the SMB redirector.

The data descriptor string describes the format of a data structure, or data buffer, which is sent to the API routine. The API routine on the SMB redirector is normally given a pointer to this buffer. Note that this descriptor string is also used by the server to determine the format of the data buffer to be sent back from the API call.

The parms field contains the actual subroutine arguments, as described by the parameter descriptor string.

The auxiliary data descriptor string describes the format of a second, auxiliary data structure which is either sent to or received from the API routine, in addition to that defined by the data descriptor string. The data described by this descriptor string is located in the data section (*smb_data*) of *SMBtrans*, immediately following the data described by the primary data descriptor.

B.4.2 Data Section

The data section (*smb_data*) of the *SMBtrans* request contains the following:

- the primary data buffer, as described by the data descriptor string in the parameter section
- the auxiliary data buffer (optional), as described by the auxiliary data descriptor in the parameter section

B.5 Transaction API Response Format

B.5.1 Parameter Section

The parameter section (*smb_param*) of the *SMBtrans* response contains the following:

- Status: a 16-bit integer. This is the return status as if the requested LAN Manager API routine would be executed on the responder's system. Zero normally indicates success.
- Converter word: 16-bit integer, used by the requestor's system to adjust the pointer in the data section. The use of this field is described below.
- Parms: return parameters, as described by the parameter descriptor string in the request message. Only those parameters which are identified in the parameter descriptor string as being receive pointers (that is, which will be modified by the server) are actually returned here.

B.5.2 Data Section

The data section (*smb_data*) of the *SMBtrans* request contains:

- the primary returned data buffer, as described by the data descriptor in the request message
- the auxiliary data buffer (optional), as described by the auxiliary data descriptor in the request message

B.6 Descriptor Strings

A descriptor string is a null-terminated ASCII string. Descriptor string elements consist of a letter describing the type of the argument, possibly followed by a number (in ASCII representation), specifying the size of the argument. Each item in the descriptor string describes one data element.

B.6.1 Descriptor String Types

The following describes the characters which may be encountered in a descriptor string, and the format of the corresponding data described by the descriptor string.

B Byte

If followed by one or more digits (that is, B13) this refers to an array of bytes. One or more bytes will be located in the corresponding data area. Note that this type will not be found in the parameter descriptor string (that is, it will not be used to describe subroutine arguments), since single bytes cannot be pushed onto the stack by the SMB redirector.

W 16-bit integer

If followed by one or more numbers (that is, W4) this refers to an array of 16-bit integers. One or more 16-bit integers will be located in the corresponding parameter or data area.

D 32-bit integer

If followed by one or more numbers (that is, D3) this refers to an array of 32-bit integers. One or more 32-bit integers will be located in the corresponding parameter or data area.

z Null-terminated ASCII string

The corresponding parameter or data area contains a null-terminated ASCII string. This type has a different meaning when applied to returned data. (See below.)

b Byte pointer

The original argument list or data structure contained a pointer to one (that is, b) or more (that is, b8) bytes at this position. The bytes themselves are located in the corresponding parameter or data area. This type has a different meaning when applied to returned data. (See below.)

w Word pointer

The original argument list or data structure contained a pointer to one (that is, w) or more (that is, w2) 16-bit integers at this position. The integers themselves are located in the corresponding parameter or data area. This type has a different meaning when applied to returned data. (See below.)

d Dword pointer

The original argument list or data structure contained a pointer to one (that is, d) or more (that is, d3) 32-bit integers at this position. The integers themselves are located in the corresponding parameter or data area. This type has a different meaning when applied to returned data. (See below.)

g Receive byte pointer

The original argument list contained a pointer to one (that is, g) or more (that is, g8) bytes at this position, which are to receive return values from the API call. The Transaction request contains nothing at this position in the corresponding parameter or data area; the response message contains data.

h Receive word pointer

Contains data in the parameter section. The original argument list contained a pointer to one (that is, h) or more (that is, h2) 16-bit integers at this position, which are to receive return values from the API call. The Transaction request contains nothing at this position in the corresponding parameter or data area; the response message contains data in the parameter section.

i Receive dword pointer

The original argument list contained a pointer to one (that is, i) or more (that is, i3) 32-bit integers at this position, which are to receive return values from the API call. The Transaction request contains nothing at this position in the corresponding parameter or data area; the response message contains data in the parameter section.

O Null pointer

The original argument list or data structure contained a null pointer at this position. There is nothing stored at this position in the corresponding parms or data area.

s Send data buffer pointer

The original argument list contained a pointer at this position to a data structure containing more data arguments to the API call. This item appears only in a parameter descriptor string. The format of the secondary data structure is described in the data descriptor string (contained in the parameter section of the Transaction request message). The data itself is contained in the data section of the Transaction request message.

T Length of send buffer

The original argument list contained a 16-bit integer argument at this position which specified the length of the send buffer. This item appears only in a parameter descriptor string. No value is placed in the corresponding parameter area.

r Receive data buffer pointer

The original argument list contained a pointer at this position to a data structure which was to be filled in by the API call. This item appears only in a parameter descriptor string. The format of the secondary data structure is described in the data descriptor string (contained in the parameter section of the Transaction request message). The data itself is contained in the data section of the Transaction response message.

L Length of receive buffer

The original argument list contained a 16-bit integer argument at this position which specified the length of the receive buffer. This item appears only in a parameter descriptor string. The corresponding parameter area contains a 16-bit integer specifying the length of the receive buffer.

P Parameter number

The corresponding parameter or data area contains a 16-bit short integer.

e Entries read

The original argument list contained a pointer to a 16-bit integer at this position, which is to receive the number of entries returned by the API call in the receive buffer. The Transaction request contains nothing at this position in the corresponding parameter or data area; the response message contains the numbers of entries returned in the receive data buffer.

N Number of auxiliary structures

This field is only found in data descriptor strings. The presence of the field indicates that there will be auxiliary data sent (if found in a send data descriptor string), or received (if found in a receive data descriptor string). The corresponding data block contains a 16-bit integer specifying the number of auxiliary data structures to be sent (for a send data buffer), or which have been received (for a receive data buffer).

K Unstructured data block

This will normally be the only item in a descriptor string.

F Fill

The corresponding data area contains one (that is, F) or more (that is, F3) fill bytes at this position.

B.6.2 Pointer Types and Returned Data

Lower-case letters are considered pointer types. These pointer types z, b, w and d have a different meaning if they are used to describe returned information. In this case the pointers occur in a data descriptor string or auxiliary data descriptor string and describe data to be returned in the data section (*smb_data*) of the *SMBtrans* response message. In this case the item referred to by the pointer is not the array or string itself, but a 32-bit integer. The high-order 16-bits are to be ignored and the low-order 16-bits contain an offset. The offset subtracted by the converter word points to the array or string within the returned data buffer itself.

The data descriptor describes one instance of the returned data structure. The response buffer may contain several of these data structures, each of which is a fixed size. Together, these make up the fixed-length portion of the returned data area. The returned data buffer may also contain data pointed to by the various pointer types described above. This data may contain strings, and is likely to be of variable length. The fixed-length data is always placed at the beginning of the returned data buffer; the placement of the variable-length data is up to the server.

The responder must place variable-length data at the end of the data buffer and set the pointers accordingly. Since the total length of the data buffer is only known at the end of processing, there may be a gap between the fixed-length data and the variable-length data. To avoid sending this gap accross the network the responder may position the variable-length data to a position immediately following the fixed-length data. The pointers in the data descriptor string do not need to get updated if the "converter word" in the response parameter section is set to the value that the requestor must subtract from all pointer values referencing data in the variable-length section.

B.7 Examples

The following examples may help clarify details of the protocol. Some details have been simplified for ease of explanation. Note that the format of some data structures may differ in various versions of LAN Manager.

B.7.1 NetShareDel

This is one of the simplest examples of a remote API call. Suppose an SMB redirector programme does the following call:

```
NetShareDel(SERVER, C, 0);
```

This call deletes the outstanding share C on the server machine SERVER.

The parameter section of the Transaction request message contains:

4: API number for the NetShareDel function.

zW: Parameter descriptor string. Note that the servername argument is not specified in the descriptor. There are two arguments: a string specifying the name of the share to be deleted, and a reserved 16-bit integer MBZ (Must Be Zero).

: Data descriptor string. There is no data buffer in the arguments, so this descriptor string is empty.

parms: The actual subroutine arguments, as described by the parameter descriptor string:

C: A null-terminated string.

0: A 16-bit word.

There is no auxiliary data descriptor string.

The data section of the Transaction request message is empty.

The parameter section of the Transaction response message contains:

return status: (16-bit word.)

converter word: 0 in this case.

return parms: There are no return parameters in this case, so this section will be empty.

The data section of the Transaction response message is empty.

B.7.2 NetShareAdd

This example uses a send buffer:

```
struct share_info_2 buf;
NetShareAdd(SERVER, 2, &buf, sizeof(buf);
```

The parameter section of the Transaction request message contains:

3: API number for the NetShareAdd function.

WsT: Parameter descriptor string.

B13BWzWWWzB9B: Data descriptor string. This corresponds to the elements of the *share_info_2* structure.

parms: The actual subroutine arguments, as described by the parameter descriptor string:

2: The second argument.

Note that there is no data here corresponding to the sT portion of the parameter descriptor string.

There is no auxiliary data descriptor string.

The data section of the Transaction request message contains the contents of the *share_info_2* structure:

- thirteen bytes (from the *shi2_netname* field)
- one byte (from *shi2_pad1*)
- one 16-bit word (from *shi2_type*)
- null-terminated ASCII string, copied from the one pointed to by *shi2_remark*
- one 16-bit word (from *shi2_permissions*)
- two 16-bit words (*shi2_max_uses* and *shi2_current_uses*)
- null-terminated ASCII string, copied from the one pointed to by *shi2_path*
- nine bytes (from *shi2_passwd*)
- one byte (from *shi2_pad2*)

The parameter section of the Transaction response message contains:

- return status (16-bit word)
- converter word: 0 in this case
- return parms: there are no return parameters in this case, so this section will be empty

The data section of the Transaction response message is empty.

B.7.3 NetShareEnum

This example has both return parameters and return data:

```
struct share_info_1 buf[10];
NetShareEnum (SERVER, 1, &buf, sizeof(buf), &nentries, &total);
```

The parameter section of the Transaction request message contains:

0: API number for the NetShareEnum function.

WrLeh: Parameter descriptor string.

B13BWz: Data descriptor string (for returned data, in this case).

parms: The actual subroutine arguments, as described by the parameter descriptor string:

1: Second argument

sizeof(*buf*): This is a send parameter because the server needs to know how much space it has available in which to return results

Note that the other arguments are result parameters, and are thus not passed to the server.

There is no auxiliary data descriptor string.

The data section of the Transaction request message is empty.

The parameter section of the Transaction response message contains:

- return status (16-bit word)
- converter word: (possibly set by server)
- entries returned (16-bit word)
- total number of available entries (16-bit word)

The data section of the response Transaction message contains a number of *share_info_1* structures. The number of such structures is given by the entries returned return parameter. Each structure contains:

- thirteen bytes (the *shi1_netname* field)
- one byte (*shi1_pad1*)
- one 16-bit word (*shi1_type*)
- the *shi1_remark* field. This is a four-byte value. The two low-order bytes contain the offset within the data section of the null-terminated ASCII string. The value may need adjusting: the converter word value must be subtracted from this offset in order to obtain the true offset of the string.
- a possible gap following the fixed-length data. This is up to the server.
- the null-terminated string pointed to by the *shi1_remark* field

B.8 API Numbers

The following are the API numbers used to specify the various remote LAN Manager routines. They are included here so that an implementor can build an LMX server which can handle this class of SMB redirector requests. However, their inclusion in this specification does not imply any X/Open endorsement of these mechanisms as the basis for future X/Open network management functionality. (A routine name beginning with R identifies a routine which gets special handling by the LMX server, rather than simply calling the local version of the routine.)

0 RNetShareEnum
1 RNetShareGetInfo
2 NetShareSetInfo
3 NetShareAdd
4 NetShareDel
5 NetShareCheck
6 NetSessionEnum
7 NetSessionGetInfo
8 NetSessionDel
9 NetConnectionEnum
10 NetFileEnum
11 NetFileGetInfo
12 NetFileClose
13 RNetServerGetInfo
14 NetServerSetInfo
15 NetServerDiskEnum
16 NetServerAdminCommand
17 NetAuditOpen
18 NetAuditClear
19 NetErrorLogOpen
20 NetErrorLogClear
21 NetCharDevEnum
22 NetCharDevGetInfo
23 NetCharDevControl
24 NetCharDevQEnum
25 NetCharDevQGetInfo
26 NetCharDevQSetInfo
27 NetCharDevQPurge
28 RNetCharDevQPurgeSelf
29 NetMessageNameEnum
30 NetMessageNameGetInfo
31 NetMessageNameAdd
32 NetMessageNameDel
33 NetMessageNameFwd
34 NetMessageNameUnFwd
35 NetMessageBufferSend
36 NetMessageFileSend
37 NetMessageLogFileSet
38 NetMessageLogFileGet
39 NetServiceEnum
40 RNetServiceInstall
41 RNetServiceControl
42 RNetAccessEnum
43 RNetAccessGetInfo
44 RNetAccessSetInfo
45 RNetAccessAdd
46 RNetAccessDel
47 NetGroupEnum
48 NetGroupAdd
49 NetGroupDel
50 NetGroupAddUser
51 NetGroupDelUser
52 NetGroupGetUsers
53 NetUserEnum
54 RNetUserAdd
55 NetUserDel
56 NetUserGetInfo
57 RNetUserSetInfo
58 RNetUserPasswordSet
59 NetUserGetGroups
60 NetWkstaLogon
61 NetWkstaLogoff
62 NetWkstaSetUID
63 NetWkstaGetInfo
64 NetWkstaSetInfo
65 NetUseEnum
66 NetUseAdd
67 NetUseDel
68 NetUseGetInfo
69 DosPrintQEnum
70 DosPrintQGetInfo
71 DosPrintQSetInfo
72 DosPrintQAdd
73 DosPrintQDel
74 DosPrintQPause
75 DosPrintQContinue
76 DosPrintJobEnum
77 DosPrintJobGetInfo
78 RDosPrintJobSetInfo
79 DosPrintJobAdd
80 DosPrintJobSchedule
81 RDosPrintJobDel
82 RDosPrintJobPause
83 RDosPrintJobContinue
84 DosPrintDestEnum
85 DosPrintDestGetInfo
86 DosPrintDestControl
87 NetProfileSave

88 NetProfileLoad
89 NetStatisticsGet
90 NetStatisticsClear
91 NetRemoteTOD
92 NetBiosEnum
93 NetBiosGetInfo
94 NetServerEnum
95 I_NetServerEnum
96 NetServiceGetInfo
97 NetSplQmAbort
98 NetSplQmClose
99 NetSplQmEndDoc
100 NetSplQmOpen
101 NetSplQmStartDoc
102 NetSplQmWrite
103 DosPrintQPurge

Appendix C

The X/Open Security Package

The X/Open security package, as defined in this appendix, permits the LMX server to select encryption functions from lists sent by the SMB redirector. This appendix defines some suggested *E*() and *U*() dialect names and the functions associated with those names.

The definitions in this section are not a part of the X/Open specification of the SMB protocols at the present time, and might not become a part of the X/Open specification in the future. Nonetheless, it is recommended that the dialect names defined here are used as defined; if other encryption functions are supported, names defined in this appendix should not be used for them.

C.1 E() Functions

The *E*() function is used to respond to the server and (optional) SMB redirector challenges. It cryptographically combines the challenge string and the password string (in server form, see Section C.2 to produce the response string. The function should be chosen so that it is difficult or expensive to derive the password string from the challenge string and response string, even if the cryptographic function is not secret.

The following table gives the *E*() dialect name and a definition for the function to be used if that dialect is selected.

NULL	Value is the password string (in server form), unchanged. Used when the network is known to be secure against eavesdropping (for example, link encryption).
DES[2]	The password string is used as a key to encrypt the challenge string using the DES block mode algorithm. The DES function is applied as described in Appendix D on page 279.
UNIX	The server-form password string is used as input to the well-known UNIX password encryption algorithm[3]. Instead of using a data block of all zeros, the challenge string is used; the salt is two NULL characters.

2. U.S. Department of Commerce Data Encryption Standard.
3. Morris, Robert and Thompson, Ken; Password Security: A Case History. Bell Laboratories Technical Memorandum, April 3, 1978. Reprinted in *UNIX Programmers' Manual, Seventh Edition*, Volume 2, page 595. New York: Holt, Rinehart and Winston (1983).

C.2 U() Functions

The *U*() function is used to transform a cleartext password into the form in which it is stored on the server (that is, server-form). Many X/Open-compliant systems store passwords in an encrypted form, and many of these functions are one-way; that is, the transformation from cleartext to cryptotext is not reversible. Negotiation of the *U*() function permits the SMB redirector to reproduce the cryptotext password given the clear password as typed by the user.

Some *U*() functions require additional data aside from the password and username. If the server selects such a *U*() function, it will return the necessary additional data in the *SMBsecpkgX* response. Some LMX server implementations support a mechanism for changing a user's password via some additional protocol; those LMX server implementations should also return any additional data required for that process.

The following table defines *U*() dialect names and the functions to be performed if that dialect is selected. The contents of the *xp_ouinf* and *xp_nuinf* fields of the *SMBsecpkgX* response are also described.

NULL — The server-form of the password is identical to the cleartext form.

UNIX — The well-known UNIX password encryption algorithm is used. The *xp_ouinf* field contains the two-character salt required by the algorithm. If the LMX server supports password changes via protocol, the *xp_nuinf* field should be the new salt to be used if the SMB redirector changes passwords.

Appendix D

SMB Encryption Techniques

D.1 SMB Authentication

The SMB authentication scheme is based upon the server knowing a particular encrypted form of the user's password, the client system constructing that same encrypted form based upon user input, and the client passing that encrypted form in a secure fashion to the server so that it can verify the client's knowledge.

The scheme uses the DES[4] encryption function in block mode; that is, there is a function *E(K,D)* which accepts a 7-byte key *(K)* and 8-byte data block *(D)* and produces an 8-byte encrypted data block as its value. If the data to be encrypted is longer than 8 bytes, the encryption function is applied to each block of 8 bytes in sequence and the results appended together. If the key is longer than 7 bytes, the data is first completely encrypted using the first 7 bytes of the key, then the second 7 bytes, etc., appending the results each time. In other words:

$$E(K_0K_1,D_0D_1)=E(K_0,D_0)\ E(K_0,D_1)E(K_1,D_0)E(K_1,D_1)$$

D.1.1 SMBnegprot Response

The *SMBnegprot* response field *smb_cryptkey* is the result of computing:

C8=E*(P7,S8)*

where:

- *P7* is a 7-byte string which is non-repeating. This is usually a combination of the time (in seconds since January 1, 1970) and a counter which is incremented after each use.
- *S8* is an 8-byte string whose value is `????????` (eight question marks).

D.1.2 SMBtcon, SMBtconX, SMBsessetupX Requests

The client system may send an encrypted password in any one of these requests. The server must validate that encrypted password by performing the same computations the client did to create it, and ensuring the strings match. The server must compute:

P16=E*(P14,S8)*

and:

P24=E*(P21,C8)*

where:

- *P14* is a 14-byte string containing the user's password in cleartext, padded with spaces.
- *S8* is the 8-byte well-known string (see above).

---

4. U.S. Department of Commerce Data Encryption Standard.

- *P21* is a 21-byte string obtained by appending 5 null (0) bytes to the string *P16*, just computed.
- *C8* is the value of *smb_cryptkey* sent in the *SMBnegprot* response for this connection.

The final string, *P24*, should be compared to the encrypted string in the request:

- the *smb_passwd* field in *SMBtcon*
- the *smb_spasswd* field in *SMBtconX*
- the *smb_apasswd* field in *SMBsesssetupX*

If they do not match, it is possible the client system was incapable of encryption; if so, the string should be the user's password in cleartext. The server should try to validate the string, treating it as the user's unencrypted password. If this validation fails as well, the password (and the request) should be rejected.

Appendix E

TOP/NetBIOS

This appendix reproduces, in full and unedited, the MAP/TOP Users Group Technical Report Specification of NetBIOS Interface and Name Service Support by Lower Layer OSI Protocols, Version 1.0, September 27, 1989.

MAP/TOP Users Group Technical Report
Specification of NetBIOS Interface and Name Service
Support by Lower Layer OSI Protocols
Version 1.0, September 27, 1989

1 INTRODUCTION

In addition to the universal interoperability TOP products offer, many users have purchased products that conform to proprietary and de facto networking standards. For IBM personal computers and compatibles, a de facto networking standard is the Network Basic Input Output System, or NetBIOS. A majority of popular network applications for these computers require a NetBIOS-compatible interface.

Many vendors recognize this fact and understand the need to preserve investments in these applications while allowing the support of new TOP based applications. Several of these vendors have introduced or plan to introduce TOP products with a NetBIOS-compatible interface.

In order to prevent these vendors from developing separate and incompatible implementations, the TOP NetBIOS Migration Technical Committee has defined a uniform way to support the NetBIOS interface in TOP systems. All products that conform to this specification interoperate with each other, and networks composed of such products support both TOP applications and current PC software packages. The PC applications operate without modification on the local network and, in many cases, as described in section 3.4, across the TOP internetwork. In order to support TOP applications, an implementation must conform to the TOP V3.0 Specification in addition to this NetBIOS support specification.

The specification defined by the TOP NetBIOS Migration Technical Committee consists of this specification. It is logically divided into two parts. The first part defines a mapping of the NetBIOS Interface to ISO Transport Services and Data Link Services. The second part defines a naming protocol for the NetBIOS environment over TOP-recognized subnetworks that support NetBIOS name support services.

Sections 3 through 6 and Appendix I comprise the first part. Section 2, ''Reference Documents,'' specifies the documents that the Technical Committee considers to define the NetBIOS interface and the ISO transport services. Readers should become familiar with these documents, as the remaining sections assume a knowledge of both the NetBIOS interface and ISO transport services and ISO transport profiles.

Section 3 describes the general principles behind the mapping of NetBIOS commands to transport services. Section 4, ''Special Considerations,'' discusses several significant issues in the NetBIOS/transport mapping. Sections 5 and 6 detail the mapping. ''NetBIOS Commands'' describes the mapping of each NetBIOS command to ISO transport services. It identifies the level of support required for each NetBIOS command, and it indicates the specific transport service requests associated with each command. Section 6, ''Transport Service Indications and Confirmations,'' describes the response of the NetBIOS interface to each transport service indication and confirmation. Finally, Appendix I, ''State Tables,'' presents state tables that precisely define the mapping between NetBIOS ''sessions'' and class four transport connections.

Sections 7 through 9 and Appendices II through V define the NetBIOS Name Service Protocol. Appendix VI is provided for future errata or clarifications discovered during product implementation and interoperability testing.

2 REFERENCES AND DEFINITIONS

The first step in defining a mapping between the NetBIOS interface and ISO transport services is to agree on a definition of the NetBIOS interface and OSI services. This section lists the reference documents that the SIG has agreed to use as the definition for NetBIOS and transport.

2.1 The NetBIOS Interface

For the purposes of the mapping specified by this specification, the NetBIOS interface is defined by the first section, ''NetBIOS,'' in the first edition (April 1987) of the IBM publication NetBIOS Application Development Guide (IBM product number 68X2270). When that section directs readers to adapter specific sections for exact details of certain commands (ADAPTER STATUS, for example), those details can be found in this specification. Note that the IBM specification defines the exchange of NCBs (Network Control Blocks - contents and error responses) between a NetBIOS Client and NetBIOS service provider. The contents of the NCBs and error responses are the same for NetBIOS Interfaces for DOS and OS/2 environments; however, the NCB transfer mechanism for these two environments is different and is not covered in this specification.

2.2 OSI Services

- ISO 8072-1986: Open Systems -- Transport Service Definition
- ISO 8072-ADD1: Transport Service Definition -- Addendum 1: Connectionless-Mode Transmission
- ISO 8073-1986: Connection Oriented Transport Protocol Specification
- ISO/DIS 8602: Protocol for Providing the Connectionless-Mode Transport Service
- ISO 8473/N4542: Protocol for Providing the Connectionless-mode Network Service
- ISO 8648: Internal Organization of Network Layer
- ISO 8348, AD1, AD2: Network Service Definition, Connectionless Data Transmission, Network Layer Addressing
- ISO 8802/2: Logical Link Control
- ISO 8802/3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- ISO 8802/4: Token Passing Bus Access Method
- ISO 8802/5: Token Ring Access Method

2.3 Definitions

2.3.1 Reference Model Definitions

This specification makes use of the following concepts defined in the ISO/OSI's Basic Reference Model [ISO 7498]:

DUA ISO Directory User Agent

DSA ISO Directory Service Agent

DIB Directory Information Base

ES End System

IS Intermediate System

LSAP Link Layer Service Access Point

NSAP Network Service Access Point

PDU Protocol Data Unit

psel presentation selector

SNPA Subnetwork Point of Attachment

SNPDU Subnetwork Protocol Data Unit

ssel session selector

TPDU Transport Protocol Data Unit

TSDU Transport Service Data Unit

tsel transport selector

2.3.2 Other Definitions

The following terms/concepts used in this specification, which are not defined in ISO 7498, are as follows:

NCB Network Control Block

NDUA NetBIOS Directory User Agent

NDSE NetBIOS Directory Service Entity

NSP NetBIOS Name Service Protocol

NSPDU NetBIOS Name Service Protocol Data Unit

2.3.3 Service Conventions Definitions

This Protocol Specification makes use of the following terms from the OSI Service Conventions Technical Report (ISO TR 8509):

1. Service provider
2. Service user

2.3.4 Additional Definitions

For the purposes of this specification, the following definitions apply:

1. Group Name: a name which can be shared among multiple owners; a name which is not unique. This definition derives from the NetBIOS group name concept, rather than from the ISO/CCITT group entry.
2. Local Matter: a decision made by a system concerning its behavior in the Directory System that is not prescribed or constrained by this specification.
3. Protocol Address: the complete protocol address of an object or entity, consisting of its transport address.
4. Byte and Octet: used interchangeably in the specification.

3 GENERAL PRINCIPLES

Before embarking on a detailed description of the mapping between the NetBIOS interface and ISO transport services, it is important to understand several general principles upon which this specification is based. The NetBIOS interface is best supported at the ISO transport layer; NetBIOS ''sessions'' best map to class 4 transport connections, and NetBIOS Datagrams best map to connectionless transport data requests except in the case of broadcast datagrams (broadcast name services) where a Data Link level mapping is required. The NetBIOS general commands, with one exception, do not require

any exchange of peer-to-peer protocol data units. The following subsections discuss each of these principles in more detail.

3.1 NetBIOS Supported on a Transport Service

The best level in the OSI reference model at which to map the NetBIOS interface is the level whose services most closely parallel the services offered by the NetBIOS interface. That is the OSI transport level. The NetBIOS interface requires reliable, sequenced data delivery, a service only available at the transport level and above. The NetBIOS interface, however, does not provide upper level services such as token management, synchronization and activity management. The only OSI level above the network level and below the session level is, of course, the OSI transport level, and it is to this level that the NetBIOS interface best maps.

Readers should be cautioned that the NetBIOS interface definition (see above) often refers to the NetBIOS interface as a ''session'' level interface. These references exist because the protocols that support the original NetBIOS interface (on the original PC Network Adapter) were developed before the OSI reference model was widely understood. The highest level protocols on the adapter were called ''session'' protocols despite the fact that they do not provide OSI session services. Throughout this specification, terms which refer to the NetBIOS view of a ''session'' will be placed in quotation marks. Terms which refer to the OSI view of a session will remain unquoted.

In addition to its data transfer services, NetBIOS provides name service support. The specific naming services NetBIOS provides differ fundamentally from the current ISO directory services. No reasonable mapping between NetBIOS name support and ISO directory services exists, so NetBIOS name support does not affect the choice of protocol level at which to map the NetBIOS interface. A protocol that provides NetBIOS naming services is specified in the Sections 7 through 9.

Choosing to map NetBIOS to the transport level does provoke another concern: the NetBIOS assumption of confirmed data delivery. NetBIOS data transfer between ''sessions'' is a confirmed service, while ISO transport services provide only unconfirmed data delivery (see ''Confirmed Data Delivery'' in the following section).

One important consequence of mapping the NetBIOS interface to transport services is that NetBIOS ''addresses'' equate to transport selectors. A NetBIOS ''address'' is a NetBIOS name; NetBIOS names correspond to transport selectors. The transport address is the combination of a network service access point (NSAP) address and a transport service access point selector (T-Selector). The NSAP address for a name is an NSAP address on the network node at which the name exists; the T-Selector for a name is equal to the full NetBIOS name itself. Since the NetBIOS interface requires that names be exactly sixteen characters long, T-Selectors used by NetBIOS names are also sixteen bytes long. The correspondence between a NetBIOS name and a transport address (an NSAP address and T-Selector pair) is detailed in part two of this specification.[5]

3.2 NetBIOS ''Sessions'' as Transport Class Four Connections

Since the NetBIOS interface best maps to the transport level, NetBIOS ''sessions'' correspond to transport connections. Furthermore, since NetBIOS ''sessions'' require reliable data delivery with automatic error detection

5. Sections 7-9 and Appendices II-V.

and recovery, when operating over a connectionless network service, they require class four (TP4) transport connections. Since this specification assumes a connectionless network service, the NetBIOS ''session'' support commands map to TP4 services. LISTEN and CALL commands establish a TP4 connection; SEND, CHAIN SEND, RECEIVE and RECEIVE ANY commands transfer data on that connection, and HANG UP commands terminate the connection. The ''NetBIOS Commands'' and ''Transport Service Indications and Confirmations'' sections of this specification describe the operations required to support each of these commands. Appendix I, ''State Tables,'' details the mapping between ''sessions'' and TP4 connections.

3.3 NetBIOS Datagrams as Connectionless Transport Unitdata Requests

Data transfer with NetBIOS datagrams, unlike NetBIOS ''sessions'', is a connectionless mode of transmission. Naturally, therefore, NetBIOS datagrams correspond to data transfers using the connectionless mode transport service. NetBIOS datagrams may be sent as broadcast datagrams or as multicast datagrams to group names. In order to support broadcast datagrams and datagrams to group names, the NetBIOS interface requires some form of multicast or broadcast addressing. Currently, the ISO transport and network layers do not support multicast or broadcast network addresses.

TOP support for multicast and broadcast addressing is only available through the ISO 8802 link level protocols, so broadcast datagrams and datagrams to group names must use link level addressing. Section 4.3 of this paper, ''Broadcast Datagrams and Datagrams to Group Names,'' details the addressing techniques used.

Because NetBIOS datagrams may contain as many as 512 bytes, the NetBIOS interface requires the lower level services to support a datagram size able to include both the 512 bytes of data and header information for NetBIOS, Transport, Network and Data link Layers. This requires a minimum frame size of 650 octets.

Detailed documentation of the support required for SEND DATAGRAM, SEND BROADCAST DATAGRAM, RECEIVE DATAGRAM and RECEIVE BROADCAST DATAGRAM can be found in the ''NetBIOS Commands'' and ''Transport Service Indications and Confirmations'' sections below.

3.4 Guidelines and Constraints

1. There are three levels of NetBIOS interface services which imply different constraints on the networked NetBIOS based application interconnectivity, see Figure 2.

   - Level A - NetBIOS Connection Services: These services rely on the Connection Oriented Transport and Connectionless Network Protocols, thus following full communication beyond the local network.
   - Level B - NetBIOS Connection and Point-to-Point Datagram Services: These services are a superset of Level A services. As they rely on the Connectionless Network Protocol, communication is possible beyond the local subnetwork. However as the Connectionless Transport is used, the loss of NetBIOS Datagram, if it occurs, would not be recovered from by the Transport Layer.
   - Level C - Extended NetBIOS Services: These services are a superset of Level B services which adds the support of the NetBIOS broadcast and multicast datagram services. As these added services do not use the Connectionless Network Protocol, no direct communication (i.e., no OSI Routing) is possible beyond the local subnetwork. As a consequence any NetBIOS based application requiring Level C Services will have to be distributed only within a single Subnetwork.

2. The use of NetBIOS Name Services and the manner in which they are distributed imply the following constraints.

   a. Name Services scope support based on multicast mechanism is limited to a local subnetwork (the same as NetBIOS native networking).

   b. The expected way to extend the local scope of NetBIOS naming is to integrate the NetBIOS Name Servers into an OSI Directory Services Environment.

3.5 NetBIOS General Commands

Normally, the NetBIOS general commands do not require any peer-to-peer protocol support. For example, no mapping to an ISO protocol is required for RESET, CANCEL, UNLINK and SESSION STATUS commands. The type of support required for each of these commands is detailed below in ''NetBIOS Commands.''

However, one general command, ADAPTER STATUS, sometimes requires communication with a remote system. When the ADAPTER STATUS specifies a remote name, the local system must communicate with the remote system in order to obtain the status. This communication uses the naming protocol defined in NetBIOS Name Service Protocol Specification, so complete documentation of this procedure can be found Appendix V.

The ADAPTER STATUS command also returns a buffer with fields that only apply to specific adapters. The values that adapters conforming to this specification should use for these fields are stipulated in ''ADAPTER STATUS'' in Appendix V.

4 SPECIAL CONSIDERATIONS

A straightforward mapping from the NetBIOS interface to ISO transport services does not resolve all the major NetBIOS/transport issues. It does not specify how transport services provide zero octet sends, confirmed data delivery, how they prevent data loss during hang ups, how they deliver broadcast datagrams and datagrams to group names, how they affect NetBIOS timeouts, how they resolve connections between group names, or how they support permanent node names. This section discusses each of these topics.

This NetBIOS ''Session'' (mapping) Protocol resides above the transport layer and makes use of the services provided by the transport protocol. This protocol specifies use of two-octet NetBIOS headers for data transfer requests (TSDUs). The headers are fixed and always present.[6] The specific values for the header are given in Table 1. The headers are used to solve the issues of zero octet length messages and data loss during hang ups, as described in the following subsections. The most significant octet is transmitted first.

Value	Description
0100H	normal data (connection-oriented or connectionless)
0200H	close request (connection-oriented only)
0300H	close response (connection-oriented only)

TABLE 1. NetBIOS Header Values

6. Note that NetBIOS ''Session'' header is applied to the first TPDU only, and not all the TPDUs when a TSDU is segmented into multiple TPDUs.

Note: A TSDU with an invalid header will be ignored.

Once the transport circuit is established, all the connection oriented data TSDUs generated by the NetBIOS interface/protocol layer will contain a two octet fixed header, carrying NetBIOS opcode as defined above. Additionally all non name service NetBIOS datagram TSDUs contain the two octet fixed header with value 0100H. Note, however, that this does not apply to TSDUs generated by the Name Service Protocol described in sections 7 through 9.

Also, note that the header applies to TSDUs, not TPDUs or TIDUs.

4.1 Zero Length Data and Normal Data Transfer

The NetBIOS data transfer requests are mapped into data TSDUs with NetBIOS header of 0100H for normal data as well as zero length data. Implementations must evaluate the length of TSDUs to determine whether or not it has zero length ''user data''.

4.2 Confirmed Data Delivery

The issue with mapping the NetBIOS interface to transport services is guaranteeing data delivery on ''sessions''. When a NetBIOS SEND or CHAIN SEND command completes, the local user is assured that the remote user has actually received the data. The ISO transport services, however, provide no indication to the sender of actual data delivery; they do not have a T-DATA confirmation primitive. Software implementing a NetBIOS interface does not necessarily know when to indicate that a SEND command has completed.

This behavior can create a problem because, in some application programs, the sender may take actions based on an assumption that the receiver has possession of the data. Taking these actions before the receiver actually does have the data may cause the application program to fail. Fortunately, most NetBIOS application programs do not require true confirmed data delivery; they only need assurance that data is not lost when the ''session'' is closed. This specification, therefore, provides a means of preventing data loss during hang up (see below). Implementations are, of course, free to add a confirmed data delivery service during normal data transfer. The details of such a service are a local matter.

4.3 Data Loss During Hang Up

Because the NetBIOS interface cannot depend on ISO transport services to guarantee data delivery at all times, the interface must prevent data loss during hang up. The NetBIOS definition states that a HANG UP command does not complete until all outstanding SEND and CHAIN SEND commands on the ''session'' have completed (either successfully or unsuccessfully). Because NetBIOS confirms data delivery by completing the SEND command, NetBIOS users are guaranteed that either all data will be delivered prior to the hang up, or that an unsuccessful SEND or CHAIN SEND completion will alert them to data that could not be delivered.

The transport T-DISCONNECT request, on the other hand, is not graceful. It does not wait for all data sent to be delivered to the user. Without confirmed data delivery, the transport user has no way of knowing whether or not data has been delivered to the receiver before the disconnect completes.

To prevent data loss, the NetBIOS interface must delay the transport disconnect until all data has been delivered to the user. To find out when all data has been successfully delivered, the interface that wishes to hang up sends a simple close request packet to the remote interface. This close request is sent ''in stream'' as a normal data TPDU with NetBIOS opcode of 0200H. When the remote interface has received all of these data messages followed by a ''close request'' message and successfully delivered data

messages to the remote user, it sends a ''close response'' back to the local interface, with NetBIOS opcode of 0300H. When the local interface receives the close response, it knows that all data has been delivered. At that point it issues a T- DISCONNECT request and completes the HANG UP command.

The close request and close response are each sent as a single data TSDU with two octet of transport data for the NetBIOS header. The appropriate headers are given in Table 1.

The case of close request collision is handled in a fashion similar to OSI Session Protocol. Under these circumstances, close indication is given to each end point. The action taken by each end point depends on its role at the time the connection was established. The end point which originally issued the connect request should immediately send a close response. The end point which originally accepted the connect request should not send its close response until a close response has been received from the other end point.

In addition to sending the close request, the NetBIOS interface initiating a hang up starts a timer. If that timer expires before the interface receives a close response, the ''session'' is terminated abnormally and the interface immediately issues a T-DISCONNECT request. The interface also aborts the ''session'' if it receives a T-DISCONNECT indication without having sent a close response.

The close operation is detailed in the state tables of Appendix I.

4.4 Broadcast Datagrams and Datagrams to Group Names

An important issue in mapping the NetBIOS interface directly to transport services is NetBIOS datagrams to group names and NetBIOS broadcast datagrams. In order to support broadcast datagrams and datagrams to group names, the NetBIOS interface requires some form of multicast or broadcast addressing. Currently, however, the ISO transport and network layers do not support multicast or broadcast network addresses. These datagrams, therefore, cannot be transferred by the current ISO transport or network level protocols. Note that here ''broadcast'' refers to NetBIOS BROADCAST DATAGRAM commands, not true media level broadcasts.

ISO support for multicast and broadcast addressing is available through the ISO 8802 link level protocols, so broadcast datagrams and datagrams to group names may be transferred by the link level. When the NetBIOS interface wishes to send either type of multicast datagram, it directs the datagram to TOP/NetBIOS Specific Media Access Control (MAC) Multicast Address [see Appendix IV][7]. The interface uses the node's normal MAC address as the source MAC address. Address recommendations for Token Ring networks are provided in Appendix IV ''Well Known Addresses''.

In order to differentiate these NetBIOS datagrams from non- NetBIOS ''pure'' OSI traffic, the interface also uses a special Logical Link Control (LLC) service access point for NetBIOS multicast datagrams. By using a separate LSAP, nodes avoid the possibility of conflict between invented NetBIOS protocol for multicast/broadcast datagrams and an ISO multicast/broadcast service which might be provided through the regular ISO LSAP in the future. The specific LLC service access point defaults to the recommended value of ECH[8]; however, conforming implementations must give users the ability to

7. The Specific Multicast Address for IEEE 802.3 is 09.00.6A.00.01.00. This MAC address is part of the block of Ethernet addresses assigned to AT&T; AT&T has agreed to contribute it to the NetBIOS Special Interest Group. This address must be configurable.

8. This value of LSAP is from public domain, and this value must be configurable.

configure it to any other value. The selected service access point serves as both the source and destination LLC address. Note that all the nodes on the subnetwork have to be configured with the same LSAP value for this purpose; inconsistent LSAP values will prevent intercommunication.

This addressing allows NetBIOS to send and receive multicast datagrams, but the interface requires additional addressing information. NetBIOS must know the source and destination names for each datagram sent to a group name, and it must know the source name for each broadcast datagram. For point-to-point communications, this information is normally available through the T-Selector.

In order to provide complete addressing information, NetBIOS multicast datagrams continue to use the connectionless transport and connectionless network protocols. Thus each datagram still has local and remote T-Selectors associated with it, and, as is the case with normal datagrams, these T-Selectors indicate the local source and destination names. At the network level, multicast datagrams use the same source NSAP as normal datagrams; the destination NSAP, however, is a special NSAP which indicates the destination is a multicast NSAP. The recommended NSAP address is 49.nn.nn.09.00.6A.00.01.00.01, where [nn.nn=00.00] represents the subnetwork number. Note that these datagrams use a special LLC service access point and this NSAP address is not reported in the ES-IS protocol. Thus, strict TOP-conformant (i.e., non-NetBIOS) implementations of the ISO Connectionless Network Protocol which do not support this special multicast NSAP need not send or receive these datagrams. See Appendix VI for all the ''well known addresses.''

Strictly speaking, NetBIOS multicast datagrams have their own protocol stack invented by the NetBIOS SIG for operation over the ISO datalink layer. This stack, which includes the connectionless transport layer and full network layer (not the inactive subset) protocols, separates from the standard stack at the LLC level, and the two stacks are kept separate by distinct LLC service access points. Implementations, of course, are free to combine these two logical stacks into a single physical stack. Such a combination allows efficient use of common code. A protocol model of this NetBIOS implementation under OSI environment is given in Figure 1[9]. Figure 2 provides a NetBIOS architecture based on the protocol model presented in Figure 1.

As an important consequence of using link level addressing, NetBIOS sacrifices the ability to send multicast datagrams across the TOP internet. NetBIOS broadcast datagrams and datagrams to group names are restricted to the local subnetwork.

Another issue with NetBIOS broadcast datagrams (but not datagrams to group names) is the selection of a remote T- Selector to which they should be sent. Since there is no destination name for these datagrams, the remote T-Selector cannot be determined from the name as it is for normal datagrams. Broadcast datagrams, therefore, use a destination T-Selector equal to the ASCII value for an asterisk (2AH) followed by fifteen bytes equal to the ASCII value for a space (20H).

Table 2 summarizes the addresses NetBIOS requires for multicast and point-to-point datagrams. The actual recommended value for the TOP/NetBIOS Multicast and Functional address are defined in Appendix IV.

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9. The dotted line in Figure 1 indicates the boundary between OSI Standard Protocol and NetBIOS specific support protocol.

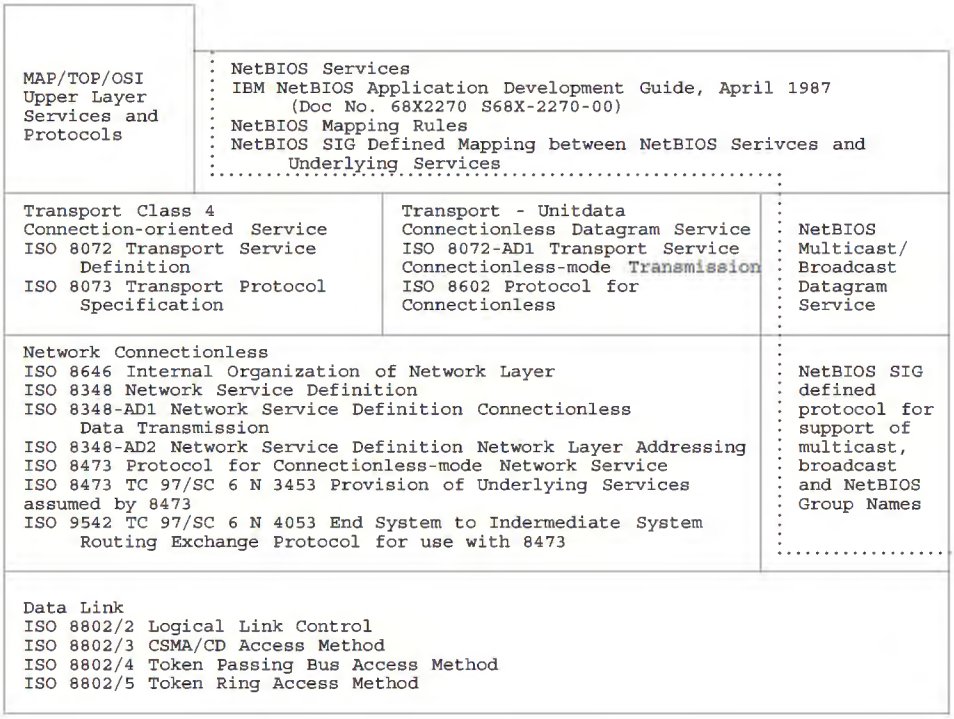

Figure 1. NetBIOS Protocol Model

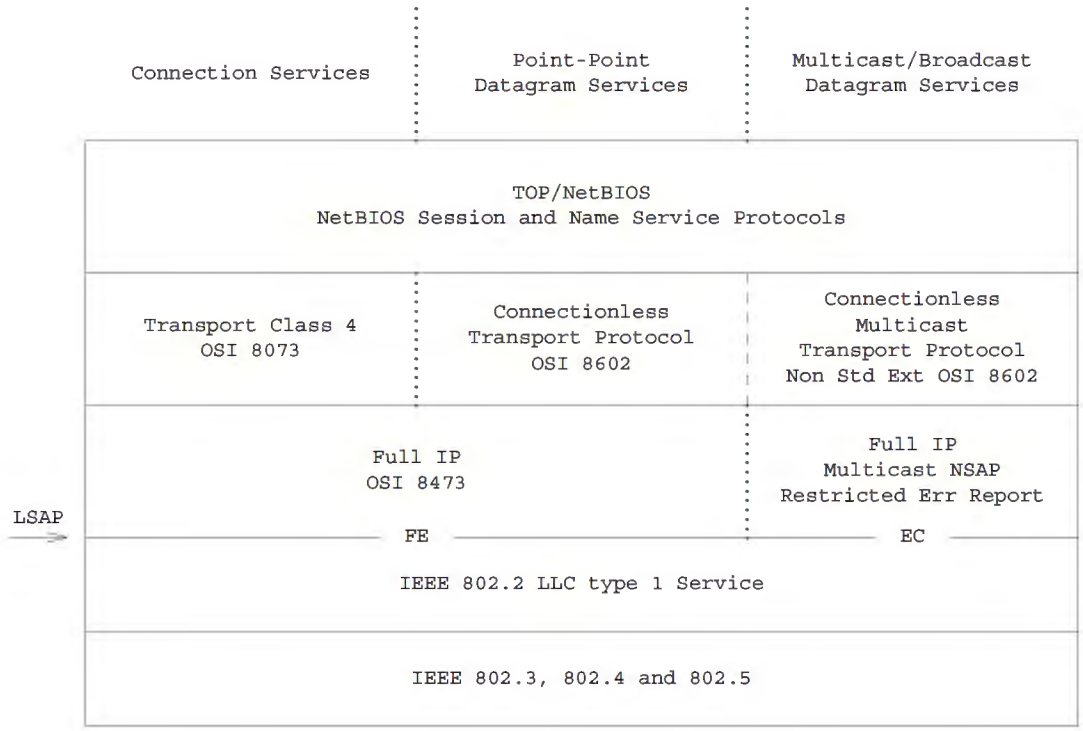

Figure 2. OSI/NetBIOS Architecture

Type	Point-to-Point	Multicast
Source MAC address	source adapter's	source adapter's
Dest. MAC address (CSMA/CD)	dest. adapter's	TOP/NetBIOS Multicast Address
Dest. MAC address (Token Ring)	dest. adapter's	TOP/NetBIOS Functional Address
Source LLC SAP	FEH	ECH
Destination LLC SAP	FEH	ECH
Source NSAP	source adapter's	source adapter's
Destination NSAP	dest. adapter's	multicast NSAP
Source T-Selector	source name	calling name
Dest. T-Selector	destination name	called name or "*<15 sp>"

TABLE 2. Default NetBIOS Addresses

4.4.1 Network Header - Multicast NPDUs

The network header for the PDUs for multicast traffic will be as per OSI 8473 Specification with the error bit turned off.

4.5 Send and Receive Timeouts

The NetBIOS interface defines send and receive timeouts for its ''sessions''. These timeouts limit the amount of time the interface should wait for a SEND, CHAIN SEND or RECEIVE command to complete. Application programs that use these timeouts usually base their values on local subnetwork ''sessions''. Since the original NetBIOS does not support internetworking, application programs are unlikely to account for internetwork transit delay when they specify a send or receive timeout value. Implementations that map the NetBIOS interface to ISO transport services should adjust the send and receive timeout values appropriately for ''sessions'' in case they cross subnetwork boundaries. The definition of ''appropriately'' in this case is left as a local matter.

4.6 ''Sessions'' with Group Names

Another consideration in the mapping of NetBIOS to transport is the establishment of ''sessions'' with group names. This specification requires support of ''sessions'' between group names. NetBIOS LISTEN and CALL commands with group names for the local name are accepted by the interface. The LISTEN command responds to any T-CONNECT indication specifying the correct T-Selector, and the CALL command results in a T-CONNECT request with the appropriate local T-Selector. Additionally, the interface accepts LISTEN and CALL commands with group names for the remote name. The LISTEN command matches any T-CONNECT indication with the appropriate remote T-Selector, and the CALL command results in a T-CONNECT request with a remote T-Selector equal to the remote group name. In all cases, communication occurs through standard ISO protocols attached to the normal ISO LSAP.

The only significant concern in connecting group names is the NSAP address used in a T-CONNECT request when an application program calls a remote group name. That NSAP address should be the specific address (i.e., not generic or group address) of one system on which the group name exists. When the group name exists on more than one system, the choice of which remote NSAP address to use is, for the purposes of this specification, arbitrary. In cases where an NDSE receives multiple responses, it is a local matter how one is chosen for use. In the case where an NDUA is responding to an NDSE, the NDUA may choose one address to put into the response PDU. The approach to be used to make the choice is a local matter.

4.7 Permanent Node Names

A permanent node name, which consists of ten octets of zeros followed by six octets of Mac address, should be treated the same as any other NetBIOS name. Calls to permanent node names, for example, should attempt to discover the address of the remote name just as they would for normal names. The six non-zero bytes in a permanent node name cannot be assumed to correspond to the Ethernet or MAC-layer address of the adapter (but may actually be). Those same six bytes, however, should be returned as the unit identification number by the ADAPTER STATUS command (see below).

An adapter must, of course, successfully register its permanent node name with the NetBIOS naming services each time it is initialized.

5 NetBIOS COMMANDS

The previous three sections specify a definition for the NetBIOS interface and ISO transport services, outline the general principles for mapping the two to each other, and discuss significant complications arising from the mapping. This section begins a detailed description of that mapping. It identifies the level of support required for each NetBIOS command, and it indicates the specific transport service requests and responses associated with each command. NetBIOS commands not listed in this section (TRACE and FIND NAME, for example) are not part of the NetBIOS interface as defined in section 2.1. This specification does not specify support for these additional commands.

Most NetBIOS commands require some initial validation before the interface accepts them. This initial validation may include verifying that the correct adapter was specified, that a name has a valid format, that a local name exists, that a name number is valid, that a ''session'' exists, etc.. The NetBIOS interface definition described in section two, of the referred IBM document, includes an adequate description of this validation. Consequently, this specification omits any description of the validation procedures. Conforming implementations, however, must perform validation for each command as it is described in the NetBIOS interface definition.

Conforming implementations must be able to process NO WAIT commands issued from a post routine call by NetBIOS when a previous NO WAIT command has completed.

5.1 RESET

Implementations conforming to this standard accept and process RESET commands. A RESET command resets the adapter status, deletes all names except the permanent node name, and terminates all ''sessions''. It does not reset traffic and error statistics.

The only protocol interactions resulting from a RESET command are requests to delete NetBIOS names and T- DISCONNECT requests to close NetBIOS connections. Implementations need not delete names belonging to non- NetBIOS programs or protocols, nor must they close non- NetBIOS connections. This specification does not attempt to specify the operation of non-NetBIOS names and connections.

The RESET command may also specify the number of commands and the number of ''sessions'' to be supported by the adapter. Conforming implementations must accept and process these parameters. If the RESET command specifies a value of zero for either parameter, the minimum number of sessions and the number of commands are configured to implementation specific values.

5.2 CANCEL

Conforming implementations accept and process CANCEL commands. Processing is identical to that specified in the NetBIOS definition. Cancelling a CALL, SEND, CHAIN SEND or HANG UP commands results in an immediate T-DISCONNECT request on the affected connection. Cancelling any other valid command does not require any protocol interaction.

5.3 ADAPTER STATUS

ADAPTER STATUS commands for both local and remote adapters are accepted and processed. Local status requests need not require protocol interaction (details are left up to individual implementations); remote status requests, however, use the services of the NetBIOS naming protocol. The format of adapter status request/response is given in Appendix III.

When responding to an ADAPTER STATUS command, the NetBIOS interface fills in a buffer with appropriate status information. Several fields within that buffer apply only to specific adapters or specific network topologies. Since it is not the intent of this specification to restrict implementations to these few specific technologies, this specification must leave the exact support of the ADAPTER STATUS command as a local matter. Implementations should strive to use values for the status fields as close as possible to the values indicated below.

- Unit identification number: The six non-zero bytes of the adapter's permanent node name. These bytes do not necessarily form the Ethernet or MAC layer address of the adapter.
- External option status: One byte whose value is a local implementation choice.
- Results of last self test: One byte indicating the results of the last self-test. A binary value of 128 (80H) indicates that the test was successfully passed.
- Software version: Two bytes containing binary values for the major and minor version number of this specification to which the adapter conforms. The version number for this specification is 1.0.
- Duration of reporting period: Two bytes whose value is a local implementation choice. It is suggested that if the interface reports the MAC statistics indicated by the next eight items, this field contains the binary value of the time, in minutes, since the adapter began recording the statistics. This value rolls over after reaching a value of <2**16-1> minutes. If the interface does not report MAC statistics, it is suggested that this field contains zero.
- Number of CRC errors received: Two bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of MAC-layer packets (frames) with CRC errors received by the adapter. This value is not necessarily restricted to NetBIOS frames, and it does not roll over after reaching <2**16-1> errors.
- Number of alignment errors received: Two bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of MAC- layer packets (frames) with alignment errors received by the adapter. This value is not necessarily restricted to NetBIOS frames, and it does not roll over after reaching <2**16-1> errors.
- Number of collisions encountered: Two bytes whose value is a local implementation choice. It is suggested that they either contain zero or

the binary value of the number of MAC-layer collisions detected by the adapter. This value is not necessarily restricted to NetBIOS frames, and it rolls over after reaching <2**16-1> collisions.

- Number of unsuccessful transmissions: Two bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of MAC- layer packets (frames) whose transmission was aborted by the adapter. This value is not necessarily restricted to NetBIOS frames, and it rolls over after reaching <2**16-1>.
- Number of successfully transmitted packets (frames): Four bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of MAC-layer packets (frames) successfully transmitted by the adapter. This value is not necessarily restricted to NetBIOS frames, and it rolls over after reaching <2**32-1> packets.
- Number of successfully received packets: Four bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of MAC-layer packets (frames) successfully received by the adapter. This value is not necessarily restricted to NetBIOS frames, and it rolls over after reaching <2**32-1> packets.
- Number of retransmissions: Two bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of MAC-layer packets (frames) retransmitted by the adapter. This value is not necessarily restricted to NetBIOS frames, and it rolls over after reaching <2**16-1> retransmissions.
- Number of times the receiver exhausted its resources: Two bytes whose value is a local implementation choice. It is suggested that they either contain zero or the binary value of the number of times the receiver did not have sufficient buffers to receive an incoming MAC-layer packet. This value is not necessarily restricted to NetBIOS frames, and it does not roll over after reaching <2**16-1>.
- Reserved for internal use: Eight bytes whose value is a local implementation choice.
- Free NCBs: Two bytes containing the binary value of the number of additional NetBIOS commands the adapter can currently accept.
- Configured maximum NCBs: Two bytes containing the binary value of the maximum number of commands that the adapter can support, as configured by the last RESET command or initialization.
- Maximum number of NCBs: Two bytes containing the binary value of the maximum number that the adapter can accept in the next RESET command for the ''maximum number of commands supported'' parameter.
- Reserved for internal use: Four bytes whose value is a local implementation choice.
- Pending sessions: Two bytes containing the binary value of the number of currently active or pending ''sessions''.
- Configured maximum sessions: Two bytes containing the binary value of the maximum number of ''sessions'' that the adapter can support, as configured by the last RESET command or initialization.
- Maximum number of sessions: Two bytes containing the binary value of the maximum number that the adapter can accept in the next RESET command for the ''maximum number of sessions supported'' parameter.
- Maximum ''session'' data packet size: Two bytes containing the binary value, in octets, of the maximum TPDU size supported by the adapter, minus

the maximum TP header size.

- Quantity of names in local name table: Two bytes containing the binary value of the current number of NetBIOS names claimed by the adapter. This value does not include the adapter's permanent node name, nor does it include any names used by programs or protocols other than the NetBIOS interface. This number also indicates the maximum number of name entry pairs (the next two fields) which can follow.
- Name: the sixteen byte NetBIOS name.
- Name status: Two bytes, the first of which contains the binary value for the NetBIOS name number, and the second of which contains the name's status. The most significant bit of this second byte indicates whether the name is a unique name (if the bit is clear) or a group name (if the bit is set). The three least significant bits of the status denote the condition of the name. The remaining bits of the name status are undefined, and their values are a local implementation choice. The following list summarizes the values for this field.

  0xxxxxxx name is a unique name

  1xxxxxxx name is a group name

  xxxxx000 name is trying to register

  xxxxx100 name is registered

  xxxxx101 name is de-registered

  xxxxx110 name has been detected as a duplicate

  xxxxx111 name has been detected as a duplicate and is pending de-registration

5.4 UNLINK

This specification does not provide support for the UNLINK command (nor, in fact, for remote program load). A conforming implementation's response to an UNLINK command is left as a local choice.

5.5 ADD NAME

Conforming implementations accept and process ADD NAME commands. The NetBIOS interface translates the ADD NAME command into an appropriate request for the NetBIOS naming services. When the interface receives a confirmation from the naming services, it translates the confirmation's result to an appropriate NetBIOS return code and completes the ADD NAME command. Details of name registration can be found in NetBIOS Name Service Protocol (Section 9).

5.6 ADD GROUP NAME

Conforming implementations accept and process ADD GROUP NAME commands. The NetBIOS interface translates the ADD GROUP NAME command into an appropriate request for the NetBIOS naming services. When the interface receives a confirmation from the naming services, it translates the confirmation's result to an appropriate NetBIOS return code and completes the ADD GROUP NAME command. Details of name registration can be found in NetBIOS Name Service Protocol (Section 9).

5.7 DELETE NAME

Conforming implementations accept and process DELETE NAME commands according to the NetBIOS interface definition. If the name has active ''sessions'', the interface marks the name for eventual deletion and returns the DELETE NAME command with a return code of ''command completed, name has active

''sessions'' and is now de-registered'' (0FH). When all the active ''sessions'' have closed or aborted, the interface actually deletes the name. If the name has pending commands other than active ''session'' commands, those commands are returned immediately with a ''name was deleted'' (17H) completion.

When the NetBIOS interface deletes the name (either immediately or after all active ''sessions'' have closed), it sends an appropriate request to the NetBIOS naming services. Details of name deletion can be found in NetBIOS Name Service Protocol (Section 9).

5.8 CALL

Conforming implementations accept and process CALL commands. When it receives a CALL command, the implementation first finds the transport address corresponding to the remote NetBIOS name. To find this address, it sends a resolve name request to the naming services. If the naming services cannot discover the name's address, the interface completes the CALL command with a return code of ''no answer (cannot find name called)'' (14H).

If the name resolution is successful, the interface continues processing by attempting to establish a transport connection with the remote system. It formulates an appropriate T-CONNECT request to pass to the transport services. The called transport address for the indication consists of the NSAP address of the node on which the remote name resides, along with a T-Selector equal to the remote name. If the remote name is a group name, the NSAP address is that of one node on which the remote name resides; it is not the NetBIOS multicast NSAP address. If the remote group name exists on more than one node, the choice of which NSAP address to use is arbitrary (see ''Sessions with Group Names'' in section 5.6 above).

When the interface receives a T-CONNECT confirmation, it completes the CALL command successfully. If the interface receives a T-DISCONNECT indication instead, it examines the reason code of the indication. If the remote TS-user initiated the disconnect, the interface completes the call with a ''session open rejected'' (12H) return code. If the transport provider initiated the disconnect, or name resolution fails, the interface completes the call with a ''no answer (cannot find name called)'' (14H) return code.

5.9 LISTEN

Conforming implementations accept and process LISTEN commands. When the implementation receives a LISTEN for a valid local name, it holds onto the command until it receives an appropriate T-CONNECT indication (see following section). At that point, the interface completes the LISTEN command. The interface may also complete the LISTEN command if it is cancelled or if the local name is deleted; in these cases the LISTEN completes unsuccessfully.

5.10 HANG UP

Conforming implementations accept and process HANG UP commands. When an implementation receives a HANG UP command, it immediately terminates any pending RECEIVE commands and one RECEIVE ANY command for the ''session'' with a ''session closed'' (0AH) return code. Any subsequent RECEIVE, SEND, CHAIN SEND, or even HANG UP commands for the ''session'' are also immediately terminated with this same return code. The local interface also starts a timer as soon as it receives a HANG UP. If the HANG UP has not completed when this timer expires, the interface aborts the ''session''.

It sends a close request to the remote interface and waits for a close response. When the interface receives the close response, it successfully completes the HANG UP command and issues a T-DISCONNECT request.

If the interface receives a close request after it has sent one, then a ''close collision'' has encountered. Under such situation, if the local interface is the initiator of the ''session'', it will send a close response and then wait for a close response, and the normal HANG UP process continues as described above.

However, if the local interface is the acceptor of the ''session'', in a ''close collision'' situation, it will not issue a close response until it has received one. Following that it will wait for a T-DISCONNECT indication in order to complete the HANG UP process successfully.

If the interface receives a close request or a T-DISCONNECT indication before the close response, it aborts the ''session'' by completing all pending commands with ''session ended abnormally'' (18H) return codes, and, if necessary, issuing a T-DISCONNECT request.

5.11 SEND

Conforming implementations accept and process SEND commands. With each SEND command during normal data transfer, the interface sends a T-DATA request to transport. The user data for that request is the data contained in the SEND command's buffer preceded by the two octet NetBIOS header. (Note that the NetBIOS header is attached to datagram as well as connection oriented Virtual Circuit traffic.) If the interface has some knowledge of when the data is actually delivered to the user, it may withhold completion of the SEND until it knows of actual data delivery. If the interface has no such knowledge, it may complete the SEND at any time. The exact mechanism for determining when to complete the SEND command is a local matter.

If the NetBIOS interface has received a close request from the remote interface prior to receiving the SEND command from the local user, it accepts the SEND command but does not issue the T-DATA request. Since the data cannot be delivered to the remote user anyway, there is no need for the transport request. Of course, the interface also withholds completion of the SEND command until the close process completes. A SEND command retained in this manner is returned with an error code indicating that the session terminated.

5.12 CHAIN SEND

Conforming implementations accept and process CHAIN SEND commands. With each CHAIN SEND command, the interface sends a T-DATA request to transport. The user data for that request is the combination of both of the command's buffers, preceded by the two octet NetBIOS headers. If the interface has some knowledge of when the data is actually delivered to the user, it may withhold completion of the CHAIN SEND until it knows of actual data delivery. If the interface has no such knowledge, it may complete the CHAIN SEND at any time. The exact mechanism for determining when to complete the CHAIN SEND command is a local matter.

If the NetBIOS interface has received a close request from the remote interface prior to receiving the CHAIN SEND command from the local user, it accepts the CHAIN SEND command but does not issue the T-DATA request. Since the data cannot be delivered to the remote user anyway, there is no need for the transport request. Of course, the interface also withholds completion of the CHAIN SEND command until the close process completes. A CHAIN SEND command retained in this manner is returned with an error code indicating that the session terminated.

5.13 RECEIVE

Conforming implementations accept and process RECEIVE commands. When a user issues a RECEIVE command, the interface first looks for any user data

received for the ''session'' that has not yet been given to the user. If such user data exists, the interface copies the data into the RECEIVE command's buffer and completes the command. If the user data copied was the last of a T-DATA indication, the command completes successfully. If data still remains from the indication, the RECEIVE completes with a ''message incomplete'' (06H) return code.

If there is no data to satisfy the RECEIVE command, the interface simply keeps the command until data arrives or a time-out occurs. The RECEIVE may also complete if it is cancelled, if the ''session'' is closed. A RECEIVE command is not completed as a result of the local name being deleted.

5.14 RECEIVE ANY

Conforming implementations accept and process RECEIVE ANY commands. When a user issues a RECEIVE ANY command, the interface first looks for any user data received for an appropriate ''session'' that has not yet been given to the user (see ''T-DATA indication'' below). If such user data exists, the interface copies the data into the RECEIVE ANY command's buffer and completes the command. If the user data copied was the last data in a message, the command completes successfully. If data still remains to be delivered the RECEIVE ANY completes with a ''message incomplete'' (06H) return code.

If there is no data to satisfy the RECEIVE ANY command, the interface simply keeps the command until data arrives or a time-out occurs. The RECEIVE ANY may also complete if it is cancelled or if the local name is deleted.

5.15 SESSION STATUS

Conforming implementations must accept and process SESSION STATUS commands according to the NetBIOS definition. The field referred to as ''state of the session'' is not identical to the state of the NetBIOS/TP4 mapping described in Appendix I. The correspondence between the value returned by SESSION STATUS and the mapping state is:

Value returned in SESSION STATUS command	State of NetBIOS/TP4 mapping from Appendix I
IDLE (00H)	STA 00
LISTEN pending (01H)	STA 01
CALL pending (02H)	STA 02
Session established (03H)	STA 03, STA 05
HANG UP pending (04H)	STA 04, STA 08
HANG UP complete (05H)	STA 06
Session Ended Abnormally (06H)	STA 07

TABLE 3. Session Status Command Mapping

5.16 SEND DATAGRAM

Conforming implementations accept and process SEND DATAGRAM commands. When the implementation receives a SEND DATAGRAM, it first finds the transport address corresponding to the remote NetBIOS name. To find this address, it sends a resolve name request to the naming service module. If the naming services cannot resolve the name's address, the interface simply completes the SEND DATAGRAM command with an unsuccessful response code.

If naming services successfully resolves the remote name, and that name is a unique name, the NetBIOS interface sends a T-UNITDATA request with an appropriate destination transport address. That address consists of the NSAP address of the node on which the name resides, along with a T- Selector equal to the remote name. The interface then completes the SEND DATAGRAM command.

If the remote name is a group name, the interface also sends a T-UNITDATA request. In this case, however, the connectionless transport protocol will use the special multicast NSAP, and it will direct the datagram to the NetBIOS multicast MAC address and LLC service access point (see ''Broadcast Datagrams and Datagrams to Group Names'' in section 4.4). The datagram is not directed to a specific NSAP address of a node owning the group name. As with unique names, the destination T-Selector is equal to the remote name. After sending the T-UNITDATA request, the interface completes the SEND DATAGRAM command successfully.

5.17 SEND BROADCAST DATAGRAM

Conforming implementations must also accept and process SEND BROADCAST DATAGRAM commands. Since a SEND BROADCAST command does not specify a destination name, there is no need for name resolution. The interface simply sends a T-UNITDATA request to transport services with the special broadcast T-Selector for the destination T-Selector. The connectionless transport protocol will use the multicast NSAP, and it will direct the datagram to the NetBIOS multicast MAC address and LLC service access point (see ''Broadcast Datagrams and Datagrams to Group Names'' in section four above). After sending the T-UNITDATA request, the interface completes the SEND BROADCAST DATAGRAM command successfully.

5.18 RECEIVE DATAGRAM

Conforming implementations must accept and process RECEIVE DATAGRAM commands. When the interface receives a RECEIVE DATAGRAM command, it holds the command until an incoming datagram satisfies the command, the command is cancelled, or the local name is deleted. ''T-UNITDATA indication'' in the following section describes the actions the interface takes to successfully complete a RECEIVE DATAGRAM command.

5.19 RECEIVE BROADCAST DATAGRAM

Conforming implementations must accept and process RECEIVE BROADCAST DATAGRAM commands. When the interface receives a RECEIVE BROADCAST DATAGRAM command, it holds the command until an incoming datagram satisfies the command, or the command is cancelled. The command is also completed if the name is deleted. ''T-UNITDATA indication'' in the following section describes the actions the interface takes to successfully complete a RECEIVE BROADCAST DATAGRAM command.

6 TRANSPORT SERVICE INDICATIONS AND CONFIRMATIONS

In addition to generating appropriate transport service requests and responses, the NetBIOS interface must also respond appropriately to incoming transport service indications and confirmations. This section describes the responses to all of these service primitives.

In many implementations, the ISO transport services support upper layers other than the NetBIOS interface. Some transport service implementations, for example, may support both the NetBIOS interface and the ISO session protocol. This specification does not address the complications multiple upper layers introduce, and the primitives discussed below are assumed to be intended solely for the NetBIOS interface. For example, there is no attempt to describe how transport services know to pass a T-CONNECT indication to NetBIOS instead of to the ISO session services.

6.1 T-CONNECT Indication

When the NetBIOS interface receives a T-CONNECT indication, it looks for a pending LISTEN command to match the indication. A matching LISTEN command

must have a local name equal to the called T- Selector, and it must either have a remote name equal to the calling T-Selector or an unspecified (wildcard) remote name. If both a specific LISTEN and a wildcard LISTEN match, the specific LISTEN takes precedence.

If the interface matches a pending LISTEN command, it completes the command successfully and sends transport a T- CONNECT response. If no matching LISTEN exists, the interface sends transport a T-DISCONNECT request.

6.2 T-CONNECT Confirmation

When the NetBIOS interface receives a T-CONNECT confirmation, it completes the appropriate CALL command successfully.

6.3 T-DISCONNECT Indication

The actions the NetBIOS interface takes when it receives a T-DISCONNECT indication depend on the state of the affected ''session''. If that ''session'' has a CALL pending, the CALL command is completed with a ''session open rejected'' (12H) or a ''no answer (cannot find name called)'' (14H) return code. Which return code is returned depends on the reason given in the T-DISCONNECT indication. If the reason indicates that the remote TS user invoked the disconnect, the interface returns the call with a ''reject''ed return code; otherwise, it uses the ''no answer'' return code.

If the ''session'' is established when the T-DISCONNECT indication arrives, the interface completes any pending commands with the ''session ended abnormally'' (18H) return code. The interface also takes this action if the ''session'' is in the process of hanging up.

The only time an interface expects to receive a T-DISCONNECT indication is after sending a close response. In this case, the interface completes all pending commands with a ''session closed'' (0AH) return code. Additionally, if any RECEIVE ANY commands apply to the ''session'', one of those commands is also completed with ''session closed''. If no commands are pending on the ''session'', the interface waits for the user to issue another command. When the user issues a command, that command is completed with a ''session closed'' return code.

6.4 T-DATA Indication

A T-DATA indication tells the NetBIOS interface that data, a close request or a close response has arrived for a ''session''.

When the interface receives such an indication during normal data flow, it looks for a pending RECEIVE command with which to pass the data on to the user. If no RECEIVE command for the ''session'' is available, the interface looks for a pending RECEIVE ANY for the ''session's'' local name. If none are found, the interface then looks for a pending RECEIVE ANY for an unspecified (wildcard) name.

If the interface finds any command to satisfy the T-DATA indication, it copies the data into the command's buffer and completes the command. If all of the user data from the indication fits in the buffer, the command is completed successfully. If only part of the user data fits in the buffer specified by the command, the interface returns the command with a ''message incomplete'' (06H) return code. The interface then looks for another pending RECEIVE or RECEIVE ANY command in which to place the remaining data. The interface continues in this fashion until all of the data has been given to the user or until it can no longer find suitable commands.

If the interface cannot find a pending RECEIVE or RECEIVE ANY command, it keeps whatever user data is left until the user issues an appropriate

command.

If the NetBIOS interface receives a T-DATA indication, with a normal data NetBIOS header, after it has received a HANG UP command from the local user but before that HANG UP has completed, the T-DATA indication is simply ignored and the data discarded.

6.5 T-UNITDATA Indication

T-UNITDATA indications contain incoming NetBIOS datagrams. When the NetBIOS interface receives a T-UNITDATA indication, it examines the destination T-Selector to determine if the datagram is a broadcast datagram or if it is addressed to a specific name (see ''Broadcast Datagrams and Datagrams to Group Names'' in section four above).

If the received datagram is a broadcast datagram, the interface looks for pending RECEIVE BROADCAST DATAGRAM commands. If none exist, the interface discards the T- UNITDATA indication. If an appropriate NetBIOS command does exist, the interface copies the data from the T-UNITDATA indication to the command's buffer. If all the data fits in the buffer, the interface returns the RECEIVE BROADCAST DATAGRAM command with a successful completion. If the data exceeds the size of the buffer, the interface returns the command with a ''message incomplete'' (06H) return code, and the remaining data is lost.

If the received datagram is directed to a specific name, whether that name is a group name or a unique name, the NetBIOS interface ensures that the destination name is registered on its adapter. If the name does not exist on the local adapter, the interface discards the T-UNITDATA indication.

If the specific name exists on the local adapter, the interface searches for a pending RECEIVE DATAGRAM command for that name. If none exists, the interface then looks for a pending RECEIVE DATAGRAM command with an unspecified (wildcard) local name. If the interface is still unsuccessful, it discards the T-UNITDATA indication.

If an appropriate pending NetBIOS command does exist, the interface copies the data from the T-UNITDATA indication to the command's buffer. If all the data fits in the buffer, the interface returns the RECEIVE DATAGRAM command with a successful completion. If the data exceeds the size of the buffer, the interface returns the command with a ''message incomplete'' (06H) return code and the remaining data is lost.

6.6 T-EXPEDITED Data

This option is negotiated in the transport call request PDU as described in the MAP/TOP v3.0 specification. NetBIOS itself does not use Expedited Data, therefore T-EXPEDITED DATA Requests are never generated. If a T-EXPEDITED DATA indication is received, it is ignored.

7 NetBIOS NAME SERVICE PROTOCOL - OVERVIEW

This part, the remaining sections of this specification and Appendices II through V, defines a naming protocol for TOP networks that will support NetBIOS name support services.

7.1 Architecture

The NetBIOS Name Service is a distributed name service which provides facilities for naming objects in the internet environment, and for relating those names to useful attributes, such as protocol addresses.

The name service protocol provides a mapping of NetBIOS Names to their protocol (transport) addresses. The protocol is based on query/response primitives and a distributed information base. Every node on the network

maintains information regarding the services or names posted on that node. When a new name is to be added on any node, that node queries other nodes on the network to ensure that the name can be added. A similar process is followed to obtain the address of an object.

In a simple topology consisting of a few NetBIOS nodes on a broadcast based network, the name service protocol makes use of multicast addresses to register and resolve names. The name service element on NetBIOS nodes is called the NetBIOS Directory Service Element (NDSE). In a more complex topology having a large number of nodes, an internetworking environment or the presence of an OSI directory service, the use of a NetBIOS Directory User Agent (NDUA) is useful (but not required). If there exists an NDUA on the network, the NDSEs communicate with the NDUA using point-to-point datagram communications. NDUAs become the focal point of name service activity. NDUAs are expected to have the capability to interface with an OSI Directory User Agent (DUA) or interface with other NDUAs.

In the case when NDSEs cannot communicate with an NDUA, they revert back to multicast based communication among NDSEs. This limits the address resolution to the local subnetwork, since multicasts are not transported across subnet boundaries.

Figures 3 and 4 provide an example of a simple network topology.

The scenarios presented in this subsection depict the network activities involved for various name service related actions for internetwork communications and call-back type applications.

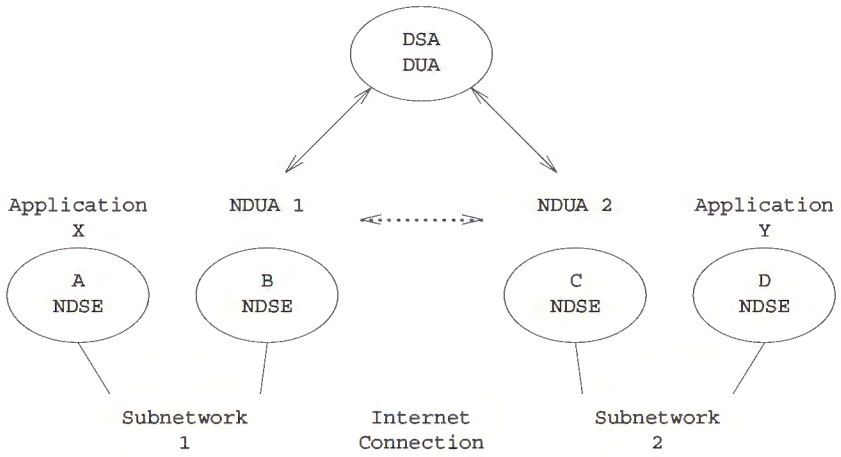

Figure 3. Name Service Example

NDSE Local NetBIOS Directory Service Entity, present on every node.

NDUA NetBIOS Directory User Agent, zero or more present on a subnetwork. At least one is needed for internet name service. It may also provide the interface to the ISO Directory Services (DUA-DSA), if present. It may also communicate with another NDUA using the name service protocol.

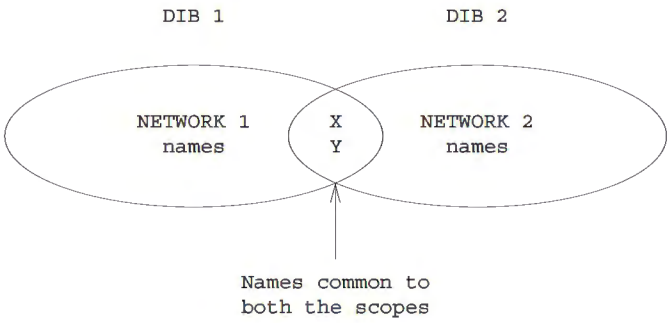

Figure 4. Name Scopes

The above topology, Figure 3, contains two subnetworks (1 and 2) with the associated NDUAs (NDUA1 and NDUA2 respectively). The following points identify the administrative actions of NDUAs to provide internetwork name resolutions.

- It is not possible for application programs using the NetBIOS interface to identify whether they wish to advertise in an internet environment. Therefore, NDUAs based on administrative filtering will update names in their directory information base (DIB) using DSA/DUA when the application programs register or unregister. The administrative filter mechanism is a local matter. It is expected that the names registered in the DIBs will be of ''server'' types providing services across internet boundaries.
- Application programs based on the call-back feature will also require administrative support. For example if the application X wishes to communicate with Y, and if it is necessary for both these applications to call each other, then the following steps can be taken by the respective NDUAs.
  - X will be posted on network 1 by application X, similarly Y will be posted on network 2 by application Y. Both these names will be entered in the DIB by their respective NDUAs.
  - Y will be posted by NDUA1 in the DIB with a pointer to the entry made by NDUA2. Similarly, X will be posted by NDUA2 in the DIB with a pointer to the entry made by NDUA1. This will serve the purpose of determining the uniqueness of ''globally'' known names within the scopes in which they are referenced.
  - If X & Y are unique names, then no other application can claim either of these two names in the two networks and associated DIBs, see Figure 4.
- Note that the information provided by the name service, particularly when using NDUAs will be ''loosely consistent'' in the sense that it may not be absolutely current.

7.2 High Level Feature Descriptions

The following set of features are provided by the NetBIOS Name Services. Some of these features are specifically developed for the NetBIOS environment, and for internetworking and performance reasons. A brief and high level description of each of the features follow.

- NetBIOS: The name service supports a flat, NetBIOS compatible name space. Names need be unique only within the context of the local subnet.

- Standards: The name service requires minimum functionality from underlying layers, a simple standard datagram transfer service is all that is needed. Also, name service is architected with migration to the ISO directory service in mind. A deliberate effort is made to ensure that we provide ISO compatible name services in a way that allow a smooth transition to a ''real'' ISO directory service when it is fully specified.
- Internetworking: The name services provide support for internetwork communication. Access to the name service is transparent to the application programs. Internet name resolution is supported. All intranet name resolution is supported by the distributed database, multicast, or point-to-point mechanisms. The name service is integrated with ISO transport service to allow the exchange of information relative to transit delay associated with a particular resource (e.g. 1200 baud link). Transit delay information is important to allow support of NetBIOS applications with dependencies on Receive-Time-Out or Send-Time-Out (RTO/STO).
- Graceful Degradation: Loss of a single node affects only local calls to that node. Loss of a NetBIOS Directory Service Entity (NDSE) on a node affects only local calls to that node. Loss of an NDUA affects only internet name resolution. Name resolution continues after the loss of an NDUA by using the multicast operation mode of the name service.
- Remote Adapter Status: The name service is integrated with support for Remote Adapter Status. A user can issue a status request on a NetBIOS name and will receive the status information associated with the node on which that end point exists, even if the node is on another subnetwork. Note that additional information regarding complete use of this service is provided in Appendix III.
- Compatibility: The NetBIOS names are used for T- Selectors (transport service access point identifiers.) This provides a simple, efficient and effective mapping between NetBIOS names and T-Selectors which becomes a part of the transport address (t-selector+nsap address with null ssap and null psap). NetBIOS is implemented on ISO Transport Class 4 (8073) and ISO Connectionless Transport (8602). Thus, NetBIOS based products and other TOP applications can coexist on the same network and on the same node.
- Set of Functions: A set of functions are defined. The name service makes use of three types of messages, request/advise, response and pending. Names, or objects, are associated with a set of attributes which include, among other things, full transport address (with null psel and null ssel) of the object.

  The set of functions supported are:

  a. Register Name

  b. Register Group Name

  c. Adapter Status

  d. Unregister Name

  e. Resolve Name

  f. Advise Name Conflict (Generation and Response)

  g. Advise NDUA Present

7.3 Scope and Purpose

This specification presents the NetBIOS Name Service Protocol (NSP). The NSP is the basic transfer mechanism for exchanging name service requests between systems. The NSP mechanism and protocol is specified here to support the needs of the NetBIOS Name Service. It is currently used only by the NetBIOS

directories, but it is constructed to allow for expansion to other directory applications.

It consists of high-level operations that support name registration, resolution and attribute association.

7.4 Underlying Services

The NetBIOS Name Service Protocol is based on datagram services provided by CLTP (see Figure 2) with a maximum TPDU size of 1024 octets.

7.5 NetBIOS Name Service (NS)

Operations supported by the NS include name registration and resolution, the storage, and the deletion of attribute information associated with names. These operations were conceived with the ISO/CCITT Directory Services model in mind, and should ease migration to that environment.

The following background information is useful when reviewing the protocol:

- the name of an object (usually an application entity) can be thought of as a search key for retrieving information about the object;
- information takes the form of attributes which describe the characteristics of an object (such as its protocol address);
- the distributed directory database maintains this information in records known as attribute tuples, which are encoded in a Type-Length-Value format.

7.6 Services

The NetBIOS Name Service Protocol primitives are summarized in Table 4:

Primitives		Parameters
NB_RegisterName	.Request/ .Indication	NB_Name, NB_InitialAttributesList
	.Response/ .Confirm	NB_ResponseCode
NB_RegisterGroupName	.Request/ .Indication	NB_Name, NB_InitialAttributesList
	.Response/ .Confirm	NB_ResponseCode
NB_UnregisterName	.Request/ .Indication	NB_Name
	.Response/ .Confirm	NB_ResponseCode
NB_ResolveName	.Request/ .Indication	NB_Name, NB_RequestAttributesList
	.Response/ .Confirm	NB_ResponseCode, NB_Name, NB_ReturnedAttributesList
NB_AdapterStatus	.Request/ .Indication	NB_Name
	.Response/ .Confirm	NB_ReturnedAttributesList
NB_NameConflictAdvise	.Request/ .Indication	NB_Name, NB_AdviseAttributeList
NB_NDUAHereAdvise	.Request/ .Indication	NB_InitialAttributeList

TABLE 4. Service Primitives for Name Service Protocol

8 NetBIOS NAME SERVICE PROTOCOL FUNCTIONS

8.1 General

This section describes the functions performed as part of the name service. All the functions described here are mandatory.

8.1.1 Response Semantics

The values given in the following sections for setting the Response-Semantics field in the name service PDUs serve as guidelines only.

Individual implementations may choose to use different values. However, any example given assumes the use of the recommended values.

8.1.2 Multicast Requests versus Requests to NDUA

In general, the operation of these functions will depend on the NDSE's reaction to the presence of an NDUA. When these functions issue remote requests, they operate as follows:

1. If an NDSE does not know the address of an NDUA, it proceeds to Step 2. Otherwise, the request is sent as a point-to-point datagram to the NDUA, as follows:

   a. DestinationAddress is set to the transport address of NDUA.

   b. ProcedureTimeout is set to ''T'' seconds. The value of ''T'', as well as the manner in which ''T'' may be configured, is left as a local matter.

   c. ResponseSemantics is set to Unconditional Response.

   d. Other portions of the request PDU are set as appropriate for each function. See below for details.

   e. The request is sent as a point-to-point datagram to the NDUA. If no response is received within ''T'' seconds, the request is retransmitted every ''T'' seconds until such time as a response is received or until some maximum number of retransmissions has been reached (see also section 8.7). The maximum number of times a given request may be sent to an NDUA is denoted by ''X'' (X>=1). The value of ''X'', as well as the manner in which ''X'' may be configured, is left as a local matter.

   f. If no response is received after ''X'' transmissions, proceed to Step 2. If a response is received, then the function will complete by sending either a success or failure indication to the originator depending on the response received, and Step 2 is not performed.

2. In the absence of an NDUA (or no response from NDUA after ''X'' tries), the request is sent as a multicast datagram to all other NDSEs, as follows:

   a. DestinationAddress is set to the transport address that represents ''ALL NetBIOS DIRECTORY SERVICE ENTITIES''. This address consists of the t-selector reserved for NDSEs and the multicast NSAP. See Appendix IV for details.

   b. ProcedureTimeout is set to ''T'' seconds. The value of ''T'', as well as the manner in which ''T'' may be configured, is left as a local matter.

   c. ResponseSemantics is set as recommended for each function. Details are given below for each function.

   d. Other portions of the request PDU are set as appropriate for each function. See below for details.

   e. The request is sent as multicast datagram to all NDSEs. If no response is received within ''T'' seconds, the request is retransmitted every ''T'' seconds until such time as a response is received or until some maximum number of retransmissions has been reached (see also Section 8.7). The maximum number of times a given request may be sent to NDSEs is denoted by ''Y'' (Y >= 1). The value of ''Y'', as well as the manner in which ''Y'' may be configured, is left as a local matter.

   f. If no response is received after ''Y'' transmissions, then the function will complete either a success or failure indication to the originator depending on the ResponseSemantics used. (If Response on Success was used, then failure is assumed. If Response on Failure was used, then success is assumed, etc.)

      If a response is received, then the function will complete by sending either a success or failure indication to the originator depending on the response received.

8.1.3 Actions of NDSE (or NDUA) on Receipt of Remote Request

In general, when an NDSE (or NDUA) receives a request PDU from other NDSEs or NDUAs it will process the request and return a response PDU as appropriate. The general actions of NDSE are as given below. More specific actions of NDUA are given in Appendix V.

1. All the response PDUs must contain the same source reference that was provided in the request PDU.
2. If for any reason, the NDSE expects a delay in processing the request within the ProcedureTimeout value provided in the request PDU, it must return a point-to-point pending PDU to the originator.
3. The NDSE must return the Response PDU based upon the type of request and the ResponseSemantics.
   a. A response PDU is always returned if Unconditional Response was requested.
   b. A response PDU is returned if the operation was a success (or a partial success) and Response on Success was requested.
   c. A response PDU is returned if the operation was a failure and Response on Failure was requested.

8.2 Register Name Function

This function is responsible for verifying the unambiguity of a new (non-group) name, registering the name on the network, and, optionally, associating attributes with the name.

Name service clients are allowed to choose a name for their application entities, but a name must be determined to be unambiguous; that is, not already in use[10]. The function queries all relevant databases, local or remote, to determine if the name is already in use. If the name is not found, the function assumes that the name is unclaimed and registration succeeds. If the name is found to already exist, the function aborts and returns a failure indication to the originator.

The following actions are taken by this function:

1. If the name exists in the local (node) version of the specified database, the entire procedure is aborted and a failure indication is returned; otherwise, the name is tentatively registered (put into ''being registered state'') in the local database in order to avoid race conditions with other systems adding the same name; and this name is defended by generating responses to the received Register Name Requests and Register Group Name Requests as if the name were registered, but will respond to the Resolve Name Request as if the name were not registered.
2. A request is sent to an NDUA or all NDSEs, as described in Section 8.1.2. Parameter values particular to the Register Name Request are set as follows:
   - Procedure is set to NB_RegisterName;
   - DestinationAddress is set to the transport address of a valid NDUA, otherwise to the transport group address that indicates ''ALL NetBIOS DIRECTORY ENTITIES'';

10. Note that this does not apply to group names which are ambiguous by definition. Group names are registered using the Register Group Name Function.

- ProcedureTimeout is set to ''T'' seconds;
- ResponseSemantic is set to Unconditional Response if NDUA[11] address is specified, otherwise it is set to Respond-on-Failure. Note that the NDSE trying to register a name will receive a response, success or failure if there exists an NDUA on the network. Otherwise it will receive a failure response with response code of Registration Error.
- NB_Name is taken from the original NB_RegisterName.Request;
- NB_Initial Attribute List contains at least two elements, i.e., protocol address and unique attribute.

3. If a failure response is received from any NDUA or NDSE, the name is already in use on another node. In this case, the tentative registration in the local database is cancelled, the procedure aborts, and a failure indication is returned to the originator.

   If a successful response is received from an NDUA (indicating either the name was unknown or the name was previously registered to the NDUA with the same protocol address as specified in the current request) or if no response is received from any NDSE, then the name is considered to be claimed by the local node. The tentative registration of the name in the local database is made permanent, and the procedure completes by sending a success indication to the originator.

4. The return code is returned in the NB_ResponseCode.

See Appendix II for a set of sample PDU encoding generated by a typical NB_RegisterName function.

8.3 Register Group Name Function

This function is responsible to verify the unambiguity of a new group name, registering the name on the network, and, optionally, associate attributes with the name.

Names on the network must normally be unique; that is, referring to only one owner. In the case of group names, however, the name is allowed to be shared by several owners so long as all the owners recognize the situation. This function is used when an application specifically wishes to share a name with other applications.

This function queries all relevant databases, local or remote, to determine if the name is already in use as a unique name. If a unique version of the name is not found, the function assumes that the name is free to be claimed as a group name, and registration succeeds. If the name is found to already exist in a unique form, the function aborts and returns a failure indication to the originator.

This function performs the following actions:

1. If a unique version of the name exists in the local version of the appropriate database, the entire procedure is aborted and a failure indication is returned; otherwise, the name is tentatively registered (put into ''being registered state'') in the local database in order to avoid race conditions with other systems adding the same name as a unique name. While the name is tentatively registered, this node will defend the name by generating responses to the Register Name Requests as if the name were actually registered, but will respond to Resolve Name Requests as if

11. The operation of NDUA and NetBIOS Object Class definition is given in Appendix V.

the name were not registered.

2. A request is sent to an NDUA and/or all NDSEs, as described in Section 8.1.2. Parameter values particular to the Register Group Name Request are set as follows:

   - Procedure is set to NB_RegisterGroupName;
   - ProcedureTimeout is set to ''T'';
   - ResponseSemantics is set to Unconditional Response if an NDUA address is specified, else it is set to Respond-on-Failure. Note that the NDSE trying to register a name will receive a response, success or failure, if an NDUA exists on the network. Otherwise it will receive a failure response with response code of Registration Error;
   - NB_Name is taken from the original NB_RegisterGroupName.Request;
   - NB_Initial Attribute List contains at least two elements, i.e., protocol address and group attribute.

3. If a failure response is received from any NDUA or NDSE, the name is already in use on another node as a unique name. In this case, the tentative registration in the local database is cancelled, the procedure aborts, and a failure indication is returned to the originator.

   If a successful response is received from an NDUA (indicating either the name was unknown or the name was previously registered to the NDUA as a group name) or if no response is received from any NDSE, then the name is considered to be claimed by the local node. The tentative registration of the name in the local database is made permanent, and the procedure completes by sending a success indication to the originator.

4. The return code is returned in the NB_ResponseCode.

See Appendix II for a set of sample PDU encodings generated by a typical NB_RegisterGroupName function.

8.4 Unregister Name Function

This function is used to remove a registered name from the network.

This function attempts to update or remove both local and remote database entries corresponding to this name. In the case of a unique name, all attributes associated with the name are deleted from the entry, and the name is released. In the case of a group name, specific sets of attributes contained in the Unregister Name Request (viz. transport address) are deleted, and the name is released when the last set of attributes are deleted.

Note that if the node just ''disappears'' without unregistering a name, it is possible that cached entries and NDUA databases may contain invalid entries. The name service is designed to be ''loosely consistent'' and allows for the possibility of invalid entries, so the protocol will still function when a node ''disappears''.

This function performs the following actions:

1. If the name does not exist in the local (node) version of the appropriate database, the entire procedure is aborted and a failure indication is returned.

2. A request is sent to an NDUA and/or all NDSEs, as described in Section 8.1.2. Parameter values particular to the Unregister Name Request are set as follows:

- procedure is set to NB_UnregisterName;
- if the name is being unregistered in other domains (scopes) or Directory Service Agents (DSAs) then for every DSA an Object Identifier is included in the request;
- ResponseSemantics is set to Unconditional Response if NDUA is specified, or else it is set to No Response. In addition, when NDUA receives such a request it re-multicasts this request on the local subnetwork;
- NB_Name is taken from the original NB_UnregisterName Request;
- NB_InitialAttributeList contains at least one element, viz., the protocol (transport) address associated with the name.

3. The return code is in the NB_ResponseCode.

8.5 Resolve Name Function

This function is used to resolve a name to a set of attributes (most commonly a Transport Address). If such an entry exists in a local or remote database, the requested attributes are returned to the originator along with a success indication. If the entry is found but not all requested attributes are known, then those attributes which are known and requested are returned along with a partial-success indication. If no such entry can be found, the procedure returns a failure indication to the originator.

The following actions are taken by this function:

1. A request is sent to an NDUA and/or all NDSEs, as described in Section 8.1.2. Parameter values particular to the Resolve Name Request are set as follows:
   - Procedure is set to NB_ResolveName;
   - ProcedureTimeout is set to ''T'' seconds;
   - ResponseSemantics is set to unconditional response if an NDUA address is specified, otherwise it is set to Respond-on-Success;
   - Arguments for the remote NB_Resolvename procedure, if NDUA is specified, are as specified below.
     - NB_Name is taken from the original NB_ResolveName.Request;
     - NB_RequestAttributesList is taken from the same parameter on the original NB_ResolveName.Request.
2. If a failure response is received from any NDUA or if the request(s) to NDSEs timed out without response, then the name is unknown. In this case, the procedure aborts and a failure indication is returned to the originator.
   - It is possible that the resolve name response may contain fewer attributes than requested. In such a case, the response code will be of partial success. Such responses are also treated as a ''successful response''.

   If a successful response is received from an NDUA or an NDSE, then the requested, or received attributes, when fewer attributes are received, are returned to the originator with an indication of success.
3. The return code, name and requested attributes are returned as the NB_ResponseCode, NB_Name and NB_ReturnedAttributesList parameters, respectively, with the above parameters being passed as NB_ReturnedAttributesList.

A successful resolve name response must have the requested transport address attributes. It is possible that, if the resolve name response is received from NDUA it may contain more than one transport address when the name is a group name. Similarly, resolve name responses may come from several NDSEs when the name is a group name. Also, note that it is possible all the attributes may not fit in a PDU. In that case the attribute list is truncated based on local choice.

See Appendix II for a set of sample PDU encodings generated by typical NB_ResolveName functions.

8.6 Name Conflict Advise Function

This function consists of two parts. The first part of the function requires detection of conflict, and the second part requires the processing of the ''NameConflictAdvise'' indication.

This function is used to detect names in ''conflict''. It is possible, though by remote chance, that a given subnetwork will contain two or more identical unique names, or one or more identical group names along with at least one identical unique name posted in the name service databases, such that every node posting such name thinks that it has posted a unique name.

The function is defined in two parts. The first part is associated with the detection of conflict. It requires that the node resolving a name detects more than one response to a resolve name request (either by waiting for or by accepting more than one response.) If more than one response is received, for a unique name, it indicates that the name is in conflict. The node detecting the conflict sends a point-to-point advise (NameConflictAdvise PDU) back to all but one (generally the first) responder indicating that that name posted is in conflict.

The second part of the function is associated with the processing of a ''NameConflictAdvise'' indication. When a node receives the conflict indication, it will set the ''Name-In-Conflict'' attribute for that name. When all the current sessions are terminated that are associated with a name with the ''Name-In-Conflict'' attribute set, the name should be removed/unbound/deleted from its database by explicit user delete name command. During this period, the node will not allow the use of that name for any other ACTIVITY other than for currently active sessions and adapter status.

8.7 Pending Function

This Pending function is invoked by the receiver of a request PDU if it expects a longer delay in processing the request than the procedure timeout indicated in the request PDU. The response PDU is returned to the source of the request with the type field set to ''pending'' and the procedure timeout field set to a new timeout value.

8.8 NDUA Here Advise Function

This function generates the ''NDUA here PDU'' to announce the presence of an NDUA on a subnetwork. This function is used only by NDUAs. An NDUA uses this function to multicast a message when it first joins the subnetwork. It also uses the function to send point-to-point messages to NDSEs which may be unaware of an NDUA's presence. See Appendix V for further details.

8.9 Special Comments

8.9.1 Cache

Cache table cleanup may be a concern in various applications. However, the mechanism chosen to cleanup the cache table may or may not be desirable, depending on a particular application. This protocol does not provide any indication when a name is unadvertised, because there can be no guarantee that such an indication will always be given.

It is possible to associate timers with every name in the cache table, so that names are deleted after a finite amount of time. In addition, it also possible to send ''keep- alive'' PDUs periodically for every posted name. However, both these techniques become cumbersome for a large network or network with many posted names. Therefore, maintaining a cache is treated as a local matter. Caches are set-up for reasons of performance. The protocols do not specify or recommend a mechanism to maintain caches.

9 STRUCTURE AND ENCODING OF PDUs

9.1 Structure

All the Protocol Data Units shall contain an integral number of octets. The octets in a PDU are numbered starting from 1 and increasing in the order they are put into a TSDU. The bits in an octet are numbered from 1 to 8, where bit 1 is the low-order bit. Note that the name service PDUs do not carry the two octet NetBIOS Header.

When consecutive octets are used to represent a binary number, the lower octet number has the most significant value.

When the encoding of a PDU is represented using a diagram in this section, the following representation is used:

1. octets are shown with the lowest numbered octet to the left, and higher number octets to the right;
2. within an octet, bits are shown with bit 8 to the left and bit 1 (least significant) to the right.

PDUs shall contain, in the following order:

1. the fixed part;
2. the variable part.

9.2 Fixed Part

9.2.1 General

The fixed part contains frequently occurring parameters such as the PDU type and total length.

If any of the parameters of the fixed part have an invalid value, it constitutes a protocol error and the offending PDU shall be discarded.

The format of the fixed part is shown in Figure 5.

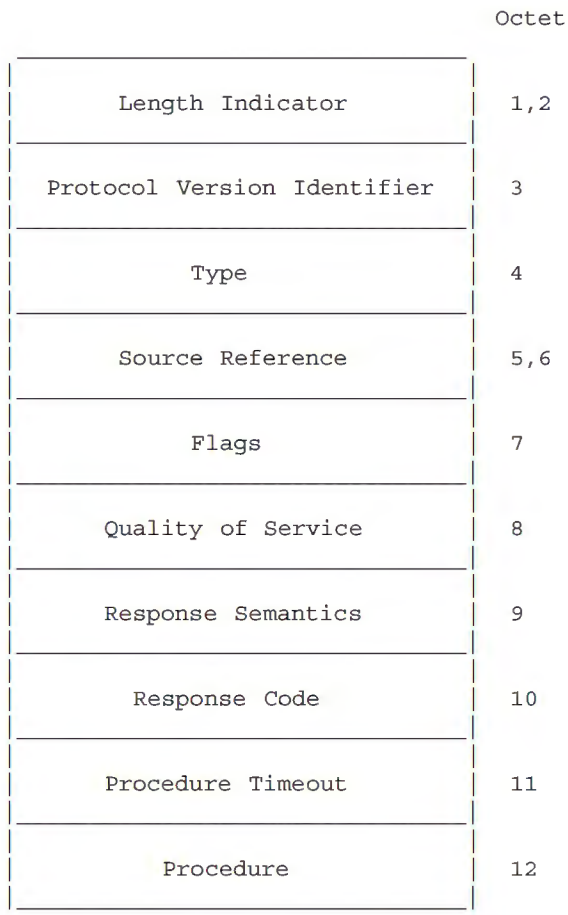

Figure 5. PDU Header - Fixed Part

9.2.2 Length Indicator

This field is contained in octets 1 and 2 of the PDU. The length is indicated by an unsigned binary number, with a maximum value of 65534, and the value 65535 (1111 1111 1111 1111 or -1) is reserved for future extensions. The length indicated shall be the header length in octets, but excluding the length indicator field.

Note that this protocol defines PDUs as consisting entirely of header, since there is no facility for carrying user data.

9.2.3 Protocol/Version Identifier

This field is contained in octet 3 of the PDU. The value of this field for the first release shall be 0001 0001.

PDUs containing protocol/version identifiers with different values shall be considered a protocol error.

9.2.4 Type

This field identifies the PDU type and is contained in octet 4. It is used to define the structure of the variable part of the PDU. Valid codes are given in Table 5.

Type	Binary Value
REQUEST pdu	0000 0010
RESPONSE pdu	0000 0100
PENDING pdu	0000 1000
ADVISE pdu	0001 0000

TABLE 5. Valid PDU Type Codes

All other values are reserved and shall constitute a protocol error.

9.2.5 Source Reference

This field is contained in octets 5 and 6. It identifies a specific invocation of a request and is used by the initiator to correlate responses with the appropriate requests. The value for this field is selected by the initiator and is returned (but not interpreted) by the responder. The same value is used in the successive retransmissions of the PDU.

9.2.6 FLAGS

This field is contained in octet 7.

Every bit in the octet signifies a flag. Only two flags are defined.

1. The NDUA Flag - the least significant bit (binary value 0000 0001). Since NDUAs must also monitor and respond to broadcast messages destined to all NDSEs, it is important to be able to distinguish which of those messages were sent by an NDUA and which ones were sent from an NDSE. NDUA sets this flag in all the PDUs it generates; NDSEs reset this flag in all the PDUs they generate.
2. The Internet Flag - the second least significant bit (binary value 0000 0010). This flag is set by NDUA in the response PDU if the object being requested is across the LAN boundary, otherwise the flag is reset. This flag is always reset in a request PDU[12].
3. Other values are reserved.

9.2.7 Quality of Service Field

This field is contained in octet 8.

When the value of this field is set to zero in the request PDU, the destination entity is requested to provide the ''fastest'' answer, e.g. an NDUA only checking its local table. When it is set to ''255'', the responder is expected to provide its best answer, e.g. an NDUA ignoring its local table and obtaining current information from NDSEs[13]. The responder, similarly, will set this field to zero or ''255'' based on the answer provided. No other intermediate values for this field are defined.

9.2.8 Response Semantics

This field is contained in octet 9 of the PDU. It is set by the initiator to define the circumstances under which the responder should send a RESPONSE PDU. Allowable values are given in Table 6, and the responder must adhere to the rules given below. This field has meaning only in the request PDUs; in

12. This flag is useful for End Systems in two cases, (1) for the selection of the proper NSAP address for group names, and (2) for the selection of proper timer values for connections.
13. The definition of best is rather subjective. It implies that the responder is requested to make the most thorough check, e.g. not just looking at the cached value but to revalidate the cache.

response PDUs this field is copied from the request PDU.

Response Semantic	Binary Value
No Response	0000 0000
Response on Success	0000 0001
Response on Failure	0000 0010
Unconditional Response	0000 0011

TABLE 6. Valid Response Semantics

All other values are reserved and shall constitute a protocol error.

The following rules shall be observed by the responder:

No Response
: No response is expected.

Response-on-Success
: The responder shall send a RESPONSE PDU only if the requested operation resulted in success or partial success (i.e., response code of S-success or S-partialResults, see below).

Response-on-Failure
: The responder shall send a RESPONSE PDU only if the requested operation resulted in failure.

Unconditional-Response
: The responder shall always send a RESPONSE PDU to indicate the result of the requested operation.

9.2.9 Response Code

This field is contained in octet 10 of the PDU. This 1-octet field is used to indicate the outcome of a requested operation. The high-order bit indicates success (0xxx xxxx) or failure (1xxx xxxx), with the other bits encoded to represent reasons. Table 7 shows a summary of the valid response codes.

Response	Code
S-success	0000 0000
S-partialResults	0000 0001
E-protocolError	1000 0001
E-nameNotFound	1000 0010
E-noAccess	1000 0011
E-registrationError	1000 0100
E-registrationNameInConflict	1000 0101
E-foundNameInConflict	1000 0110

TABLE 7. Valid Response Codes

S-success
: The request has been successfully completed.

S-partialResults
: The request has been partially completed, e.g. if the request was made for 2 attributes only one was found and returned. Note that the responding entity must not ''make up'' a value for an attribute that it does not have.

E-protocolError
: The request PDU violates the protocol (during normal operation this error must not be generated, it is a diagnostic tool, e.g., it is used when improper function code is received).

E-nameNotFound
: The name in resolve name request is not found.

E-noAccess
The resources cannot be accessed, e.g. security or database not accessible, or name not found.

E-registrationError
The register name request has been denied due to an already existing unique name when registering a unique or group name, or an already existing group name when registering a unique name.

E-registrationNameInConflict
The register name request has been denied due to already existing name/s in conflict.

E-foundNameInConflict
The resolve name request failed as the name found is in conflict.

9.2.10 Procedure Timeout

This field is contained in octet 11 of the PDU. It is interpreted as an unsigned binary number with a maximum value of 255 (1111 1111). It specifies the number of seconds the originator will wait before timing out the procedure.

The timeout value of 0 is valid; it indicates infinity (no timeout).

9.2.11 Procedure

This field is contained in octet 12 of the PDU. It identifies the remote procedure to be performed, and defines the format of the variable portion of the PDU. Allowable values are given in Table 8.

Procedure	Binary Value
NS-RegisterName	0000 0001
NS-RegisterGroupName	0000 0010
NS-UnRegisterName	0000 0011
NS-ResolveName	0000 0100
NS-AdapterStatus	0000 1000
NS-NDUAHereAdvise	0011 0000
NS-NameConflictAdvise	0010 0000
FUTURE DIRECTORY PROCEDURES	reserved

TABLE 8. Valid Procedure Codes

All other values are reserved and constitute a protocol error.

9.3 The Variable Part

9.3.1 General

The variable part is used to convey the parameters for the remote procedure, or values being returned from such a call. If the variable part is present, it may contain one or more parameters. Each remote procedure defines the number, type and order of parameters to appear in the variable part. The following are some of the most common parameters to appear in the variable part. Their order of appearance differs with the exact procedure call, and is defined in the PDU diagrams starting at sec. 9.5.

9.3.2 Name

This parameter is a variable length field used to unambiguously identify a database entry. It is usually set by the initiator and must be formed according to the rules for NetBIOS Names[14]. It is encoded in the format shown in Figure 6.

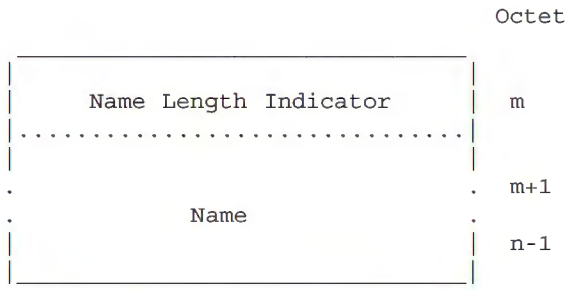

Figure 6. Encoding of the Name Parameter

9.3.3 Attribute Descriptor

This is a variable-length parameter which describes an attribute. Attribute descriptors may be specified by either the initiator (as in the case of a NB_ResolveName REQUEST pdu), or by the responder (as in the case of a NB_ResolveName RESPONSE pdu).

Attribute tuples are encoded in a standard type-length-value format as shown in Figure 7.

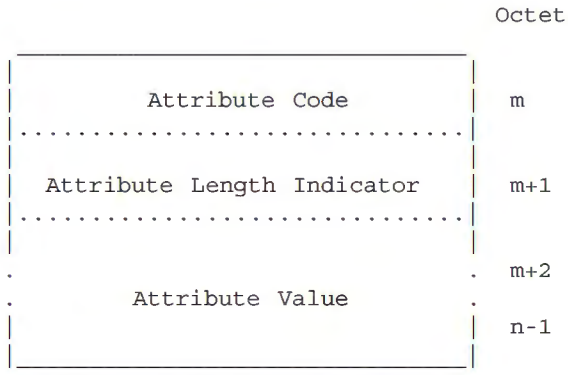

Figure 7. Encoding of an Attribute Descriptor

The Attribute Code field is a 1-octet binary value allowing a maximum of 254 different attribute types. The value of 255 is reserved for possible future extensions. The set of attribute codes in the range of 0-127 are reserved for TOP/NetBIOS use. The set of attribute codes in the range of 128-254 are assigned for private use (vendor specific). An implementation that does not recognize an attribute code will ignore the attribute. Table 9 lists the valid attribute codes defined by TOP/NetBIOS.

14. NetBIOS Names are defined to be consistent with the NetBIOS specifications to a length of exactly 16 octets.

Attribute	Attribute Value
Reserved	0000 0000
Reserved	1111 1111
Reserved	0000 0111 to 0111 1111
Unique Name	0000 0001
Transport Address	0000 0010
Name_In_Conflict	0000 0011
VC Accept	0000 0100
DG Accept	0000 0101
NodeAdminTransport Address	0000 0110
Private	1xxx xxxx*

* - values not including 1111 1111

TABLE 9. Disposition of Attribute Codes

An attribute (code) that is not recognized will be ignored. However, an unrecognizable attribute doe11not cause the entire request to be ignored. Recognized[15] attributes will still be registered (in the case of Registered Name and Registered Group Name Requests) or returned with a response code S-partialResults (in the case of Resolve Name Requests).

The Attribute Length field is a 1-octet binary value which indicates the length, in octets, of the attribute value field. The value field may be up to 254 octets in length. The value of 255 is reserved for possible future extensions.

The Attribute Value field contains the value of the attribute identified in the attribute code field. Encoding formats for standard attributes are specified in sec. 9.4.

9.3.4 Attribute Lists

In many operations, a list of attribute descriptors may be passed as parameters or return values. When such a list appears, it is preceded by an Attribute Count parameter. This parameter is a 1-octet binary value indicating the number of attribute descriptors in the list (see the previous section for the format of attribute descriptors). The field allows for a maximum of 254 attribute descriptors in the list. Such lists may contain only one item. The value 255 is reserved for possible future extensions.

The format of an attribute list is given in Figure 8.

15. Valid attributes, including private attributes, are recognized, and a list of valid attributes codes are given in Table 9.

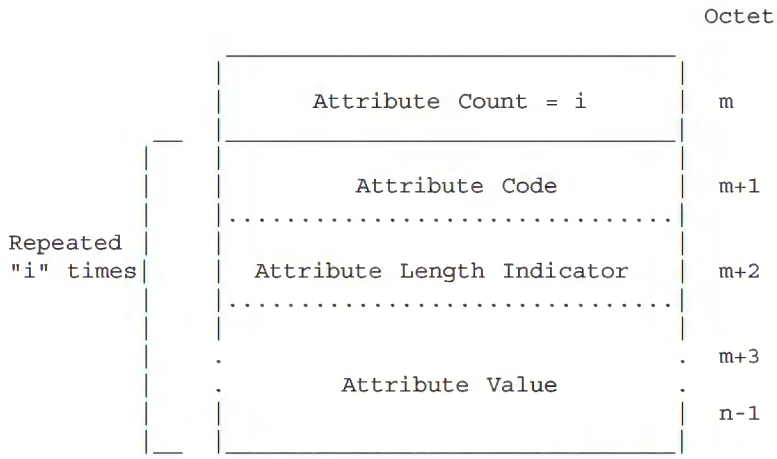

Figure 8. Encoding of an Attribute List

9.4 Encodings for Selected Attributes

9.4.1 General

When attribute tuples are passed in the protocol, they are encoded using a standard type-length- value format called an attribute descriptor (see sec. 9.3.3 for details). The following sections specify the contents of the Attribute Code, Attribute Length and Attribute Value fields for each of the standard attributes.

The following attributes are defined:

1. UniqueName
2. Transport Address
3. Name In Conflict
4. VC Accept
5. DG Accept
6. NodeAdminTransport Address

9.4.2 Encoding of the Attribute Code

In order to allow for new attributes to be added to the NetBIOS Name Service Protocol with a minimum of central coordination, the attribute code field is structured to represent a two-level hierarchy. The two levels are:

– attribute authority identifier (bit 8);

– attribute identifier (bits 1-7).

Attribute Authority Identifier

This field designates the authority responsible for allocating the attribute identifiers under its control. When the value of this field is set to zero (0), it indicates the value has been assigned by the TOP/NetBIOS SIG. The other values associated with this field set to one (1) indicate these are assigned locally for private use.

Attribute Identifier

This field designates the individual attribute within the domain of an attribute authority. Each attribute within a domain must have a unique

seven-bit code assigned by the reigning authority.

9.4.3 UniqueName

This attribute specifies whether the name corresponding to this entry is a unique name (as opposed to a group name).

Attribute Code: 0000 0001

Attribute Length: 1 octet

Attribute Value: Boolean (0xff=TRUE, 0x00=FALSE)

9.4.4 Transport Address

This attribute contains the Transport Address of the object. If this attribute is requested for a recognized name in a resolve name request, at least one transport address must be returned in the response. The encoding of the Transport Address attribute value field is as follows:

Attribute Code: 0000 0010

Attribute Length: variable

Attribute Value: See Figure 9

Figure 9. Value Field of Transport Address Attribute

9.4.5 Name In Conflict

This attribute indicates that the name is in conflict within its domain. Normally this attribute will be reset, when the name is added to the database. However, when it is detected that this name is in conflict this attribute is set. The name is said to be in conflict, when two or more objects with the same name and at least one of which with unique name attribute are present in the same domain[16].

Attribute Code: 0000 0011

Attribute Length: 1 octet

Attribute Value: Boolean (0xff=TRUE in conflict, 0x00=FALSE not in conflict)

9.4.6 VcAccept

This attribute specifies whether the server for this name is currently accepting VC connection requests, e.g., ''listen'' outstanding for that name. This attribute is only maintained by NDSEs. If these attributes are requested from NDUA then ''partial results'' may be returned[17].

Attribute Code: 0000 0100

Attribute Length: 1 octet

Attribute Value: Value (0x01-0xff=YES, 0x00=NO)

9.4.7 DgAccept

This attribute specifies whether the server for this name is currently accepting DG transactions, e.g. receive datagram/broadcast datagram outstanding for that name. This attribute is only maintained by NDSEs. If these attributes are requested from NDUA then ''partial results'' are returned.

Attribute Code: 0000 0101

Attribute Length: 1 octet

Attribute Value: Boolean (0xff=TRUE, 0x00=FALSE)

9.4.8 NodeAdminTransport Address

This attribute contains the Transport Address of the end-point used by Node Administration. This address is used for network management communication, e.g., for remote adapter status. The recommended address will be NDSE transport address. To obtain the ''remote adapter status'', the originating node will send out a query packet (Resolve Name Request) with this attribute set, and the responding node will return the address of the administrative entity (NDSE) on that node. The adapter status request is sent to this address. If this attribute is requested for a recognized name in a resolve name request, then this attribute must be returned in the response. The format of this attribute is the same as that of the ''transport address'' attribute.

Attribute Code: 0000 0110

Attribute Length: variable

Attribute Value: See Figure 9

9.5 PDUs for NB_RegisterName and NB_RegisterGroupName

16. Note that this attribute is not carried in any of the currently defined PDUs, but this attribute may be requested in a resolve name request, for administrative reasons. Internal implementation of this feature is a local matter for NDUAs and NDSEs. However, it is necessary to maintain this information locally.

17. The intent of the value for this attribute is to represent the number of VC requests the object is prepared to accept. A value of zero means the service is not available, and a value of 0xff means maximum service. It is a local matter to determine the current value of this attribute to be returned in the response PDU.

9.5.1 REQUEST PDU

The format of the REQUEST PDU is shown in Figure 10.

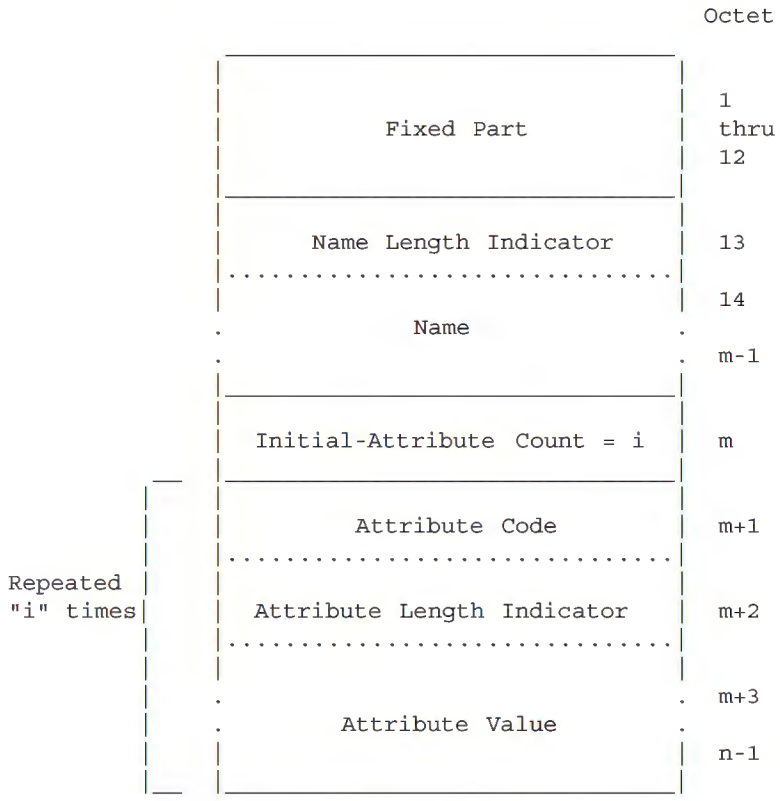

Figure 10. REQUEST PDU Format for NB_RegisterName and NB_RegisterGroupName

9.5.2 RESPONSE PDU

The format of the RESPONSE PDU is shown in Figure 11.

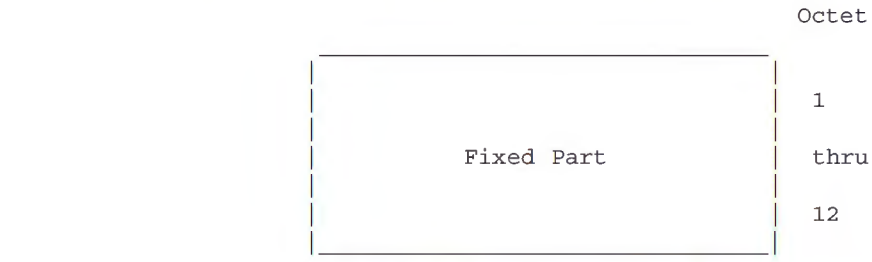

Figure 11. RESPONSE PDU Format for NB_RegisterName and NB_RegisterGroupName

9.6 PDUs for NB_UnregisterName

9.6.1 REQUEST PDU

The format of the REQUEST PDU is shown in Figure 12.

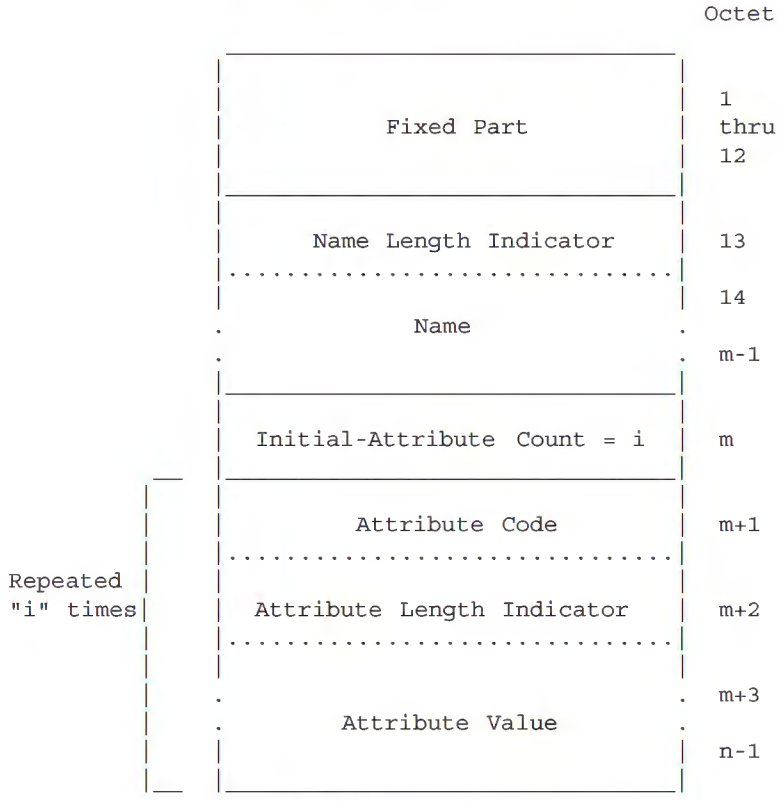

Figure 12. REQUEST PDU Format for NB_UnregisterName

9.6.2 RESPONSE PDU

The format of the RESPONSE PDU is shown in Figure 13.

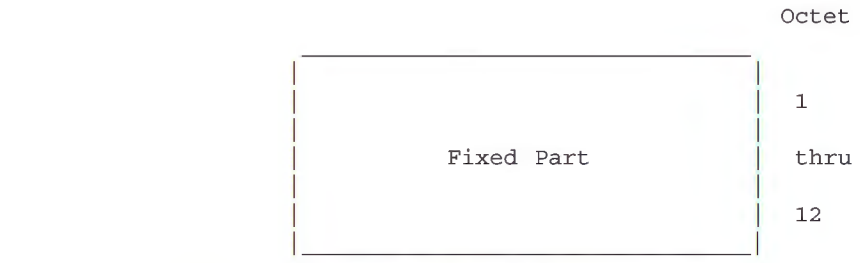

Figure 13. RESPONSE PDU Format for NB_UnregisterName

9.7 PDUs for NB_ResolveName

9.7.1 REQUEST PDU

The format of the REQUEST PDU is shown in Figure 14.

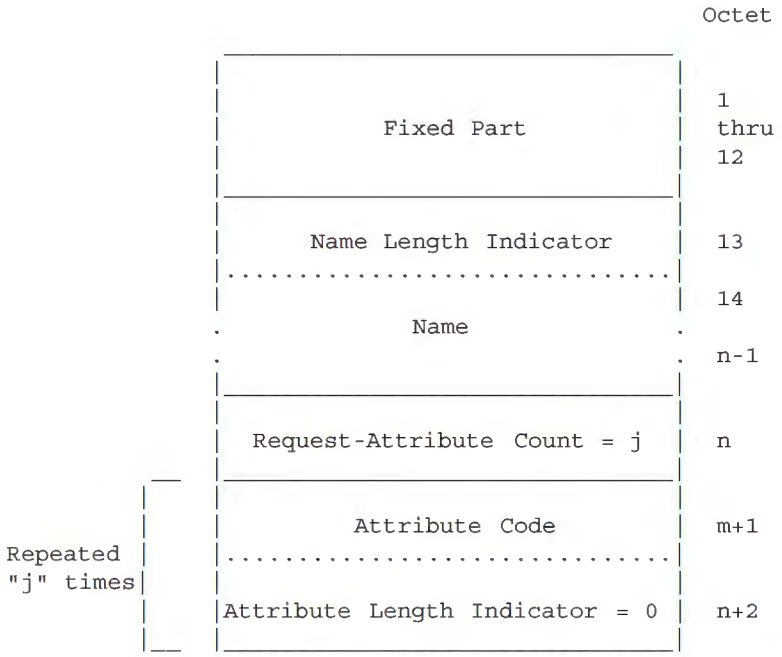

Figure 14. REQUEST PDU Format for NB_ResolveName

9.7.2 RESPONSE PDU

The format of the RESPONSE PDU is shown in Figure 15.

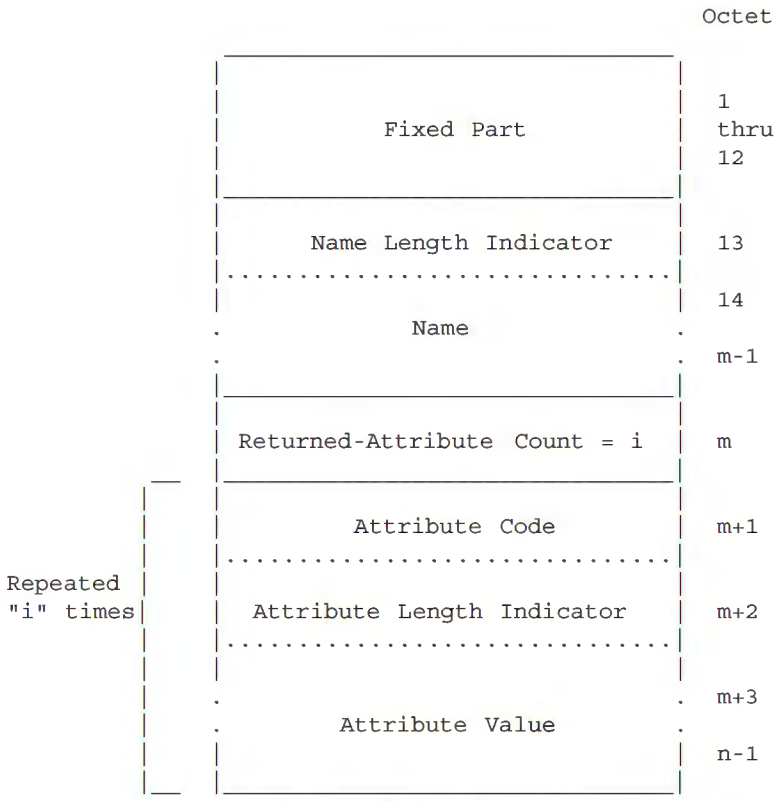

Figure 15. RESPONSE PDU Format for NB_ResolveName

Note that it is possible that the response PDU will contain fewer attributes than requested, but never more. Nodes must not make use of the source protocol control information (PCI) of a response to determine a name's address; they must parse the data contained in the response.

9.8 PDUs for NB_NameConflictAdvise

The format of the ADVISE PDU is shown in Figure 16.

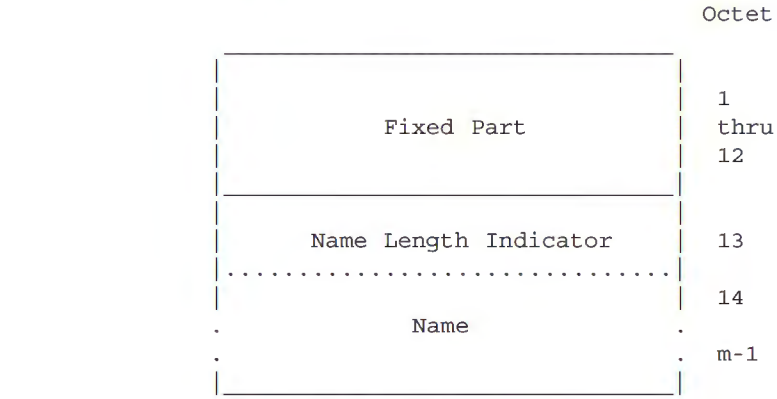

Figure 16. ADVISE PDU Format for NB_NameConflictAdvise

Note that the Type Code = ADVISE PDU Type.

9.9 PDU for NB_NDUAHere

The format for NB_NDUAHere, ''I am here'' PDU is given Figure 17.

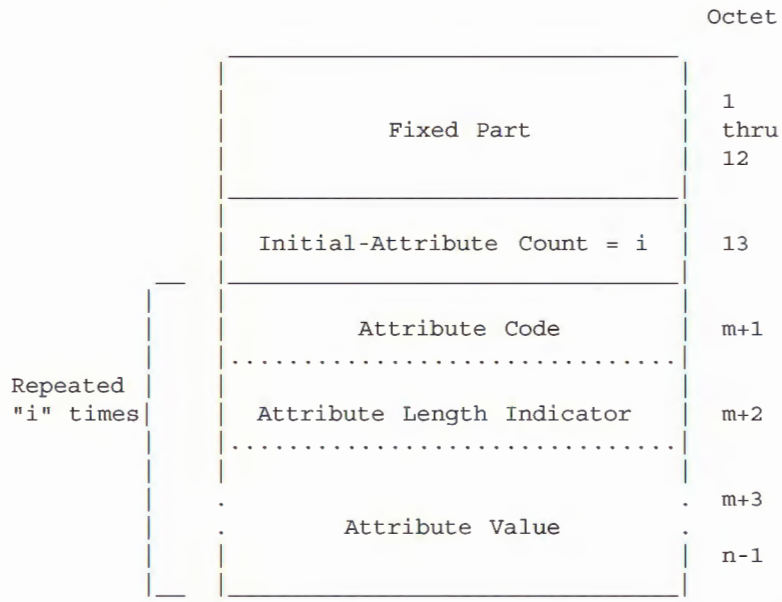

Figure 17. NDUA - I am here Advise PDU Format: NB_NDUAHere

Note that the Type Code = ADVISE PDU Type.

9.10 PDUs and Attributes

The intent of the following table is to provide general guidelines for the set of attributes that are ''meaningful'' with different PDU types. Note that Register means both unique and group registrations and address implies transport address. Attributes listed in square brackets imply optional. For example, the resolve name request may request for NodeAdmin Transport Address, or other attributes. The address attributes must be supplied in the response PDU when requested in a request PDU.

PDU Procedure	Request/Response	Attribute List
Register	Request	(name) Unique/Group Address
	Response	--
Unregister	Request	(name) Address
Resolve	Request	(name) Address [NodeAdmin-Address] [VC Accept] [DG Accept]
	Response	(name) Address(es) Unique/Group [VC Accept] [DG Accept] [NodeAdmin-Address]
NDUA Here	Advise	Address
Conflict	Advise	(name) Address

Figure 18. Sample PDUs and Attributes

APPENDIX I : STATE TABLES

This appendix is an integral part of the body of this specification. It presents, in an unambiguous form, the actions taken by the NetBIOS interface in response to user commands and transport primitives. The state tables detail the mapping between NetBIOS ''sessions'' and class four transport connections. They do not describe general, name service, or datagram service commands, nor do they attempt to show the interaction with NetBIOS name services. The state tables also omit any description of the validation procedures performed on each NetBIOS command; those procedures are adequately described in the NetBIOS interface definition.

The following subsections introduce the state tables by outlining the notation, conventions, actions and variables used by the tables. The tables themselves, which follow the text of this appendix, consist of six figures that specify the incoming events, states, outgoing events, specific actions, predicates and state tables. The actions defined by the state tables apply to a single NetBIOS ''session''. Each NetBIOS ''session'' operates under an independent state table.

I.1 Notation for State Tables

The state tables represent incoming events, states, and outgoing events with their abbreviated names. Tables 10, 11, and 12 specify these abbreviated names. The state tables represent specific actions with the notation [n], where ''n'' is the number of the specific action in Table 10. Predicates are represented by the notation pn, where ''n'' is the number of the predicate in Table 14. Notes are indicated by (n), where ''n'' is the note number at the foot of the figure. Finally, the tables show boolean operations with the characters ''&'' (logical and), ''|'' (logical or), and ''!'' (logical not).

I.2 Conventions for Entries in State Tables

The intersection of each state and incoming event in the state tables (Table 15) either is left blank, contains the notation ''//'', or contains an entry. If the intersection is blank, the incoming event is invalid. An invalid event can only occur if the NetBIOS interface commits an error. If the intersection contains ''//,'' it is logically impossible for the interface to receive the incoming event. Impossible events either cannot occur, or can only occur if an entity other than the NetBIOS interface (for example, the transport provider) commits an error. (These entries are often a consequence of the tabular presentation of the state tables.)

If the intersection of current state and incoming event contains an entry, the incoming event is valid and the entry specifies the actions the NetBIOS interface should take. Each valid entry either contains an action list or one or more conditional action lists. An action list may include outgoing events and specific actions, and it always specifies the resultant state. A conditional action list consists of a predicate expression made up of predicates and boolean operators, and an action list.

I.3 Actions to be Taken by the NetBIOS Interface

The NetBIOS interface takes the actions defined by the state tables (Table 15). Where those tables do not specify an action (if the incoming event is invalid or impossible), the action taken is a local matter.

For valid entries, if the intersection of the incoming event and state contains an action list, the NetBIOS interface takes the specific actions specified in the table. It then changes state to the indicated resultant state. If the intersection contains one or more conditional action lists, for each predicate expression that is true the NetBIOS interface takes the

specific actions in the order given by the action list for the predicate expression. If none of the predicate expressions are true, the incoming event is considered invalid and the actions taken are a local matter.

I.4 Variables

This specification defines several variables for the NetBIOS interface. The state tables use these variables to clarify the effect of certain actions and to clarify the conditions under which certain actions are valid. For purposes of this specification, these variables are purely logical entities; the way implementations actually represent them is a local matter.

- Nsto - timeout value for SEND and CHAIN SEND commands
- Nrto - timeout value for RECEIVE commands
- Vtca - False: the NetBIOS entity initiated the t- connect request (transport connection initiator), True: the NetBIOS entity received the t-connect indication (transport connection acceptor).

I.5 Incoming Events

Abbreviated Name	Name and Description
LISTEN	NetBIOS LISTEN command from user
CALL	NetBIOS CALL command from user
TCONind	T-CONNECT indication primitive
TCONcnf+	T-CONNECT confirmation (positive) primitive
TDATAind	T-DATA indication primitive
RECEIVE	NetBIOS RECEIVE or RECEIVE ANY command from user
SEND	NetBIOS SEND or CHAIN SEND command from user
SENDcnf	NetBIOS SEND or CHAIN SEND command confirmed
HANGUP	NetBIOS HANG UP command from user
CLSreq	Close request from remote interface
CLSrsp	Close response from remote interface
TDISCind	T-DISCONNECT indication primitive
STO	NetBIOS send timeout expiration
RTO	NetBIOS receive timeout expiration
TIM	Hang up timeout expiration

TABLE 10. Incoming Events

Notes:

The exact definition of SEND or CHAIN SEND command confirmation (see ''SENDcnf'' above) is a local matter. It is whatever event causes the interface to complete a SEND or CHAIN SEND command. Some implementations may define this event to be coincident with the SEND event; others may define it to occur when the buffer containing user data is returned to the NetBIOS interface, while still other implementations may define it to occur when the transport provider receives a transport level acknowledgement of receipt of the user data from the remote transport provider. Because the event cannot be precisely defined in this specification, the following state tables do not specify an implementation's actions when it receives a HANG UP command with SEND commands pending. Implementations are free to handle this case in any manner consistent with the NetBIOS definition and with this specification. Regardless of its exact definition, this event does not apply to the ''completion'' of close requests or close responses, despite the fact that they, like user data, are sent in TSDUs.

I.6 Outgoing Events

Abbreviated Name	Name and Description
TCONreq	T-CONNECT request primitive
TCONrsp+	T-CONNECT response (positive) primitive
LSTNcplt	Complete NetBIOS LISTEN command ''good''
CALLcplt	Complete NetBIOS CALL command ''good''
TDATAreq	T-DATA request primitive
SENDcplt	Complete NetBIOS SEND/CHAIN-SEND command ''good''
RCVcplt	Complete NetBIOS RECEIVE/RECEIVE-ANY command ''good''
CLSreq	Close request to remote interface
CLSrsp	Close response to remote interface
TDISCreq	T-DISCONNECT request primitive
HANGcplt	Complete NetBIOS HANG UP command ''good''

TABLE 11. Outgoing Events

Notes:

The completion of a NetBIOS command is only considered an outgoing event if the completion is successful, i.e., the command completes with a return code of ''good'' (0x00). This distinction, though somewhat arbitrary, does make the state tables more manageable.

I.7 States

Abbreviated Name	Name and Description
STA 00	Idle, ''session'' does not exist
STA 01	Listening
STA 02	Calling
STA 03	Established
STA 04	Hanging up, waiting for CLOSE RESPONSE
STA 05	Waiting for disconnect
STA 06	Closed, waiting to notify user
STA 07	Aborted, waiting to notify user
STA 08	Close Collison

TABLE 12. States

Notes:

For the correspondence between these states and the ''state of the session'' returned in the SESSION STATUS command, please refer to ''SESSION STATUS'' in section five.

I.8 Specific Actions

State	Description
[1]	set Nsto and Nrto to appropriate values
[2]	retain received data, waiting for RECEIVE or RECEIVE ANY command
[3]	discard data
[4]	return NetBIOS command with ''Command timed out'' (0x05) return code
[5]	return appropriate NetBIOS commands with ''Message incomplete'' (0x06) return code
[6]	return NetBIOS command with ''Session closed'' (0x0A) return code
[7]	return NetBIOS command with ''Session open rejected'' (0x12) return code
[8]	return all NetBIOS commands with ''Session ended abnormally'' (0x18) return code
[9]	terminate all pending RECEIVE commands and one RECEIVE ANY command with ''Session closed'' (0x0A) return code
[10]	start send timer
[11]	start receive timer
[12]	start hang up timer
[13]	cancel send timer
[14]	cancel receive timer
[15]	cancel all timers for ''session''
[16]	return NetBIOS command with ''No answer (cannot find name called)'' (0x14) return code
[17]	Set Vtca = false
[18]	Set Vtca = true

TABLE 13. Specific Actions

I.9 Predicates

p1	any RECEIVE or RECEIVE ANY commands available?
p2	enough RECEIVE or RECEIVE ANY commands available?
p3	more than one RECEIVE or RECEIVE ANY command required for the received data?
p4	retained data available for RECEIVE or RECEIVE ANY command?
p5	all of retained data from a single received TSDU fits in RECEIVE or RECEIVE ANY command?
p6	Any commands available to notify user of new ''session'' state?
p7	Does disconnect reason indicate ''remote TS user invoked''?
p8	Vtca = false ?
p9	Any command available, in addition to send or chainsend?

TABLE 14. Predicates

I.10 State Tables

STATE ----- EVENT	STA00 idle	STA01 listening	STA02 calling	STA03 established
LISTEN	[1] STA01	//	//	//
CALL	[1] [17] TCONreq STA02	//	//	//
TCONind	TDISCreq STA00	[18] TCONrsp+ LSTNcplt STA03	//	//
TCONcnf+	//	//	CALLcplt STA03	//
TDATAind	//	//	//	p1&p2&p3 [5] [14] RCVcplt STA03 p1&p2&!p3 [14] RCVcplt STA03 p1&!p2 [5] [2] [14] STA03 !p1 [2] STA03
RECEIVE	//	//	//	p4&p5 RCVcplt STA03 p4&!p5 [5] STA03 !p4 [11] STA03
SEND	//	//	//	[10] TDATAreq STA03
SENDcnf	//	//	//	[13] SENDcplt STA03
HANGUP	//	//	//	[12] [9] [14] CLSreq STA04

TABLE 15. State Tables

STATE ----- EVENT	STA00 idle	STA01 listening	STA02 calling	STA03 established
CLSreq	//	//	//	CLSrsp STA05
CLSrsp	//	//	//	
TDISCind	//	//	p7 [7] STA00 !p7 [16] STA00	p6 [8] [15] STA00 !p6 STA07
STO	//	//	//	p9 [4] [8] [15] TDISCreq STA00 !p9 TDISCreq STA07
RTO	//	//	//	[4] STA03
TIM	//	//	//	//

TABLE 15. State Tables (continued)

STATE ----- EVENT	STA04 wait close-resp.	STA05 wait disconnected	STA06 closed, waiting	STA07 aborted, waiting	STA08 close collision
LISTEN	//	//	//	//	
CALL	//	//	//	//	
TCONind	//	//	//	//	
TCONcnf+	//	//	//	//	
TDATAind	[3] STA04		//	//	
RECEIVE	[6] STA04	[11] STA05	[6] STA00	[8] STA00	
SEND	[6] STA04	[10] STA05	[6] STA00	[8] STA00	
SENDcnf		[13] SENDcplt STA05			
HANGUP	[6] STA04	[9] [15] HANGcplt STA05	[6] STA00	[8] STA00	
CLSreq	p8 CLSrsp STA04 !p8 STA08		//	//	//
CLSrsp	[15] HANGcplt TDISCreq STA00		//	//	CLSrsp STA5
TDISCind	[8] [15] STA00	p6 [6] [15] STA00 !p6 STA06	//	//	p6 [8] [15] STA00 !p6 STA07
STO	//	[4] [8] [15] TDISCreq STA00			
RTO	//	[4] STA05			
TIM	[8] [15] TDISCreq STA00	[8] [15] TDISCreq STA00			

TABLE 15. State Tables (end)

APPENDIX II : SAMPLE PDU ENCODINGS

II.1 Register Name Operation

The following tables contain sample PDU encodings for the NB_RegisterName REQUEST and RESPONSE PDUs exchanged as a result of a NB_RegisterName operation, with repeat count N=3 (X=1 and Y=2). In this example, the first request PDU is sent to NDUA, and the subsequent PDUs are multicasted assuming no response from NDUA.

Field	Value		
	PDU #1	PDU #2	PDU #3
Length Indicator	variable	same	same
Protocol/Version Indicator	0001 0001	same	same
Type	0000 0010	same	same
Source Reference	variable	same	same
FLAGs	reset	same	same
QOS	variable	same	same
Response Semantics	0000 0011 0000 0010 same		
Response Code	-	same	same
Procedure Timeout	variable	same	same
Procedure	0000 0001	same	same
Name LI	variable	same	same
Name	variable	same	same
Initial-Attb Count	n	n	n
List of Attributes	variable	same	same

TABLE 16. NB_RegisterName req. pdus generated by NB_RegisterName operation

The response PDU generated by the NDUA after successful registration of a name will have a Response Code of success. If an NDUA is not present on the network the response PDU will be generated by other Nodes with a Response Code of registration error if a name conflict exists.

Field	Value
	PDU #1
Length Indicator	0000 0000 0000 1010
Protocol/Version Indicator	0001 0001
Type	0000 0100
Source Reference	variable
FLAGs	-
QOS	-
Response Semantics	0000 0011
Response Code	0000 0001
Procedure Timeout	variable
Procedure	0000 0001

TABLE 17. NB_RegisterName res. pdu generated by NDUA NB_RegisterName operation

II.2 Register Group Name

The following tables contain sample PDU encodings for the NB_RegisterGroupName REQUEST and RESPONSE PDUs exchanged as a result of an NB_RegisterGroupName operation, with repeat count N=3 (X=1, Y=2). In this example, the first request PDU is generated for NDUA and the subsequent PDUs are generated assuming no response from NDUA.

Field	Value		
	PDU #1	PDU #2	PDU #3
Length Indicator	variable	same	same
Protocol/Version Indicator	0001 0001	same	same
Type	0000 0010	same	same
Source Reference	variable	same	same
FLAGs	reset	same	same
QOS	variable	same	same
Response Semantics	0000 0011	0000 0010	same
Response Code	-	same	same
Procedure Timeout	variable	same	same
Procedure	0000 0010	same	same
Name LI	variable	same	same
Name	variable	same	same
Initial-Attb Count	variable	same	same
List of Attributes	variable	same	same

TABLE 18. NB_RegisterGroupName req. pdus generated by NB_RegisterGroupName operation

The response PDU generated by the NDUA after successful registration of name will have response code of success. If an NDUA is not present on the network the response PDU will be generated by other Nodes with Response Code of registration error if there exist a name conflict.

Field	Value
	PDU #1
Length Indicator	0000 0000 0000 1010
Protocol/Version Indicator	0001 0001
Type	0000 0100
Source Reference	variable
FLAGs	-
QOS	-
Response Semantics	0000 0001
Response Code	0000 0001
Procedure Timeout	variable
Procedure	0000 0010

TABLE 19. NB_RegisterGroupName res. pdu generated by NDUA NB_RegisterGroupName operation

II.3 Resolve Name

The following tables contain sample PDU encodings for the NB_ResolveName REQUEST, RESPONSE and PENDING PDUs exchanged as a result of an NB_ResolveName operation, with repeat count N=3 (X=1, Y = 2). In this example the first request PDU is generated for NDUA and the subsequent PDU are generated assuming no response from NDUA.

Field	Value		
	PDU #1	PDU #2	PDU #3
Length Indicator	variable	same	same
Protocol/Version Indicator	0001 0001	same	same
Type	0000 0010	same	same
Source Reference	variable	same	same
FLAGs	reset	same	same
QOS	variable	same	same
Response Semantics	0000 0011	0000 0001	same
Response Code	-	-	-
Procedure Timeout	variable	variable	same
Procedure	0000 0100	same	same
Name LI	variable	same	same
Name	variable	same	same
Request-Attb Count	0000 0010	same	same
Attb Code (UniqueName)	0000 0001	same	same
Attb LI	zero	same	same
Attb Code (TransportAddress)	0000 0010	same	same
Attb LI	zero	same	same

TABLE 20. NB_ResolveName req. pdus generated by NB_ResolveName operation

Field	Value
	PDU #1
Length Indicator	variable
Protocol/Version Indicator	0001 0001
Type	0000 0100
Source Reference	variable
FLAGs	-
QOS	-
Response Semantics	0000 0001
Procedure Timeout	variable
Procedure	0000 0100
Response Code	0000 0001
Name LI	variable
Name	variable
Returned-Attb Count	0000 0010
Attb Code (UniqueName)	0000 0001
Attb LI	0000 0001
Attb Value	1111 1111
Attb Code (TransportAddress)	0000 0010
Attb LI	variable
Attb Value	variable

TABLE 21. NB_ResolveName res. pdu generated by NB_ResolveName operation

The following points should be noted in the REQUEST and RESPONSE PDU encodings shown above:

- The UniqueName attribute in this example indicates that a system holding a unique version of the name is responding to the NB_ResolveName, although it could just have readily been a system with a group version of the name.

Field	Value
	PDU #1
Length Indicator	0000 0000 0000 1010
Protocol/Version Indicator	0001 0001
Type	0000 1000
Source Reference	variable
FLAGs	-
QOS	-
Response Semantics	0000 0001
Procedure Timeout	variable
Procedure	0000 0100

TABLE 22. NB_ResolveName pending pdu generated by NB_ResolveName operation

APPENDIX III : REMOTE ADAPTER STATUS

The remote adapter status processing consists of the following steps.

1. Obtain the address of the NDSE (remote machine) where the object (name) resides by executing resolve name function with NodeAdminTransport Address attribute set. This step is skipped if the address is already cached.
2. Send the adapter status request PDU, point-to-point, to the remote NDSE (only the fixed header).
3. The NDSE will process the adapter status request indication, and return the status information in the response PDU.

III.1 AdapterStatus Request PDU Format

The Adapter Status Request PDU will consist of a FIXED HEADER part as defined in the following table. It is the same fixed format as given in Figure 5.

Field	Value
Length Indicator	0000 0000 0000 1010
Protocol Version	0001 0001
Type	0000 0010
Source Reference	variable
Flags	0000 0000
QOS	variable
Response Semantics	0000 0001
Response Code	0000 0000
Procedure Timeout	variable
Procedure	0000 1000

TABLE 23. AdapterStatus Request PDU Format

III.2 AdapterStatus Response PDU Format

The adapter status response PDU will consist of two parts, fixed part and variable part. The format for the fixed part will be the same as the request PDU but for the following changes:

Length will be length of the PDU following length indicator field.

Type will be set to response PDU, 0000 0100.

Response will be set to appropriate response code.

The variable part will consist of the following:

Response PDU Variable Part		
Field		
Length Indicator	2 Octets	
MAC Address	6 Octets	
External Option	1 Octet	
Result of Last Self Test	1 Octet	
Software Version	2 Octets	impl. specific
Reporting Period	2 Octets	
CRC Errors	2 Octets	
Alignment Errors	2 Octets	
Number of Collisions	2 Octets	
Number of Unsuccessful Xmit	2 Octets	
Frames Transmitted	4 Octets	
Frames Received	4 Octets	
Number of Retransmissions	2 Octets	
Resource Exhaustions	2 Octets	
Local Implementation	4 Octets	
Local Implementation	4 Octets	
Free NCBs	2 Octets	
Conf. Max NCBs	2 Octets	
Max NCBs	2 Octets	
Local Implementation	2 Octets	
Local Implementation	2 Octets	
Pending Sessions	2 Octets	
Conf. Max Sessions	2 Octets	
Max Sessions	2 Octets	
Max TPDU Size	2 Octets	
Quantity of Local Names	2 Octets	
List of Names	variable	
--Name	16 Octets	
--Name Number	1 Octet	
--Name Status	0xxx xxxx	unique name
	1xxx xxxx	group name
	xxxx x000	trying to register
	xxxx x100	registered
	xxxx x101	de-registered
	xxxx x110	duplicate name
	xxxx x111	duplicate name being de-registered

TABLE 24. Adapter Status Variable Part PDU Format

APPENDIX IV : WELL KNOWN ADDRESSES

There are several well known addresses, described here, for the effective operation of NetBIOS and the Name Service.

IV.1 Transport Selectors

1. NetBIOS Broadcast Address: T-Selector

   The NetBIOS broadcast address t-selector is defined as ''*'' followed by 15 blank spaces.

   T-Selector for Broadcast = ''*<15 spaces>''

2. All NetBIOS Directory Service Entities: T-Selector

   The NetBIOS Name Service Element for a Node, NetBIOS DIRECTORY SERVICE ENTITY (NDSE), will have a ''well known'' transport service access point identifier (t- selector), of 16 octet in length. This will be a reserved value.

   T-Selector for NDSE = ''*NetBIOS_NDSE<3 spaces>''

   Note that the choice of source NSAP address for the nodes that support multiple NSAPs is a local matter.

3. Recommended NDUA: T-Selector

   The recommended T-Selector, of 16 octets in length, for NDUAs on a network is given below. This will be a configurable parameter. The complete protocol address of the NDUA entities will be included in the ''I am Here PDUs''.

   Recommended T-Selector for NDUA = ''*NetBIOS_NDUA<3 spaces>''

IV.2 Network Layer Addresses

1. Group NSAP Address

   In order to implement group datagrams at transport level, only for intranet traffic, a special node number (station number) value is reserved in the network service access point address (NSAP Address). The same NSAP address will be used by the NDUA and NDSEs for their group datagrams.

   The group NSAP address will identify all the nodes on the given subnetwork.

   The general structure of the NSAP address, as per the TOP 3.0 specifications for binary syntax, is used here. Additional semantic constraints are described in the following two points.

   1. The recommended value of NSEL will be 01H, but it can be set to any other value as per the installation option.
   2. The station number field of NSAP address is set to group multicast address.

      STATION NUMBER [6 OCTETS] = 09006A000100H

   3. The format of the remaining DSP must be configurable following TOP 3.0 specifications.

   The NSAP address will use local AFI (49H) and the recommended format for full NSAP address will be[18]:

NSAP LENGTH [1 OCTET] = 10 (decimal)

NSAP = 49.nn.nn.09.00.6A.00.01.00.01

nn.nn=00.00, subnetwork number (default).

2. NSAP Address Formats

The general NSAP address formats will be as per the TOP 3.0 Specifications.

IV.3 Link Layer Addresses

1. Multicast/Functional Addresses

Multicast addresses (broadcast based LANs) will be used as the destination subnetwork point of attachment (SNPA) address for the group NSAP address defined in the previous item. The multicast address is given below. Note that the same functionality can also be achieved by using a broadcast address. Also, the recommended functional addresses used as multicast addresses in the token ring environment are provided. These are recommended values and must be configurable.

Function	Address
TOP/NetBIOS Multicast Address - IEEE 802.3	09.00.6A.00.01.00
End System Hellos (IS Address) - IEEE 802.5	C0.00.00.10.00.00
Intermediate System Hellos (ES Address) - IEEE 802.5	C0.00.00.08.00.00
TOP/NetBIOS Functional Address - IEEE 802.5	C0.00.00.20.00.00

TABLE 25. Recommended Multicast and Functional Addresses

2. LSAP Value

The LSAP value used by the NetBIOS Protocol for multicast and broadcast datagrams is given below. This is a recommended value and must be configurable.

ECH

18. Note that if the connected subnetwork is token ring, the multicast NSAP address maps to the functional address of C0.00.00.20.00.00 as the SNPA address.

APPENDIX V : OBJECTIVES AND ACTIONS OF NDUAs

The NetBIOS Directory User Agent provides two major support functions.

1. It helps in reducing the multicast traffic on the media.
2. It provides an interface to the OSI Directory Services for all the NetBIOS Entities.

V.1 New Protocol Element

One new protocol element is defined to support the NDUA functionalities, ''I am here PDU''.

I am here PDU is an advise PDU with:

- fixed header with ''I am here'' Procedure type and timeout=0, and
- protocol address (presentation address).

There is NO ''I am signing OFF'' PDU. The NDSEs can detect the absence of NDUAs based on timeouts. The actual implementation of this detection is a local matter.

V.2 Actions

There is a set of actions for NDUAs and NDSEs.

a. NDUAs multicast the ''I am here PDU'' N times at T intervals when joining the network.

b. NDSEs save the information received in ''I am here PDU'' of at least one NDUA.

c. NDSEs will multicast ''register name'' and ''resolve name'' requests if there is no known NDUA on the network, otherwise a point to point request is sent to one of the NDUAs.

d. NDUA will process the ''resolve name'' request by checking the cache, or making a request to the DUA and/or sending a multicast ''resolve name'' request if the entry is not available in cache.

   When processing a resolve name request for a group name, the NDUA may choose one among many transport addresses to put into its response. However, it is a local matter how NDUA makes this choice.

e. NDUAs will process the point-to-point ''register name'' request by checking in the local database (cache).

   - If the name is not found in the local database, the NDUA will multicast the ''register name'' request on the LOCAL network with the ResponseSemantics set to response on failure.
   - If it does not receive any response, that means the name is available and the registration request is granted and a success response is returned to the originator.
   - If the name was found in the local database and the presentation address supplied in the request is the same as that in the local database, the registration request is granted and a positive (success) response is returned to the originator.
   - If the name was found in the local database and the presentation address supplied in the request is different than in the local database, a point to point resolve name request is sent to the NDSE where the name was registered. If the resolve name succeeds, then the new register name request is denied, but if the resolve name request fails, then the register name request is granted. If the register name

request is granted then the local database is updated appropriately. Success or failure response is returned to the originator of the register name request. These checks are necessary as the NetBIOS objects can move from one machine to another, or nodes can go down and come back up without unregistering their services.

The NDUA will maintain in its database all the information (attributes) that was provided in the registration request PDU. Private attributes supplied with the register name request will be saved, and will be returned in the resolve name response PDU, if those attributes are requested. NDUA will not make any semantic analysis of this data.

f. Also, based on administrative ''filtering'', NDUAs will propagate the ''register name'' request to its DUA (if present). When such a request is propagated it will include the appropriate ''object-id'' attribute in the request to its DUA.

g. NDUAs will process the ''unregister name'' request by cleaning up the cache and propagating it to DUAs (point-to-point).

h. In addition, NDUAs will return point-to-point ''I am here PDU'' if an NDSE request is received as a multicast PDU. Note that this implies that an NDUA must receive datagrams that were sent to NDSE's t- selector (*NetBIOS_NDSE).

i. NDSEs will multicast the ''resolve name'' request (N- X) times if no responses are received for the first ''X'' point-to-point requests.

j. NDUAs will set the NDUA FLAG in all the PDUs generated by them. Thus other NDUAs, if present on the subnetwork, can distinguish between the PDUs received from NDUAs and from NDSEs. The NDSEs will always reset the NDUA flag in all PDUs generated by them, and they do not attach any semantic meaning to this flag in the received PDUs.

V.3 Object Class Definition

The following NetBIOS Object Class is defined for use in conjunction with OSI Directory Services.

```
NetBIOSEntity OBJECT-CLASS
    SUBCLASS OF top
    MUST CONTAIN {
        NetBIOSName
        nameType
        presentationAddressSet
        adminPresentationAddress
    }
::= {NetBIOSEntity-object-identifier-value}

NetBIOSName ATTRIBUTE
    WITH ATTRIBUTE SYNTAX
        octetStringSyntax (SIZE(16))
::= {netBIOSName-object-identifier-value}

nameType ATTRIBUTE
    WITH ATTRIBUTE SYNTAX
        INTEGER{
            group (0),
            unique (1)
        }
        MATCHES FOR EQUALITY
        SINGLE VALUE
::= {nameType-object-identifier-value}

presentationAddressSet ::=
    SET OF PresentationAddress

adminPresentationAddress ::=
    PresentationAddress
```

Note that the above definition, object identifier value, must be assigned by an OSI Registration Authority. Currently the U.S. does not have one, though it will likely be NIST (previously known as NBS) or ANSI. Once a registration authority is set up, it will be requested to assign the value.

APPENDIX VI : ERRATA AND CLARIFICATION

For future use.

Appendix F

RFC 1001

This appendix reproduces, in full and unedited, RFC 1001, Protocol Standard for a NetBIOS Service on a TCP/UDP Transport: Concepts and Methods.

Network Working Group
Request for Comments: 1001 March, 1987

PROTOCOL STANDARD FOR A NetBIOS SERVICE ON A TCP/UDP TRANSPORT: CONCEPTS AND METHODS

ABSTRACT

This RFC defines a proposed standard protocol to support NetBIOS services in a TCP/IP environment. Both local network and internet operation are supported. Various node types are defined to accommodate local and internet topologies and to allow operation with or without the use of IP broadcast.

This RFC describes the NetBIOS-over-TCP protocols in a general manner, emphasizing the underlying ideas and techniques. Detailed specifications are found in a companion RFC, "Protocol Standard For a NetBIOS Service on a TCP/UDP Transport: Detailed Specifications".

SUMMARY OF CONTENTS

TABLE OF CONTENTS

PROTOCOL STANDARD FOR A NetBIOS SERVICE ON A TCP/UDP TRANSPORT: CONCEPTS AND METHODS

1. STATUS OF THIS MEMO

This RFC specifies a proposed standard for the Internet community. Since this topic is new to the Internet community, discussions and suggestions are specifically requested.

Please send written comments to:

Karl Auerbach
Epilogue Technology Corporation
P.O. Box 5432
Redwood City, CA 94063

Please send online comments to:

Avnish Aggarwal
Internet: mtxinu!excelan!avnish@ucbvax.berkeley.edu
Usenet: ucbvax!mtxinu!excelan!avnish

Distribution of this document is unlimited.

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The following individuals have contributed to the development of this RFC:

Avnish Aggarwal	Arvind Agrawal	Lorenzo Aguilar
Geoffrey Arnold	Karl Auerbach	K. Ramesh Babu
Keith Ball	Amatzia Ben-Artzi	Vint Cerf
Richard Cherry	David Crocker	Steve Deering
Greg Ennis	Steve Holmgren	Jay Israel
David Kaufman	Lee LaBarre	James Lau
Dan Lynch	Gaylord Miyata	David Stevens
Steve Thomas	Ishan Wu	

The system proposed by this RFC does not reflect any existing Netbios-over-TCP implementation. However, the design incorporates considerable knowledge obtained from prior implementations. Special thanks goes to the following organizations which have provided this invaluable information:

CMC/Syros Excelan Sytek Ungermann-Bass

3. INTRODUCTION

This RFC describes the ideas and general methods used to provide NetBIOS on a TCP and UDP foundation. A companion RFC, "Protocol Standard For a NetBIOS Service on a TCP/UDP Transport: Detailed Specifications"[1] contains detailed descriptions of packet formats, protocols, and defined constants and variables.

The NetBIOS service has become the dominant mechanism for personal computer networking. NetBIOS provides a vendor independent interface for the IBM Personal Computer (PC) and compatible systems.

NetBIOS defines a software interface not a protocol. There is no "official" NetBIOS service standard. In practice, however, the IBM PC-Network version is used as a reference. That version is described in the IBM document 6322916, "Technical Reference PC Network"[2].

Protocols supporting NetBIOS services have been constructed on diverse protocol and hardware foundations. Even when the same foundation is used, different implementations may not be able to interoperate unless they use a common protocol. To allow NetBIOS interoperation in the Internet, this RFC defines a standard protocol to support NetBIOS services using TCP and UDP.

NetBIOS has generally been confined to personal computers to date. However, since larger computers are often well suited to run certain NetBIOS applications, such as file servers, this specification has been designed to allow an implementation to be built on virtually any type of system where the TCP/IP protocol suite is available.

This standard defines a set of protocols to support NetBIOS services.

These protocols are more than a simple communications service involving two entities. Rather, this note describes a distributed system in which many entities play a part even if they are not involved as an end-point of a particular NetBIOS connection.

This standard neither constrains nor determines how those services are presented to application programs.

Nevertheless, it is expected that on computers operating under the PC-DOS and MS-DOS operating systems that the existing NetBIOS interface will be preserved by implementors.

NOTE: Various symbolic values are used in this document. For their definitions, refer to the Detailed Specifications[1].

4. DESIGN PRINCIPLES

In order to develop the specification the following design principles were adopted to guide the effort. Most are typical to any protocol standardization effort; however, some have been assigned priorities that may be considered unusual.

4.1. PRESERVE NetBIOS SERVICES

In the absence of an "official" standard for NetBIOS services, the version found in the IBM PC Network Technical Reference[2] is used.

NetBIOS is the foundation of a large body of existing applications. It is desirable to operate these applications on TCP networks and to extend them beyond personal computers into larger hosts. To support these applications, NetBIOS on TCP must closely conform to the services offered by existing NetBIOS systems.

IBM PC-Network NetBIOS contains some implementation specific characteristics. This standard does not attempt to completely preserve these. It is certain that some existing software requires these characteristics and will fail to operate correctly on a NetBIOS service based on this RFC.

4.2. USE EXISTING STANDARDS

Protocol development, especially with standardization, is a demanding process. The development of new protocols must be minimized.

It is considered essential that an existing standard which provides the necessary functionality with reasonable performance always be chosen in preference to developing a new protocol.

When a standard protocol is used, it must be unmodified.

4.3. MINIMIZE OPTIONS

The standard for NetBIOS on TCP should contain few, if any, options.

Where options are included, the options should be designed so that devices with different option selections should interoperate.

4.4. TOLERATE ERRORS AND DISRUPTIONS

NetBIOS networks typically operate in an uncontrolled environment. Computers come on-line at arbitrary times. Computers usually go off-line without any notice to their peers. The software is often operated by users who are unfamiliar with networks and who may randomly perturb configuration settings.

Despite this chaos, NetBIOS networks work. NetBIOS on TCP must also

be able to operate well in this environment.

Robust operation does not necessarily mean that the network is proof against all disruptions. A typical NetBIOS network may be disrupted by certain types of behavior, whether inadvertent or malicious.

4.5. DO NOT REQUIRE CENTRAL MANAGEMENT

NetBIOS on TCP should be able to operate, if desired, without centralized management beyond that typically required by a TCP based network.

4.6. ALLOW INTERNET OPERATION

The proposed standard recognizes the need for NetBIOS operation across a set of networks interconnected by network (IP) level relays (gateways.)

However, the standard assumes that this form of operation will be less frequent than on the local MAC bridged-LAN.

4.7. MINIMIZE BROADCAST ACTIVITY

The standard pre-supposes that the only broadcast services are those supported by UDP. Multicast capabilities are not assumed to be available in any form.

Despite the availability of broadcast capabilities, the standard recognizes that some administrations may wish to avoid heavy broadcast activity. For example, an administration may wish to avoid isolated non-participating hosts from the burden of receiving and discarding NetBIOS broadcasts.

4.8. PERMIT IMPLEMENTATION ON EXISTING SYSTEMS

The NetBIOS on TCP protocol should be implementable on common operating systems, such as Unix(tm) and VAX/VMS(tm), without massive effort.

The NetBIOS protocols should not require services typically unavailable on presently existing TCP/UDP/IP implementations.

4.9. REQUIRE ONLY THE MINIMUM NECESSARY TO OPERATE

The protocol definition should specify only the minimal set of protocols required for interoperation. However, additional protocol elements may be defined to enhance efficiency. These latter elements may be generated at the option of the sender, although they must be accepted by all receivers.

4.10. MAXIMIZE EFFICIENCY

To be useful, a protocol must conduct its business quickly.

4.11. MINIMIZE NEW INVENTIONS

When an existing protocol is not quite able to support a necessary function, but with a small amount of change, it could, that protocol should be used. This is felt to be easier to achieve than development of new protocols; further, it is likely to have more general utility for the Internet.

5. OVERVIEW OF NetBIOS

This section describes the NetBIOS services. It is for background information only. The reader may chose to skip to the next section.

NetBIOS was designed for use by groups of PCs, sharing a broadcast medium. Both connection (Session) and connectionless (Datagram) services are provided, and broadcast and multicast are supported. Participants are identified by name. Assignment of names is distributed and highly dynamic.

NetBIOS applications employ NetBIOS mechanisms to locate resources, establish connections, send and receive data with an application peer, and terminate connections. For purposes of discussion, these mechanisms will collectively be called the NetBIOS Service.

This service can be implemented in many different ways. One of the first implementations was for personal computers running the PC-DOS and MS-DOS operating systems. It is possible to implement NetBIOS within other operating systems, or as processes which are, themselves, simply application programs as far as the host operating system is concerned.

The NetBIOS specification, published by IBM as "Technical Reference PC Network"[2] defines the interface and services available to the NetBIOS user. The protocols outlined by that document pertain only to the IBM PC Network and are not generally applicable to other networks.

5.1. INTERFACE TO APPLICATION PROGRAMS

NetBIOS on personal computers includes both a set of services and an exact program interface to those services. NetBIOS on other computer systems may present the NetBIOS services to programs using other interfaces. Except on personal computers, no clear standard for a NetBIOS software interface has emerged.

5.2. NAME SERVICE

NetBIOS resources are referenced by name. Lower-level address information is not available to NetBIOS applications. An application, representing a resource, registers one or more names that it wishes to use.

The name space is flat and uses sixteen alphanumeric characters. Names may not start with an asterisk (*).

Registration is a bid for use of a name. The bid may be for exclusive (unique) or shared (group) ownership. Each application contends with the other applications in real time. Implicit permission is granted to a station when it receives no objections. That is, a bid is made and the application waits for a period of time. If no objections are received, the station assumes that it has permission.

A unique name should be held by only one station at a time. However, duplicates ("name conflicts") may arise due to errors.

All instances of a group name are equivalent.

An application referencing a name generally does not know (or care) whether the name is registered as a unique or a group name.

An explicit name deletion function is specified, so that applications may remove a name. Implicit name deletion occurs when a station ceases operation. In the case of personal computers, implicit name deletion is a frequent occurrence.

The Name Service primitives are:

1) Add Name

   The requesting application wants exclusive use of the name.

2) Add Group Name

   The requesting application is willing to share use of the name with other applications.

3) Delete Name

   The application no longer requires use of the name. It is important to note that typical use of NetBIOS is among independently-operated personal computers. A common way to stop using a PC is to turn it off; in this case, the graceful give-back mechanism, provided by the Delete Name function, is not used. Because this occurs frequently, the network service must support this behavior.

5.3. SESSION SERVICE

A session is a reliable message exchange, conducted between a pair of NetBIOS applications. Sessions are full-duplex, sequenced, and reliable. Data is organized into messages. Each message may range in size from 0 to 131,071 bytes. No expedited or urgent data capabilities are present.

Multiple sessions may exist between any pair of calling and called names.

The parties to a connection have access to the calling and called names.

The NetBIOS specification does not define how a connection request to a shared (group) name resolves into a session. The usual assumption is that a session may be established with any one owner of the called group name.

An important service provided to NetBIOS applications is the detection of sessions failure. The loss of a session is reported to an application via all of the outstanding service requests for that session. For example, if the application has only a NetBIOS receive primitive pending and the session terminates, the pending receive will abort with a termination indication.

Session Service primitives are:

1) Call

   Initiate a session with a process that is listening under the specified name. The calling entity must indicate both a calling name (properly registered to the caller) and a called name.

2) Listen

   Accept a session from a caller. The listen primitive may be constrained to accept an incoming call from a named caller. Alternatively, a call may be accepted from any caller.

3) Hang Up

   Gracefully terminate a session. All pending data is transferred before the session is terminated.

4) Send

   Transmit one message. A time-out can occur. A time-out of any session send forces the non-graceful termination of the session.

A "chain send" primitive is required by the PC NetBIOS software interface to allow a single message to be gathered from pieces in various buffers. Chain Send is an interface detail and does not effect the protocol.

5) Receive

Receive data. A time-out can occur. A time-out on a session receive only terminates the receive, not the session, although the data is lost.

The receive primitive may be implemented with variants, such as "Receive Any", which is required by the PC NetBIOS software interface. Receive Any is an interface detail and does not effect the protocol.

6) Session Status

Obtain information about all of the requestor's sessions, under the specified name. No network activity is involved.

5.4. DATAGRAM SERVICE

The Datagram service is an unreliable, non-sequenced, connectionless service. Datagrams are sent under cover of a name properly registered to the sender.

Datagrams may be sent to a specific name or may be explicitly broadcast.

Datagrams sent to an exclusive name are received, if at all, by the holder of that name. Datagrams sent to a group name are multicast to all holders of that name. The sending application program cannot distinguish between group and unique names and thus must act as if all non-broadcast datagrams are multicast.

As with the Session Service, the receiver of the datagram is told the sending and receiving names.

Datagram Service primitives are:

1) Send Datagram

Send an unreliable datagram to an application that is associated with the specified name. The name may be unique or group; the sender is not aware of the difference. If the name belongs to a group, then each member is to receive the datagram.

2) Send Broadcast Datagram

Send an unreliable datagram to any application with a Receive Broadcast Datagram posted.

3) Receive Datagram

Receive a datagram sent by a specified originating name to the specified name. If the originating name is an asterisk, then the datagram may have been originated under any name.

Note: An arriving datagram will be delivered to all pending Receiving Datagrams that have source and destination specifications matching those of the datagram. In other words, if a program (or group of programs) issue a series of identical Receive Datagrams, one datagram will cause the entire series to complete.

4) Receive Broadcast Datagram

Receive a datagram sent as a broadcast.

If there are multiple pending Receive Broadcast Datagram operations pending, all will be satisfied by the same received datagram.

5.5. MISCELLANEOUS FUNCTIONS

The following functions are present to control the operation of the hardware interface to the network. These functions are generally implementation dependent.

1) Reset

Initialize the local network adapter.

2) Cancel

Abort a pending NetBIOS request. The successful cancel of a Send (or Chain Send) operation will terminate the associated session.

3) Adapter Status

Obtain information about the local network adapter or of a remote adapter.

4) Unlink

For use with Remote Program Load (RPL). Unlink redirects the PC boot disk device back to the local disk. See the

NetBIOS specification for further details concerning RPL and the Unlink operation (see page 2-35 in [2]).

5) Remote Program Load

Remote Program Load (RPL) is not a NetBIOS function. It is a NetBIOS application defined by IBM in their NetBIOS specification (see pages 2-80 through 2-82 in [2]).

5.6. NON-STANDARD EXTENSIONS

The IBM Token Ring implementation of NetBIOS has added at least one new user capability:

1) Find Name

This function determines whether a given name has been registered on the network.

6. NetBIOS FACILITIES SUPPORTED BY THIS STANDARD

The protocol specified by this standard permits an implementer to provide all of the NetBIOS services as described in the IBM "Technical Reference PC Network"[2].

The following NetBIOS facilities are outside the scope of this specification. These are local implementation matters and do not impact interoperability:

- RESET
- SESSION STATUS
- UNLINK
- RPL (Remote Program Load)

7. REQUIRED SUPPORTING SERVICE INTERFACES AND DEFINITIONS

The protocols described in this RFC require service interfaces to the following:

- TCP[3,4]
- UDP[5]

Byte ordering, addressing conventions (including addresses to be used for broadcasts and multicasts) are defined by the most recent version of:

- Assigned Numbers[6]

Additional definitions and constraints are in:

- IP[7]
- Internet Subnets[8,9,10]

8. RELATED PROTOCOLS AND SERVICES

The design of the protocols described in this RFC allow for the future incorporation of the following protocols and services. However, before this may occur, certain extensions may be required to the protocols defined in this RFC or to those listed below.

- Domain Name Service[11,12,13,14]
- Internet Group Multicast[15,16]

9. NetBIOS SCOPE

A "NetBIOS Scope" is the population of computers across which a registered NetBIOS name is known. NetBIOS broadcast and multicast datagram operations must reach the entire extent of the NetBIOS scope.

An internet may support multiple, non-intersecting NetBIOS Scopes.

Each NetBIOS scope has a "scope identifier". This identifier is a character string meeting the requirements of the domain name system for domain names.

NOTE: Each implementation of NetBIOS-over-TCP must provide mechanisms to manage the scope identifier(s) to be used.

Control of scope identifiers implies a requirement for additional NetBIOS interface capabilities. These may be provided through extensions of the user service interface or other means (such as node configuration parameters.) The nature of these extensions is not part of this specification.

10. NetBIOS END-NODES

End-nodes support NetBIOS service interfaces and contain applications.

Three types of end-nodes are part of this standard:

- Broadcast ("B") nodes
- Point-to-point ("P") nodes
- Mixed mode ("M") nodes

An IP address may be associated with only one instance of one of the above types.

Without having preloaded name-to-address tables, NetBIOS participants

are faced with the task of dynamically resolving references to one another. This can be accomplished with broadcast or mediated point-to-point communications.

B nodes use local network broadcasting to effect a rendezvous with one or more recipients. P and M nodes use the NetBIOS Name Server (NBNS) and the NetBIOS Datagram Distribution Server (NBDD) for this same purpose.

End-nodes may be combined in various topologies. No matter how combined, the operation of the B, P, and M nodes is not altered.

NOTE: It is recommended that the administration of a NetBIOS scope avoid using both M and B nodes within the same scope. A NetBIOS scope should contain only B nodes or only P and M nodes.

10.1. BROADCAST (B) NODES

Broadcast (or "B") nodes communicate using a mix of UDP datagrams (both broadcast and directed) and TCP connections. B nodes may freely interoperate with one another within a broadcast area. A broadcast area is a single MAC-bridged "B-LAN". (See Appendix A for a discussion of using Internet Group Multicasting as a means to extend a broadcast area beyond a single B-LAN.)

10.2. POINT-TO-POINT (P) NODES

Point-to-point (or "P") nodes communicate using only directed UDP datagrams and TCP sessions. P nodes neither generate nor listen for broadcast UDP packets. P nodes do, however, offer NetBIOS level broadcast and multicast services using capabilities provided by the NBNS and NBDD.

P nodes rely on NetBIOS name and datagram distribution servers. These servers may be local or remote; P nodes operate the same in either case.

10.3. MIXED MODE (M) NODES

Mixed mode nodes (or "M") nodes are P nodes which have been given certain B node characteristics. M nodes use both broadcast and unicast. Broadcast is used to improve response time using the assumption that most resources reside on the local broadcast medium rather than somewhere in an internet.

M nodes rely upon NBNS and NBDD servers. However, M nodes may continue limited operation should these servers be temporarily unavailable.

11. NetBIOS SUPPORT SERVERS

Two types of support servers are part of this standard:

- NetBIOS name server ("NBNS") nodes
- Netbios datagram distribution ("NBDD") nodes

NBNS and NBDD nodes are invisible to NetBIOS applications and are part of the underlying NetBIOS mechanism.

NetBIOS name and datagram distribution servers are the focus of name and datagram activity for P and M nodes.

Both the name (NBNS) and datagram distribution (NBDD) servers are permitted to shift part of their operation to the P or M end-node which is requesting a service.

Since the assignment of responsibility is dynamic, and since P and M nodes must be prepared to operate should the NetBIOS server delegate control to the maximum extent, the system naturally accommodates improvements in NetBIOS server function. For example, as Internet Group Multicasting becomes more widespread, new NBDD implementations may elect to assume full responsibility for NetBIOS datagram distribution.

Interoperability between different implementations is assured by imposing requirements on end-node implementations that they be able to accept the full range of legal responses from the NBNS or NBDD.

11.1. NetBIOS NAME SERVER (NBNS) NODES

The NBNS is designed to allow considerable flexibility with its degree of responsibility for the accuracy and management of NetBIOS names. On one hand, the NBNS may elect not to accept full responsibility, leaving the NBNS essentially a "bulletin board" on which name/address information is freely posted (and removed) by P and M nodes without validation by the NBNS. Alternatively, the NBNS may elect to completely manage and validate names. The degree of responsibility that the NBNS assumes is asserted by the NBNS each time a name is claimed through a simple mechanism. Should the NBNS not assert full control, the NBNS returns enough information to the requesting node so that the node may challenge any putative holder of the name.

This ability to shift responsibility for NetBIOS name management between the NBNS and the P and M nodes allows a network administrator (or vendor) to make a tradeoff between NBNS simplicity, security, and delay characteristics.

A single NBNS may be implemented as a distributed entity, such as the Domain Name Service. However, this RFC does not attempt to define

the internal communications which would be used.

11.1.1. RELATIONSHIP OF THE NBNS TO THE DOMAIN NAME SYSTEM

The NBNS design attempts to align itself with the Domain Name System in a number of ways.

First, the NetBIOS names are encoded in a form acceptable to the domain name system.

Second, a scope identifier is appended to each NetBIOS name. This identifier meets the restricted character set of the domain system and has a leading period. This makes the NetBIOS name, in conjunction with its scope identifier, a valid domain system name.

Third, the negotiated responsibility mechanisms permit the NBNS to be used as a simple bulletin board on which are posted (name,address) pairs. This parallels the existing domain sytem query service.

This RFC, however, requires the NBNS to provide services beyond those provided by the current domain name system. An attempt has been made to coalesce all the additional services which are required into a set of transactions which follow domain name system styles of interaction and packet formats.

Among the areas in which the domain name service must be extended before it may be used as an NBNS are:

- Dynamic addition of entries
- Dynamic update of entry data
- Support for multiple instance (group) entries
- Support for entry time-to-live values and ability to accept refresh messages to restart the time-to-live period
- New entry attributes

11.2. NetBIOS DATAGRAM DISTRIBUTION SERVER (NBDD) NODES

The internet does not yet support broadcasting or multicasting. The NBDD extends NetBIOS datagram distribution service to this environment.

The NBDD may elect to complete, partially complete, or totally refuse to service a node's request to distribute a NetBIOS datagram. An end-node may query an NBDD to determine whether the NBDD will deliver a datagram to a specific NetBIOS name.

The design of NetBIOS-over-TCP lends itself to the use of Internet Group Multicast. For details see Appendix A.

11.3. RELATIONSHIP OF NBNS AND NBDD NODES

This RFC defines the NBNS and NBDD as distinct, separate entities.

In the absence of NetBIOS name information, a NetBIOS datagram distribution server must send a copy to each end-node within a NetBIOS scope.

An implementer may elect to construct NBNS and NBDD nodes which have a private protocol for the exchange of NetBIOS name information. Alternatively, an NBNS and NBDD may be implemented within the same device.

NOTE: Implementations containing private NBNS-NBDD protocols or combined NBNS-NBDD functions must be clearly identified.

11.4. RELATIONSHIP OF NetBIOS SUPPORT SERVERS AND B NODES

As defined in this RFC, neither NBNS nor NBDD nodes interact with B nodes. NetBIOS servers do not listen to broadcast traffic on any broadcast area to which they may be attached. Nor are the NetBIOS support servers even aware of B node activities or names claimed or used by B nodes.

It may be possible to extend both the NBNS and NBDD so that they participate in B node activities and act as a bridge to P and M nodes. However, such extensions are beyond the scope of this specification.

12. TOPOLOGIES

B, P, M, NBNS, and NBDD nodes may be combined in various ways to form useful NetBIOS environments. This section describes some of these combinations.

There are three classes of operation:

- Class 0: B nodes only.
- Class 1: P nodes only.
- Class 2: P and M nodes together.

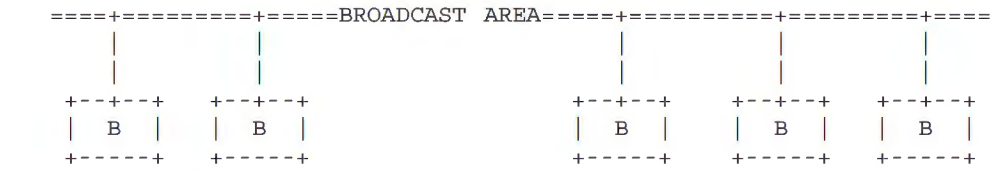
In the drawings which follow, any P node may be replaced by an M node. The effects of such replacement will be mentioned in conjunction with each example below.

12.1. LOCAL

A NetBIOS scope is operating locally when all entities are within the same broadcast area.

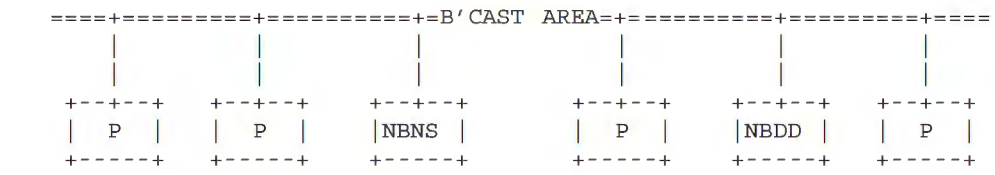
12.1.1. B NODES ONLY

Local operation with only B nodes is the most basic mode of operation. Name registration and discovery procedures use broadcast mechanisms. The NetBIOS scope is limited by the extent of the broadcast area. This configuration does not require NetBIOS support servers.



12.1.2. P NODES ONLY

This configuration would typically be used when the network administrator desires to eliminate NetBIOS as a source of broadcast activity.



This configuration operates the same as if it were in an internet and is cited here only due to its convenience as a means to reduce the use of broadcast.

Replacement of one or more of the P nodes with M nodes will not affect the operation of the other P and M nodes. P and M nodes will be able to interact with one another. Because M nodes use broadcast, overall broadcast activity will increase.

12.1.3. MIXED B AND P NODES

B and P nodes do not interact with one another. Replacement of P nodes with M nodes will allow B's and M's to interact.

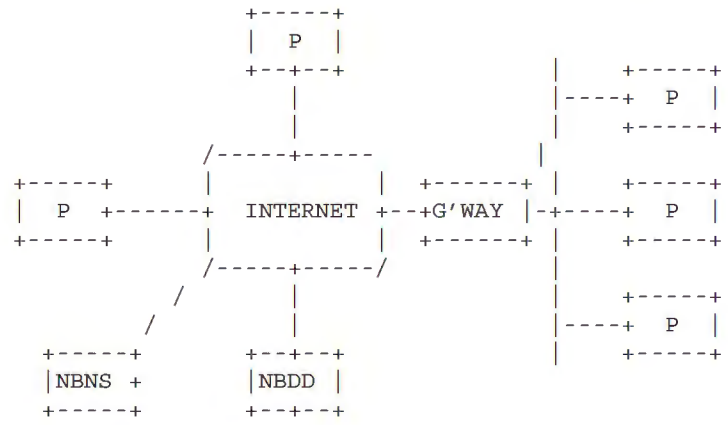
NOTE: B nodes and M nodes may be intermixed only on a local broadcast area. B and M nodes should not be intermixed in an internet environment.

12.2. INTERNET

12.2.1. P NODES ONLY

P nodes may be scattered at various locations in an internetwork. They require both an NBNS and an NBDD for NetBIOS name and datagram support, respectively.

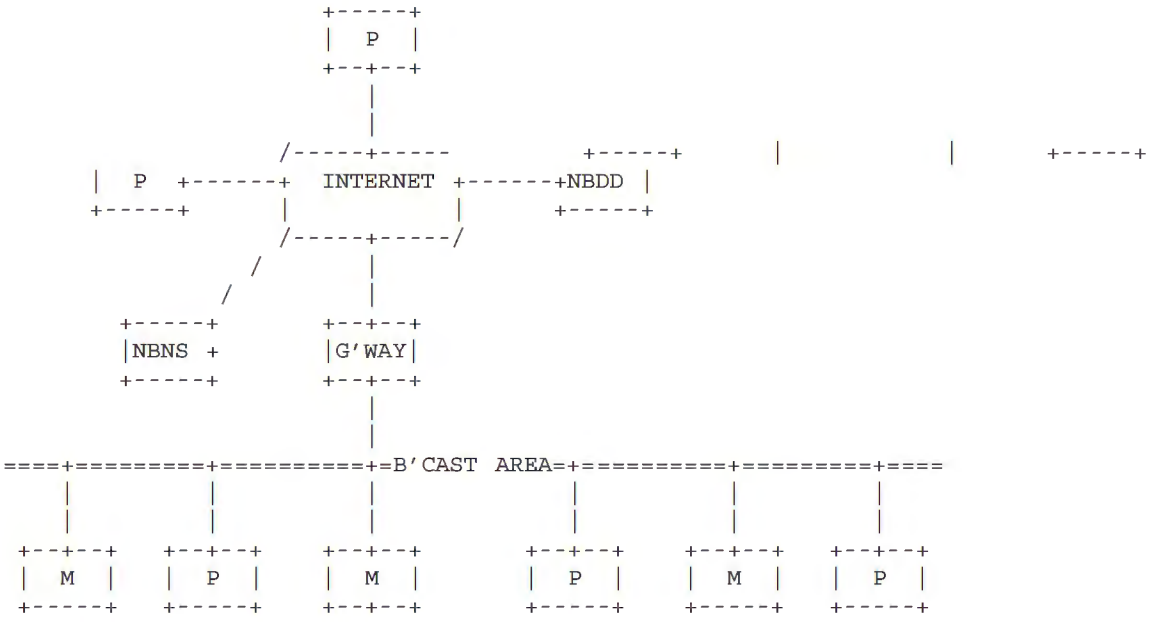
The NetBIOS scope is determined by the NetBIOS scope identifier (domain name) used by the various P (and M) nodes. An internet may contain numerous NetBIOS scopes.



Any P node may be replaced by an M node with no loss of function to any node. However, broadcast activity will be increased in the broadcast area to which the M node is attached.

12.2.2. MIXED M AND P NODES

M and P nodes may be mixed. When locating NetBIOS names, M nodes will tend to find names held by other M nodes on the same common broadcast area in preference to names held by P nodes or M nodes elsewhere in the network.



NOTE: B and M nodes should not be intermixed in an internet environment. Doing so would allow undetected NetBIOS name conflicts to arise and cause unpredictable behavior.

13. GENERAL METHODS

Overlying the specific protocols, described later, are a few general methods of interaction between entities.

13.1. REQUEST/RESPONSE INTERACTION STYLE

Most interactions between entities consist of a request flowing in one direction and a subsequent response flowing in the opposite direction.

In those situations where interactions occur on unreliable transports (i.e. UDP) or when a request is broadcast, there may not be a strict interlocking or one-to-one relationship between requests and responses.

In no case, however, is more than one response generated for a received request. While a response is pending the responding entity may send one or more wait acknowledgements.

13.1.1. RETRANSMISSION OF REQUESTS

UDP is an unreliable delivery mechanism where packets can be lost, received out of transmit sequence, duplicated and delivery can be significantly delayed. Since the NetBIOS protocols make heavy use of UDP, they have compensated for its unreliability with extra mechanisms.

Each NetBIOS packet contains all the necessary information to process it. None of the protocols use multiple UDP packets to convey a single request or response. If more information is required than will fit in a single UDP packet, for example, when a P-type node wants all the owners of a group name from a NetBIOS server, a TCP connection is used. Consequently, the NetBIOS protocols will not fail because of out of sequence delivery of UDP packets.

To overcome the loss of a request or response packet, each request operation will retransmit the request if a response is not received within a specified time limit.

Protocol operations sensitive to successive response packets, such as name conflict detection, are protected from duplicated packets because they ignore successive packets with the same NetBIOS information. Since no state on the responder's node is associated with a request, the responder just sends the appropriate response whenever a request packet arrives. Consequently, duplicate or delayed request packets have no impact.

For all requests, if a response packet is delayed too long another request packet will be transmitted. A second response packet being sent in response to the second request packet is equivalent to a duplicate packet. Therefore, the protocols will ignore the second packet received. If the delivery of a response is delayed until after the request operation has been completed, successfully or not, the response packet is ignored.

13.1.2. REQUESTS WITHOUT RESPONSES: DEMANDS

Some request types do not have matching responses. These requests are known as "demands". In general a "demand" is an imperative request; the receiving node is expected to obey. However, because demands are unconfirmed, they are used only in situations where, at most, limited damage would occur if the demand packet should be lost.

Demand packets are not retransmitted.

13.2. TRANSACTIONS

Interactions between a pair of entities are grouped into "transactions". These transactions comprise one or more request/response pairs.

13.2.1. TRANSACTION ID

Since multiple simultaneous transactions may be in progress between a pair of entities a "transaction id" is used.

The originator of a transaction selects an ID unique to the originator. The transaction id is reflected back and forth in each interaction within the transaction. The transaction partners must match responses and requests by comparison of the transaction ID and the IP address of the transaction partner. If no matching request can be found the response must be discarded.

A new transaction ID should be used for each transaction. A simple 16 bit transaction counter ought to be an adequate id generator. It is probably not necessary to search the space of outstanding transaction ID to filter duplicates: it is extremely unlikely that any transaction will have a lifetime that is more than a small fraction of the typical counter cycle period. Use of the IP addresses in conjunction with the transaction ID further reduces the possibility of damage should transaction IDs be prematurely re-used.

13.3. TCP AND UDP FOUNDATIONS

This version of the NetBIOS-over-TCP protocols uses UDP for many interactions. In the future this RFC may be extended to permit such interactions to occur over TCP connections (perhaps to increase efficiency when multiple interactions occur within a short time or when NetBIOS datagram traffic reveals that an application is using NetBIOS datagrams to support connection- oriented service.)

14. REPRESENTATION OF NETBIOS NAMES

NetBIOS names as seen across the client interface to NetBIOS are exactly 16 bytes long. Within the NetBIOS-over-TCP protocols, a longer representation is used.

There are two levels of encoding. The first level maps a NetBIOS name into a domain system name. The second level maps the domain system name into the "compressed" representation required for interaction with the domain name system.

Except in one packet, the second level representation is the only NetBIOS name representation used in NetBIOS-over-TCP packet formats. The exception is the RDATA field of a NODE STATUS RESPONSE packet.

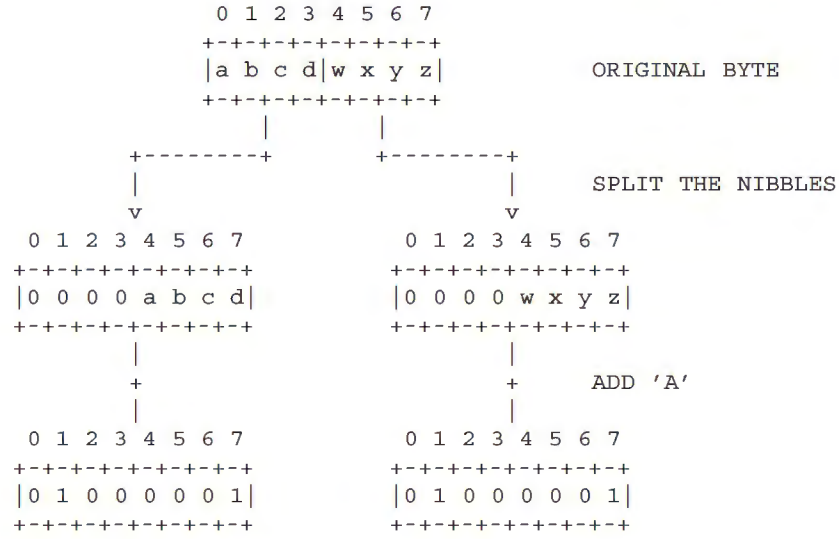
14.1. FIRST LEVEL ENCODING

The first level representation consists of two parts:

- NetBIOS name
- NetBIOS scope identifier

The 16 byte NetBIOS name is mapped into a 32 byte wide field using a reversible, half-ASCII, biased encoding. Each half-octet of the NetBIOS name is encoded into one byte of the 32 byte field. The first half octet is encoded into the first byte, the second half-octet into the second byte, etc.

Each 4-bit, half-octet of the NetBIOS name is treated as an 8-bit, right-adjusted, zero-filled binary number. This number is added to value of the ASCII character 'A' (hexidecimal 41). The resulting 8-bit number is stored in the appropriate byte. The following diagram demonstrates this procedure:



This encoding results in a NetBIOS name being represented as a sequence of 32 ASCII, upper-case characters from the set {A,B,C...N,O,P}.

The NetBIOS scope identifier is a valid domain name (without a leading dot).

An ASCII dot (2E hexidecimal) and the scope identifier are appended to the encoded form of the NetBIOS name, the result forming a valid domain name.

For example, the NetBIOS name "The NetBIOS name" in the NetBIOS scope "SCOPE.ID.COM" would be represented at level one by the ASCII character string:

FEGHGFCAEOGFHEECEJEPFDCAHEGBGNGF.SCOPE.ID.COM

14.2. SECOND LEVEL ENCODING

The first level encoding must be reduced to second level encoding. This is performed according to the rules defined in on page 31 of RFC 883[12] in the section on "Domain name representation and compression". Also see the section titled "Name Formats" in the Detailed Specifications[1].

15. NetBIOS NAME SERVICE

Before a name may be used, the name must be registered by a node. Once acquired, the name must be defended against inconsistent registration by other nodes. Before building a NetBIOS session or sending a NetBIOS datagram, the one or more holders of the name must be located.

The NetBIOS name service is the collection of procedures through which nodes acquire, defend, and locate the holders of NetBIOS names.

The name service procedures are different depending whether the end-node is of type B, P, or M.

15.1. OVERVIEW OF NetBIOS NAME SERVICE

15.1.1. NAME REGISTRATION (CLAIM)

Each NetBIOS node can own more than one name. Names are acquired dynamically through the registration (name claim) procedures.

Every node has a permanent unique name. This name, like any other name, must be explicitly registered by all end-node types.

A name can be unique (exclusive) or group (non-exclusive). A unique name may be owned by a single node; a group name may be owned by any number of nodes. A name ceases to exist when it is not owned by at least one node. There is no intrinsic quality of a name which determines its characteristics: these are established at the time of registration.

Each node maintains state information for each name it has registered. This information includes:

- Whether the name is a group or unique name
- Whether the name is "in conflict"
- Whether the name is in the process of being deleted

B nodes perform name registration by broadcasting claim requests, soliciting a defense from any node already holding the name.

P nodes perform name registration through the agency of the NBNS.

M nodes register names through an initial broadcast, like B nodes, then, in the absence of an objection, by following the same procedures as a P node. In other words, the broadcast action may terminate the attempt, but is not sufficient to confirm the registration.

15.1.2. NAME QUERY (DISCOVERY)

Name query (also known as "resolution" or "discovery") is the procedure by which the IP address(es) associated with a NetBIOS name are discovered. Name query is required during the following operations:

During session establishment, calling and called names must be specified. The calling name must exist on the node that posts the CALL. The called name must exist on a node that has previously posted a LISTEN. Either name may be a unique or group name.

When a directed datagram is sent, a source and destination name must be specified. If the destination name is a group name, a datagram is sent to all the members of that group.

Different end-node types perform name resolution using different techniques, but using the same packet formats:

- B nodes solicit name information by broadcasting a request.
- P nodes ask the NBNS.
- M nodes broadcast a request. If that does not provide the desired information, an inquiry is sent to the NBNS.

15.1.3. NAME RELEASE

NetBIOS names may be released explicitly or silently by an end- node. Silent release typically occurs when an end-node fails or is turned-off. Most of the mechanisms described below are present to detect silent name release.

15.1.3.1. EXPLICIT RELEASE

B nodes explicitly release a name by broadcasting a notice.

P nodes send a notification to their NBNS.

M nodes both broadcast a notice and inform their supporting NBNS.

15.1.3.2. NAME LIFETIME AND REFRESH

Names held by an NBNS are given a lifetime during name registration. The NBNS will consider a name to have been silently released if the end-node fails to send a name refresh message to the NBNS before the lifetime expires. A refresh restarts the lifetime clock.

NOTE: The implementor should be aware of the tradeoff between accuracy of the database and the internet overhead that the refresh mechanism introduces. The lifetime period should be tuned accordingly.

For group names, each end-node must send refresh messages. A node that fails to do so will be considered to have silently released the name and dropped from the group.

The lifetime period is established through a simple negotiation mechanism during name registration: In the name registration request, the end-node proposes a lifetime value or requests an infinite lifetime. The NBNS places an actual lifetime value into the name registration response. The NBNS is always allowed to respond with an infinite actual period. If the end node proposed an infinite lifetime, the NBNS may respond with any definite period. If the end node proposed a definite period, the NBNS may respond with any definite period greater than or equal to that proposed.

This negotiation of refresh times gives the NBNS means to disable or enable refresh activity. The end-nodes may set a minimum refresh cycle period.

NBNS implementations which are completely reliable may disable refresh.

15.1.3.3. NAME CHALLENGE

To detect whether a node has silently released its claim to a name, it is necessary on occasion to challenge that node's current ownership. If the node defends the name then the node is allowed to continue possession. Otherwise it is assumed that the node has released the name.

A name challenge may be issued by an NBNS or by a P or M node. A challenge may be directed towards any end-node type: B, P, or M.

15.1.3.4. GROUP NAME FADE-OUT

NetBIOS groups may contain an arbitrarily large number of members. The time to challenge all members could be quite large.

To avoid long delays when names are claimed through an NBNS, an

optimistic heuristic has been adopted. It is assumed that there will always be some node which will defend a group name. Consequently, it is recommended that the NBNS will immediately reject a claim request for a unique name when there already exists a group with the same name. The NBNS will never return an IP address (in response to a NAME REGISTRATION REQUEST) when a group name exists.

An NBNS will consider a group to have faded out of existence when the last remaining member fails to send a timely refresh message or explicitly releases the name.

15.1.3.5. NAME CONFLICT

Name conflict exists when a unique name has been claimed by more than one node on a NetBIOS network. B, M, and NBNS nodes may detect a name conflict. The detection mechanism used by B and M nodes is active only during name discovery. The NBNS may detect conflict at any time it verifies the consistency of its name database.

B and M nodes detect conflict by examining the responses received in answer to a broadcast name query request. The first response is taken as authoritative. Any subsequent, inconsistent responses represent conflicts.

Subsequent responses are inconsistent with the authoritative response when:

```
     The subsequent response has the same transaction ID as the
     NAME QUERY REQUEST.
  AND
     The subsequent response is not a duplicate of the
     authoritative response.
  AND EITHER:
          The group/unique characteristic of the authoritative
          response is "unique".
        OR
          The group/unique characteristic of the subsequent
          response is "unique".
```

The period in which B and M nodes examine responses is limited by a conflict timer, CONFLICT_TIMER. The accuracy or duration of this timer is not crucial: the NetBIOS system will continue to operate even with persistent name conflicts.

Conflict conditions are signaled by sending a NAME CONFLICT DEMAND to the node owning the offending name. Nothing is sent to the node which originated the authoritative response.

Any end-node that receives NAME CONFLICT DEMAND is required to update its "local name table" to reflect that the name is in conflict. (The "local name table" on each node contains names that have been

successfully registered by that node.)

Notice that only those nodes that receive the name conflict message place a conflict mark next to a name.

Logically, a marked name does not exist on that node. This means that the node should not defend the name (for name claim purposes), should not respond to a name discovery requests for that name, nor should the node send name refresh messages for that name. Furthermore, it can no longer be used by that node for any session establishment or sending or receiving datagrams. Existing sessions are not affected at the time a name is marked as being in conflict.

The only valid user function against a marked name is DELETE NAME. Any other user NetBIOS function returns immediately with an error code of "NAME CONFLICT".

15.1.4. ADAPTER STATUS

An end-node or the NBNS may ask any other end-node for a collection of information about the NetBIOS status of that node. This status consists of, among other things, a list of the names which the node believes it owns. The returned status is filtered to contain only those names which have the same NetBIOS scope identifier as the requestor's name.

When requesting node status, the requestor identifies the target node by NetBIOS name A name query transaction may be necessary to acquire the IP address for the name. Locally cached name information may be used in lieu of a query transaction. The requesting node sends a NODE STATUS REQUEST. In response, the receiving node sends a NODE STATUS RESPONSE containing its local name table and various statistics.

The amount of status which may be returned is limited by the size of a UDP packet. However, this is sufficient for the typical NODE STATUS RESPONSE packet.

15.1.5. END-NODE NBNS INTERACTION

There are certain characteristics of end-node to NBNS interactions which are in common and are independent of any particular transaction type.

15.1.5.1. UDP, TCP, AND TRUNCATION

For all transactions between an end-node and an NBNS, either UDP or TCP may be used as a transport. If the NBNS receives a UDP based request, it will respond using UDP. If the amount of information exceeds what fits into a UDP packet, the response will contain a "truncation flag". In this situation, the end- node may open a TCP

connection to the NBNS, repeat the request, and receive a complete, untruncated response.

15.1.5.2. NBNS WACK

While a name service request is in progress, the NBNS may issue a WAIT FOR ACKNOWLEDGEMENT RESPONSE (WACK) to assure the client end-node that the NBNS is still operational and is working on the request.

15.1.5.3. NBNS REDIRECTION

The NBNS, because it follows Domain Name system styles of interaction, is permitted to redirect a client to another NBNS.

15.1.6. SECURED VERSUS NON-SECURED NBNS

An NBNS may be implemented in either of two general ways: The NBNS may monitor, and participate in, name activity to ensure consistency. This would be a "secured" style NBNS. Alternatively, an NBNS may be implemented to be essentially a "bulletin board" on which name information is posted and responsibility for consistency is delegated to the end-nodes. This would be a "non-secured" style NBNS.

15.1.7. CONSISTENCY OF THE NBNS DATA BASE

Even in a properly running NetBIOS scope the NBNS and its community of end-nodes may occasionally lose synchronization with respect to the true state of name registrations.

This may occur should the NBNS fail and lose all or part of its database.

More commonly, a P or M node may be turned-off (thus forgetting the names it has registered) and then be subsequently turned back on.

Finally, errors may occur or an implementation may be incorrect.

Various approaches have been incorporated into the NetBIOS-over- TCP protocols to minimize the impact of these problems.

1. The NBNS (or any other node) may "challenge" (using a NAME QUERY REQUEST) an end-node to verify that it actually owns a name.

   Such a challenge may occur at any time. Every end-node must be prepared to make a timely response.

   Failure to respond causes the NBNS to consider that the end-node has released the name in question.

(If UDP is being used as the underlying transport, the challenge, like all other requests, must be retransmitted some number of times in the absence of a response.)

2. The NBNS (or any other node) may request (using the NODE STATUS REQUEST) that an end-node deliver its entire name table.

   This may occur at any time. Every end-node must be prepared to make a timely response.

   Failure to respond permits (but does not require) the NBNS to consider that the end-node has failed and released all names to which it had claims. (Like the challenge, on a UDP transport, the request must be retransmitted in the absence of a response.)

3. The NBNS may revoke a P or M node's use of a name by sending either a NAME CONFLICT DEMAND or a NAME RELEASE REQUEST to the node.

   The receiving end-node may continue existing sessions which use that name, but must otherwise cease using that name. If the NBNS placed the name in conflict, the name may be re-acquired only by deletion and subsequent reclamation. If the NBNS requested that the name be released, the node may attempt to re-acquire the name without first performing a name release transaction.

4. The NBNS may impose a "time-to-live" on each name it registers. The registering node is made aware of this time value during the name registration procedure.

   Simple or reliable NBNS's may impose an infinite time-to-live.

5. If an end-node holds any names that have finite time-to-live values, then that node must periodically send a status report to the NBNS. Each name is reported using the NAME REFRESH REQUEST packet.

   These status reports restart the timers of both the NBNS and the reporting node. However, the only timers which are restarted are those associated with the name found in the status report. Timers on other names are not affected.

   The NBNS may consider that a node has released any name which has not been refreshed within some multiple of name's time-to-live.

   A well-behaved NBNS, would, however, issue a challenge to-,

or request a list of names from-, the non-reporting end-node before deleting its name(s). The absence of a response, or of the name in a response, will confirm the NBNS decision to delete a name.

6. The absence of reports may cause the NBNS to infer that the end-node has failed. Similarly, receipt of information widely divergent from what the NBNS believes about the node, may cause the NBNS to consider that the end-node has been restarted.

   The NBNS may analyze the situation through challenges or requests for a list of names.

7. A very cautious NBNS is free to poll nodes (by sending NAME QUERY REQUEST or NODE STATUS REQUEST packets) to verify that their name status is the same as that registered in the NBNS.

   NOTE: Such polling activity, if used at all by an implementation, should be kept at a very low level or enabled only during periods when the NBNS has some reason to suspect that its information base is inaccurate.

8. P and M nodes can detect incorrect name information at session establishment.

   If incorrect information is found, NBNS is informed via a NAME RELEASE REQUEST originated by the end-node which detects the error.

15.1.8. NAME CACHING

An end-node may keep a local cache of NetBIOS name-to-IP address translation entries.

All cache entries should be flushed on a periodic basis.

In addition, a node ought to flush any cache information associated with an IP address if the node receives any information indicating that there may be any possibility of trouble with the node at that IP address. For example, if a NAME CONFLICT DEMAND is sent to a node, all cached information about that node should be cleared within the sending node.

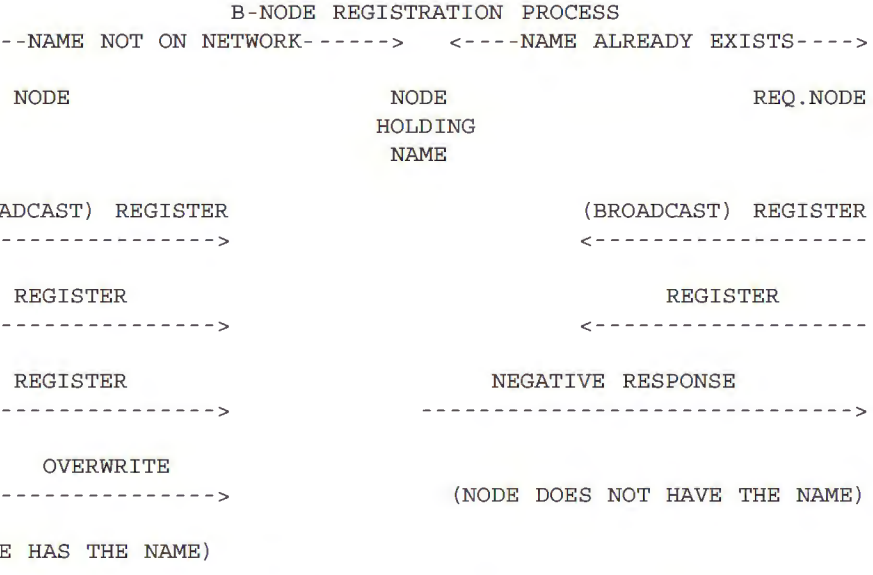
15.2. NAME REGISTRATION TRANSACTIONS

15.2.1. NAME REGISTRATION BY B NODES

A name claim transaction initiated by a B node is broadcast throughout the broadcast area. The NAME REGISTRATION REQUEST will be

heard by all B and M nodes in the area. Each node examines the claim to see whether it it is consistent with the names it owns. If an inconsistency exists, a NEGATIVE NAME REGISTRATION RESPONSE is unicast to the requestor. The requesting node obtains ownership of the name (or membership in the group) if, and only if, no NEGATIVE NAME REGISTRATION RESPONSEs are received within the name claim timeout, CONFLICT_TIMER. (See "Defined Constants and Variables" in the Detailed Specification for the value of this timer.)

A B node proclaims its new ownership by broadcasting a NAME OVERWRITE DEMAND.



The NAME REGISTRATION REQUEST, like any request, must be repeated if no response is received within BCAST_REQ_RETRY_TIMEOUT. Transmission of the request is attempted BCAST_REQ_RETRY_COUNT times.

15.2.2. NAME REGISTRATION BY P NODES

A name registration may proceed in various ways depending whether the name being registered is new to the NBNS. If the name is known to the NBNS, then challenges may be sent to the prior holder(s).

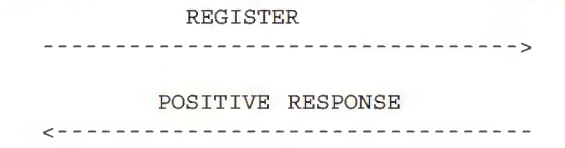
15.2.2.1. NEW NAME, OR NEW GROUP MEMBER

The diagram, below, shows the sequence of events when an end-node registers a name which is new to the NBNS. (The diagram omits WACKs, NBNS redirections, and retransmission of requests.)

This same interaction will occur if the name being registered is a group name and the group already exists. The NBNS will add the

registrant to the set of group members.

P-NODE REGISTRATION PROCESS
(server has no previous information about the name)



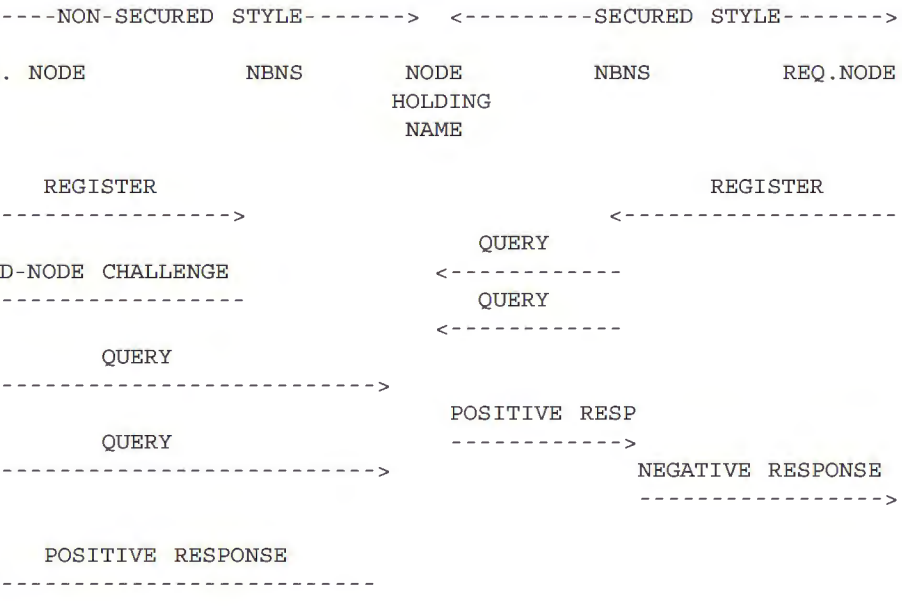
The interaction is rather simple: the end-node sends a NAME REGISTRATION REQUEST, the NBNS responds with a POSITIVE NAME REGISTRATION RESPONSE.

15.2.2.2. EXISTING NAME AND OWNER IS STILL ACTIVE

The following diagram shows interactions when an attempt is made to register a unique name, the NBNS is aware of an existing owner, and that existing owner is still active.

There are two sides to the diagram. The left side shows how a non-secured NBNS would handle the matter. Secured NBNS activity is shown on the right.

P-NODE REGISTRATION PROCESS
(server HAS a previous owner that IS active)



A non-secured NBNS will answer the NAME REGISTRATION REQUEST with a END-NODE CHALLENGE REGISTRATION RESPONSE. This response asks the end-node to issue a challenge transaction against the node indicated in the response. In this case, the prior node will defend against the challenge and the registering end-node will simply drop the registration attempt without further interaction with the NBNS.

A secured NBNS will refrain from answering the NAME REGISTRATION REQUEST until the NBNS has itself challenged the prior holder(s) of the name. In this case, the NBNS finds that that the name is still being defended and consequently returns a NEGATIVE NAME REGISTRATION RESPONSE to the registrant.

Due to the potential time for the secured NBNS to make the challenge(s), it is likely that a WACK will be sent by the NBNS to the registrant.

Although not shown in the diagram, a non-secured NBNS will send a NEGATIVE NAME REGISTRATION RESPONSE to a request to register a unique name when there already exists a group of the same name. A secured NBNS may elect to poll (or challenge) the group members to determine whether any active members remain. This may impose a heavy load on the network. It is recommended that group names be allowed to fade-out through the name refresh mechanism.

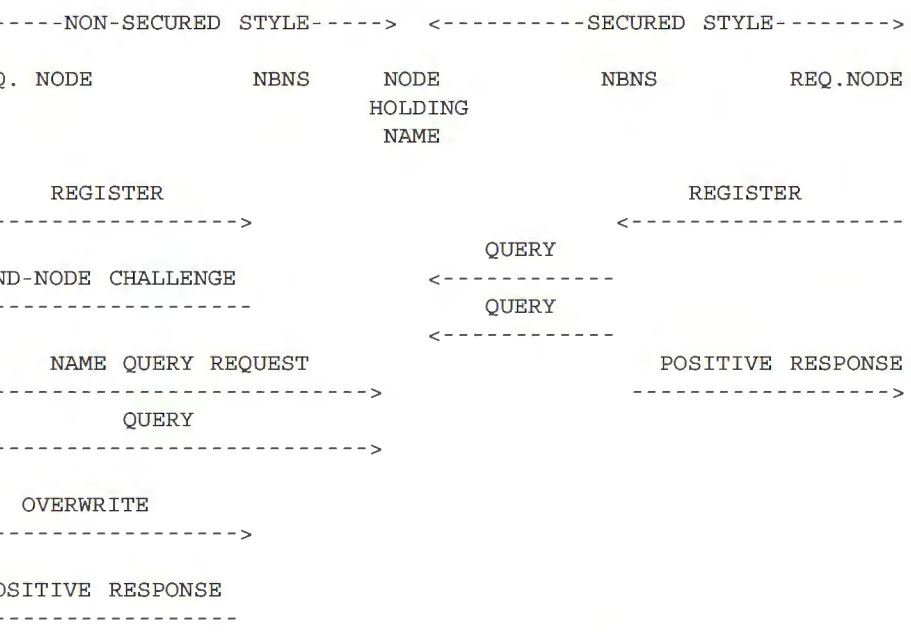
15.2.2.3. EXISTING NAME AND OWNER IS INACTIVE

The following diagram shows interactions when an attempt is made to register a unique name, the NBNS is aware of an existing owner, and that existing owner is no longer active.

A non-secured NBNS will answer the NAME REGISTRATION REQUEST with a END-NODE CHALLENGE REGISTRATION RESPONSE. This response asks the end-node to issue a challenge transaction against the node indicated in the response. In this case, the prior node will not defend against the challenge. The registrant will inform the NBNS through a NAME OVERWRITE REQUEST. The NBNS will replace the prior name information in its database with the information in the overwrite request.

A secured NBNS will refrain from answering the NAME REGISTRATION REQUEST until the NBNS has itself challenged the prior holder(s) of the name. In this case, the NBNS finds that that the name is not being defended and consequently returns a POSITIVE NAME REGISTRATION RESPONSE to the registrant.

P-NODE REGISTRATION PROCESS
(server HAS a previous owner that is NOT active)



Due to the potential time for the secured NBNS to make the challenge(s), it is likely that a WACK will be sent by the NBNS to the registrant.

A secured NBNS will immediately send a NEGATIVE NAME REGISTRATION RESPONSE in answer to any NAME OVERWRITE REQUESTS it may receive.

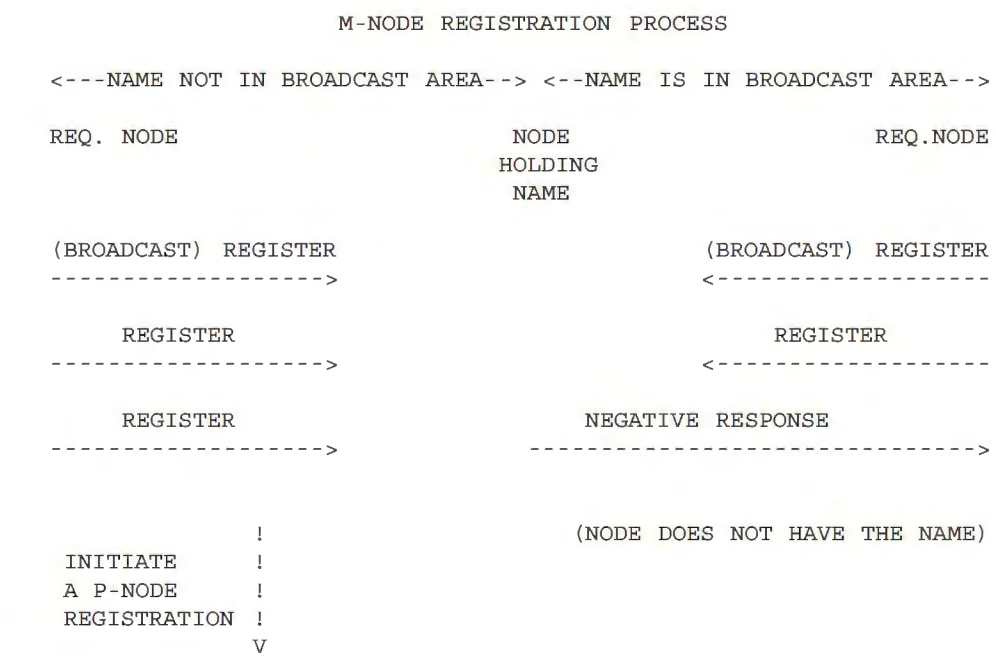
15.2.3. NAME REGISTRATION BY M NODES

An M node begin a name claim operation as if the node were a B node: it broadcasts a NAME REGISTRATION REQUEST and listens for NEGATIVE NAME REGISTRATION RESPONSEs. Any NEGATIVE NAME REGISTRATION RESPONSE prevents the M node from obtaining the name and terminates the claim operation.

If, however, the M node does not receive any NEGATIVE NAME REGISTRATION RESPONSE, the M node must continue the claim procedure as if the M node were a P node.

Only if both name claims were successful does the M node acquire the name.

The following diagram illustrates M node name registration:



15.3. NAME QUERY TRANSACTIONS

Name query transactions are initiated by end-nodes to obtain the IP address(es) and other attributes associated with a NetBIOS name.

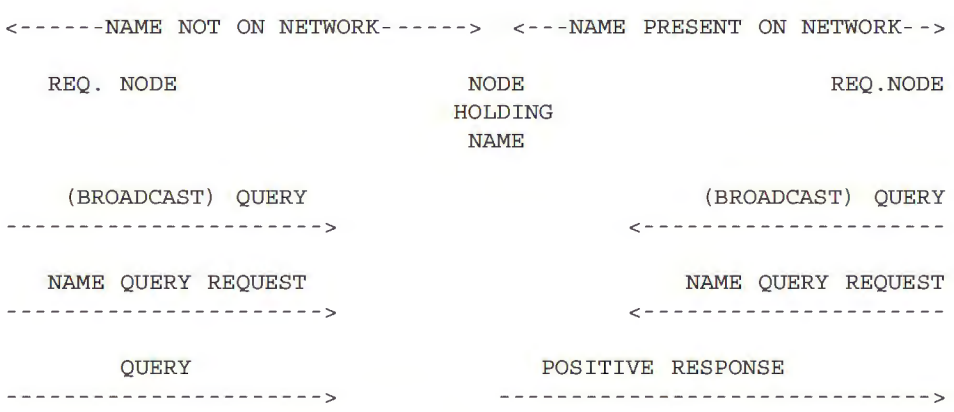
15.3.1. QUERY BY B NODES

The following diagram shows how B nodes go about discovering who owns a name.

The left half of the diagram illustrates what happens if there are no holders of the name. In that case no responses are received in answer to the broadcast NAME QUERY REQUEST(s).

The right half shows a POSITIVE NAME QUERY RESPONSE unicast by a name holder in answer to the broadcast request. A name holder will make this response to every NAME QUERY REQUEST that it hears. And each holder acts this way. Thus, the node sending the request may receive many responses, some duplicates, and from many nodes.

B-NODE DISCOVERY PROCESS



Name query is generally, but not necessarily, a prelude to NetBIOS session establishment or NetBIOS datagram transmission. However, name query may be used for other purposes.

A B node may elect to build a group membership list for subsequent use (e.g. for session establishment) by collecting and saving the responses.

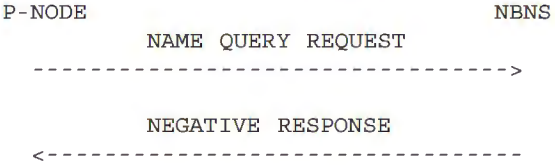
15.3.2. QUERY BY P NODES

An NBNS answers queries from a P node with a list of IP address and other information for each owner of the name. If there are multiple owners (i.e. if the name is a group name), the NBNS loads as many answers into the response as will fit into a UDP packet. A truncation flag indicates whether any additional owner information remains. All the information may be obtained by repeating the query over a TCP connection.

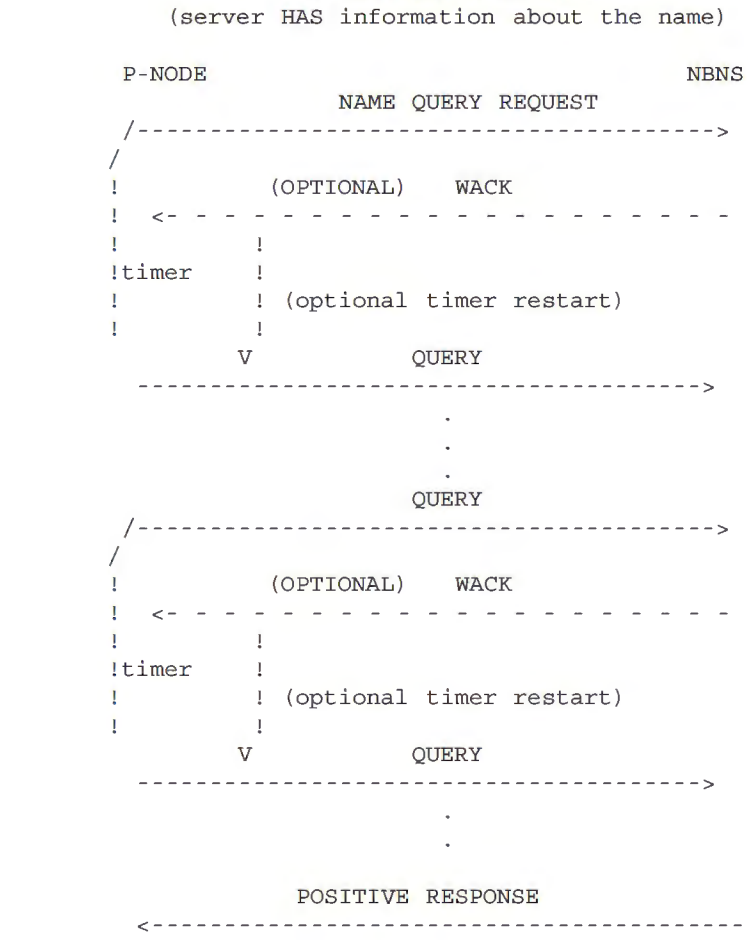
The NBNS is not required to impose any order on its answer list.

The following diagram shows what happens if the NBNS has no information about the name:

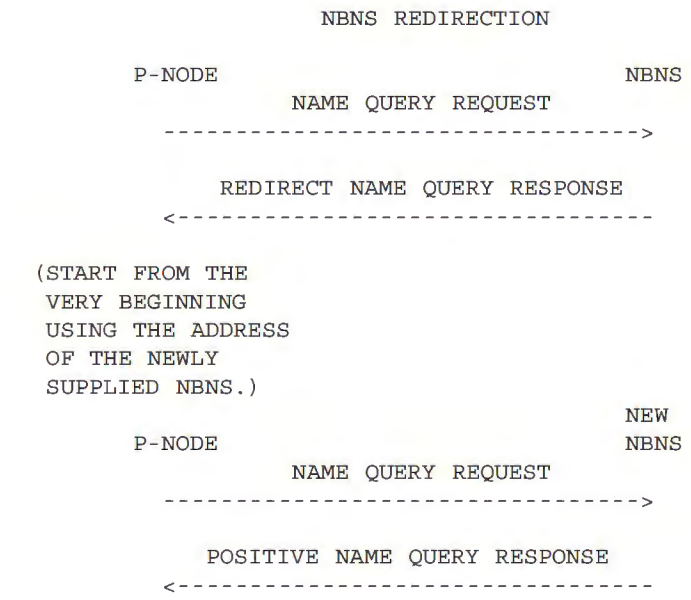
P-NODE DISCOVERY PROCESS
(server has no information about the name)



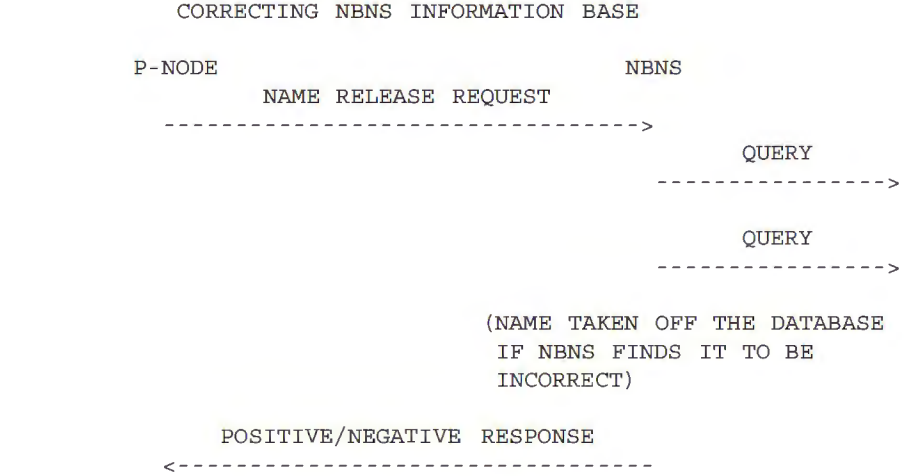
The next diagram illustrates interaction between the end-node and the NBNS when the NBNS does have information about the name. This diagram shows, in addition, the retransmission of the request by the end-node in the absence of a timely response. Also shown are WACKs (or temporary, intermediate responses) sent by the NBNS to the end-node:



The following diagram illustrates NBNS redirection. Upon receipt of a NAME QUERY REQUEST, the NBNS redirects the client to another NBNS. The client repeats the request to the new NBNS and obtains a response. The diagram shows that response as a POSITIVE NAME QUERY RESPONSE. However any legal NBNS response may occur in actual operation.



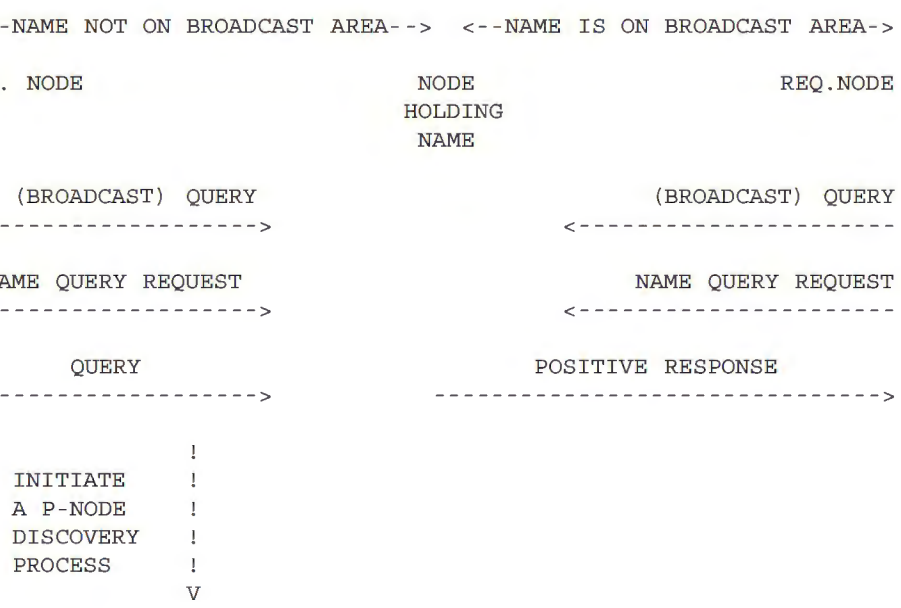
The next diagram shows how a P or M node tells the NBNS that the NBNS has provided incorrect information. This procedure may begin after a DATAGRAM ERROR packet has been received or a session set-up attempt has discovered that the NetBIOS name does not exist at the destination, the IP address of which was obtained from the NBNS during a prior name query transaction. The NBNS, in this case a secure NBNS, issues queries to verify whether the information is, in fact, incorrect. The NBNS closes the transaction by sending either a POSITIVE or NEGATIVE NAME RELEASE RESPONSE, depending on the results of the verification.



15.3.3. QUERY BY M NODES

M node name query follows the B node pattern. In the absence of adequate results, the M node then continues by performing a P node type query. This is shown in the following diagram:

M-NODE DISCOVERY PROCESS



15.3.4. ACQUIRE GROUP MEMBERSHIP LIST

The entire membership of a group may be acquired by sending a NAME QUERY REQUEST to the NBNS. The NBNS will respond with a POSITIVE NAME QUERY RESPONSE or a NEGATIVE NAME QUERY RESPONSE. A negative response completes the procedure and indicates that there are no members in the group.

If the positive response has the truncation bit clear, then the response contains the entire list of group members. If the truncation bit is set, then this entire procedure must be repeated, but using TCP as a foundation rather than UDP.

15.4. NAME RELEASE TRANSACTIONS

15.4.1. RELEASE BY B NODES

A NAME RELEASE DEMAND contains the following information:

- NetBIOS name
- The scope of the NetBIOS name
- Name type: unique or group
- IP address of the releasing node
- Transaction ID

```
REQUESTING                                          OTHER
B-NODE                                              B-NODES
                    NAME RELEASE DEMAND
              ---------------------------------->
```

15.4.2. RELEASE BY P NODES

A NAME RELEASE REQUEST contains the following information:

- NetBIOS name
- The scope of the NetBIOS name
- Name type: unique or group
- IP address of the releasing node
- Transaction ID

A NAME RELEASE RESPONSE contains the following information:

- NetBIOS name
- The scope of the NetBIOS name
- Name type: unique or group
- IP address of the releasing node
- Transaction ID
- Result:
  - Yes: name was released
  - No: name was not released, a reason code is provided

```
REQUESTING
P-NODE                                              NBNS
                    NAME RELEASE REQUEST
              ---------------------------------->

                    NAME RELEASE RESPONSE
              <----------------------------------
```

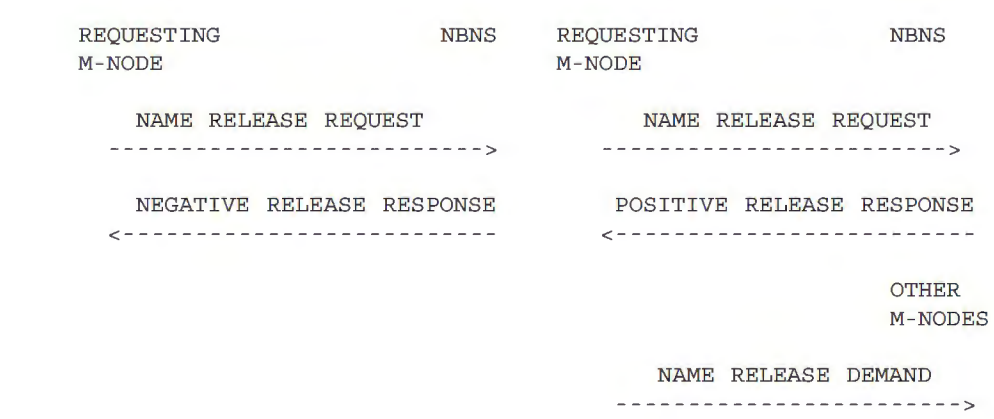
15.4.3. RELEASE BY M NODES

The name release procedure of the M node is a combination of the P and B node name release procedures. The M node first performs the P

release procedure. If the P procedure fails then the release procedure does not continue, it fails. If and only if the P procedure succeeds then the M node broadcasts the NAME RELEASE DEMAND to the broadcast area, the B procedure.

NOTE: An M node typically performs a B-style operation and then a P-style operation. In this case, however, the P-style operation comes first.

The following diagram illustrates the M node name release procedure:



15.5. NAME MAINTENANCE TRANSACTIONS

15.5.1. NAME REFRESH

Name refresh transactions are used to handle the following situations:

a) An NBNS node needs to detect if a P or M node has "silently" gone down, so that names held by that node can be purged from the data base.

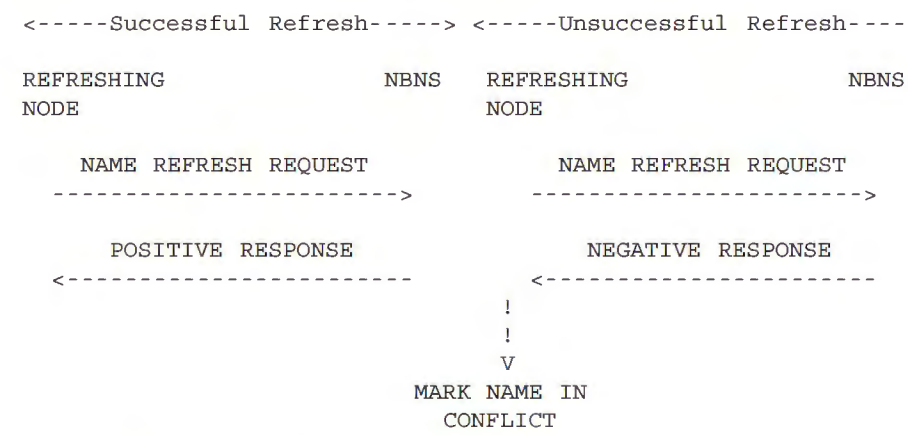
b) If the NBNS goes down, it needs to be able to reconstruct the data base when it comes back up.

c) If the network should be partitioned, the NBNS needs to be able to able to update its data base when the network reconnects.

Each P or M node is responsible for sending periodic NAME REFRESH REQUESTs for each name that it has registered. Each refresh packet contains a single name that has been successfully registered by that

node. The interval between such packets is negotiated between the end node and the NBNS server at the time that the name is initially claimed. At name claim time, an end node will suggest a refresh timeout value. The NBNS node can modify this value in the reply packet. A NBNS node can also choose to tell the end node to not send any refresh packet by using the "infinite" timeout value in the response packet. The timeout value returned by the NBNS is the actual refresh timeout that the end node must use.

When a node sends a NAME REFRESH REQUEST, it must be prepared to receive a negative response. This would happen, for example, if the the NBNS discovers that the the name had already been assigned to some other node. If such a response is received, the end node should mark the name as being in conflict. Such an entry should be treated in the same way as if name conflict had been detected against the name. The following diagram illustrates name refresh:



15.5.2. NAME CHALLENGE

Name challenge is done by sending a NAME QUERY REQUEST to an end node of any type. If a POSITIVE NAME QUERY RESPONSE is returned, then that node still owns the name. If a NEGATIVE NAME QUERY RESPONSE is received or if no response is received, it can be assumed that the end node no longer owns the name.

Name challenge can be performed either by the NBNS node, or by an end node. When an end-node sends a name claim packet, the NBNS node may do the challenge operation. The NBNS node can choose, however, to require the end node do the challenge. In that case, the NBNS will send an END-NODE CHALLENGE RESPONSE packet to the end node, which should then proceed to challenge the putative owner.

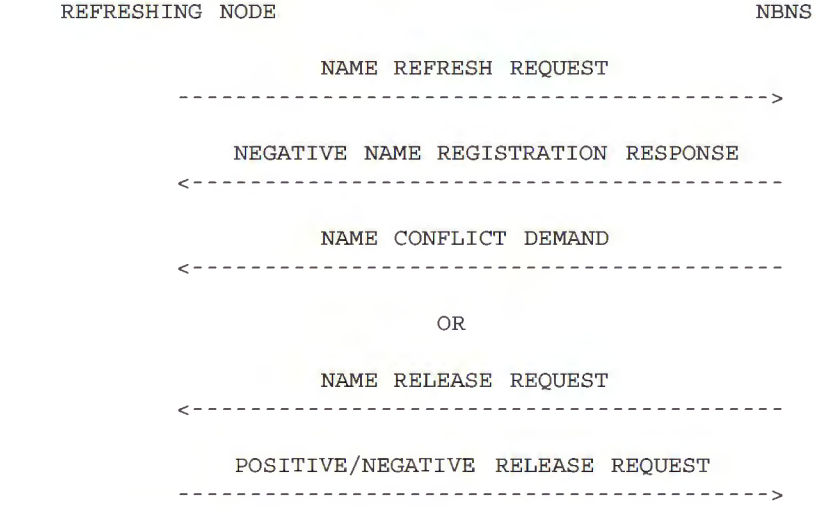
Note that the name challenge procedure sends a normal NAME QUERY REQUEST packet to the end node. It does not require a special packet. The only new packet introduced is the END-NODE CHALLENGE

RESPONSE which is sent by an NBNS node when the NBNS wants the end-node to perform the challenge operation.

15.5.3. CLEAR NAME CONFLICT

It is possible during a refresh request from a M or P node for a NBNS to detects a name in conflict. The response to the NAME REFRESH REQUEST must be a NEGATIVE NAME REGISTRATION RESPONSE. Optionally, in addition, the NBNS may send a NAME CONFLICT DEMAND or a NAME RELEASE REQUEST to the refreshing node. The NAME CONFLICT DEMAND forces the node to place the name in the conflict state. The node will eventually inform it's user of the conflict. The NAME RELEASE REQUEST will force the node to flush the name from its local name table completely. This forces the node to flush the name in conflict. This does not cause termination of existing sessions using this name.

The following diagram shows an NBNS detecting and correcting a conflict:



15.6. ADAPTER STATUS TRANSACTIONS

Adapter status is obtained from a node as follows:

1. Perform a name discovery operation to obtain the IP addresses of a set of end-nodes.

2. Repeat until all end-nodes from the set have been used:

   a. Select one end-node from the set.

   b. Send a NODE STATUS REQUEST to that end-node using UDP.

c. Await a NODE STATUS RESPONSE. (If a timely response is not forthcoming, repeat step "b" UCAST_REQ_RETRY_COUNT times. After the last retry, go to step "a".)

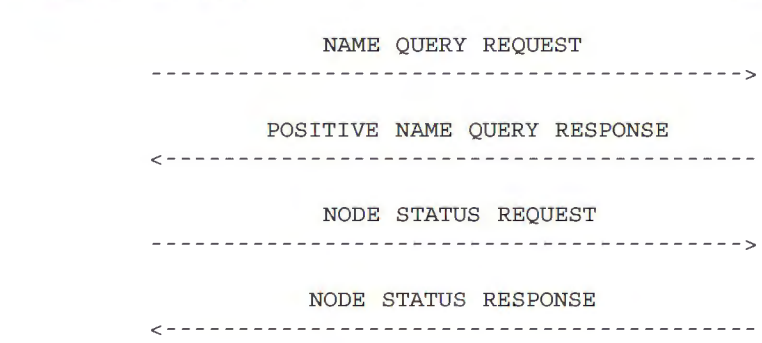
d. If the truncation bit is not set in the response, the response contains the entire node status. Return the status to the user and terminate this procedure.

e. If the truncation bit is set in the response, then not all status was returned because it would not fit into the response packet. The responder will set the truncation bit if the IP datagram length would exceed MAX_DATAGRAM_LENGTH. Return the status to the user and terminate this procedure.

3. Return error to user, no status obtained.

The repetition of step 2, above, through all nodes of the set, is optional.

Following is an example transaction of a successful Adapter Status operation:



16. NetBIOS SESSION SERVICE

The NetBIOS session service begins after one or more IP addresses have been found for the target name. These addresses may have been acquired using the NetBIOS name query transactions or by other means, such as a local name table or cache.

NetBIOS session service transactions, packets, and protocols are identical for all end-node types. They involve only directed (point-to-point) communications.

16.1. OVERVIEW OF NetBIOS SESSION SERVICE

Session service has three phases:

Session establishment - it is during this phase that the IP address and TCP port of the called name is determined, and a TCP connection is established with the remote party.

Steady state - it is during this phase that NetBIOS data messages are exchanged over the session. Keep-alive packets may also be exchanged if the participating nodes are so configured.

Session close - a session is closed whenever either a party (in the session) closes the session or it is determined that one of the parties has gone down.

16.1.1. SESSION ESTABLISHMENT PHASE OVERVIEW

An end-node begins establishment of a session to another node by somehow acquiring (perhaps using the name query transactions or a local cache) the IP address of the node or nodes purported to own the destination name.

Every end-node awaits incoming NetBIOS session requests by listening for TCP calls to a well-known service port, SSN_SRVC_TCP_PORT. Each incoming TCP connection represents the start of a separate NetBIOS session initiation attempt. The NetBIOS session server, not the ultimate application, accepts the incoming TCP connection(s).

Once the TCP connection is open, the calling node sends session service request packet. This packet contains the following information:

- Calling IP address (see note)
- Calling NetBIOS name
- Called IP address (see note)
- Called NetBIOS name

NOTE: The IP addresses are obtained from the TCP service interface.

When the session service request packet arrives at the NetBIOS server, one of the the following situations will exist:

- There exists a NetBIOS LISTEN compatible with the incoming call and there are adequate resources to permit session establishment to proceed.

- There exists a NetBIOS LISTEN compatible with the incoming call, but there are inadequate resources to permit

establishment of a session.

- The called name does, in fact, exist on the called node, but there is no pending NetBIOS LISTEN compatible with the incoming call.

- The called name does not exist on the called node.

In all but the first case, a rejection response is sent back over the TCP connection to the caller. The TCP connection is then closed and the session phase terminates. Any retry is the responsibility of the caller. For retries in the case of a group name, the caller may use the next member of the group rather than immediately retrying the instant address. In the case of a unique name, the caller may attempt an immediate retry using the same target IP address unless the called name did not exist on the called node. In that one case, the NetBIOS name should be re-resolved.

If a compatible LISTEN exists, and there are adequate resources, then the session server may transform the existing TCP connection into the NetBIOS data session. Alternatively, the session server may redirect, or "retarget" the caller to another TCP port (and IP address).

If the caller is redirected, the caller begins the session establishment anew, but using the new IP address and TCP port given in the retarget response. Again a TCP connection is created, and again the calling and called node exchange credentials. The called party may accept the call, reject the call, or make a further redirection.

This mechanism is based on the presumption that, on hosts where it is not possible to transfer open TCP connections between processes, the host will have a central session server. Applications willing to receive NetBIOS calls will obtain an ephemeral TCP port number, post a TCP unspecified passive open on that port, and then pass that port number and NetBIOS name information to the NetBIOS session server using a NetBIOS LISTEN operation. When the call is placed, the session server will "retarget" the caller to the application's TCP socket. The caller will then place a new call, directly to the application. The application has the responsibility to mimic the session server at least to the extent of receiving the calling credentials and then accepting or rejecting the call.

16.1.1.1. RETRYING AFTER BEING RETARGETTED

A calling node may find that it can not establish a session with a node to which it was directed by the retargetting procedure. Since retargetting may be nested, there is an issue whether the caller should begin a retry at the initial starting point or back-up to an intermediate retargetting point. The caller may use any method. A

discussion of two such methods is in Appendix B, "Retarget Algorithms".

16.1.1.2. SESSION ESTABLISHMENT TO A GROUP NAME

Session establishment with a group name requires special consideration. When a NetBIOS CALL attempt is made to a group name, name discovery will result in a list (possibly incomplete) of the members of that group. The calling node selects one member from the list and attempts to build a session. If that fails, the calling node may select another member and make another attempt.

When the session service attempts to make a connection with one of the members of the group, there is no guarantee that that member has a LISTEN pending against that group name, that the called node even owns, or even that the called node is operating.

16.1.2. STEADY STATE PHASE OVERVIEW

NetBIOS data messages are exchanged in the steady state. NetBIOS messages are sent by prepending the user data with a message header and sending the header and the user data over the TCP connection. The receiver removes the header and passes the data to the NetBIOS user.

In order to detect failure of one of the nodes or of the intervening network, "session keep alive" packets may be periodically sent in the steady state.

Any failure of the underlying TCP connection, whether a reset, a timeout, or other failure, implies failure of the NetBIOS session.

16.1.3. SESSION TERMINATION PHASE OVERVIEW

A NetBIOS session is terminated normally when the user requests the session to be closed or when the session service detects the remote partner of the session has gracefully terminated the TCP connection. A NetBIOS session is abnormally terminated when the session service detects a loss of the connection. Connection loss can be detected with the keep-alive function of the session service or TCP, or on the failure of a SESSION MESSAGE send operation.

When a user requests to close a session, the service first attempts a graceful in-band close of the TCP connection. If the connection does not close within the SSN_CLOSE_TIMEOUT the TCP connection is aborted. No matter how the TCP connection is terminated, the NetBIOS session service always closes the NetBIOS session.

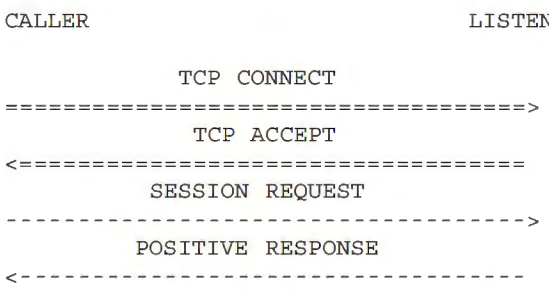
When the session service receives an indication from TCP that a connection close request has been received, the TCP connection and the NetBIOS session are immediately closed and the user is informed

of the loss of the session. All data received up to the close indication should be delivered, if possible, to the session's user.

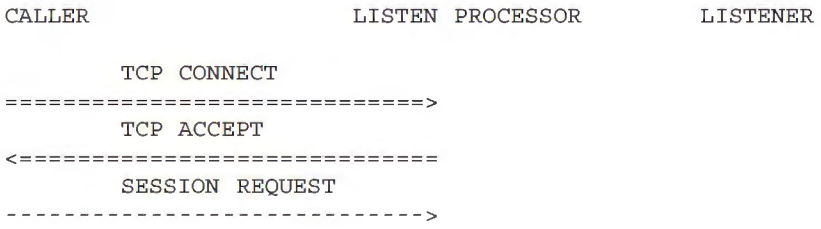
16.2. SESSION ESTABLISHMENT PHASE

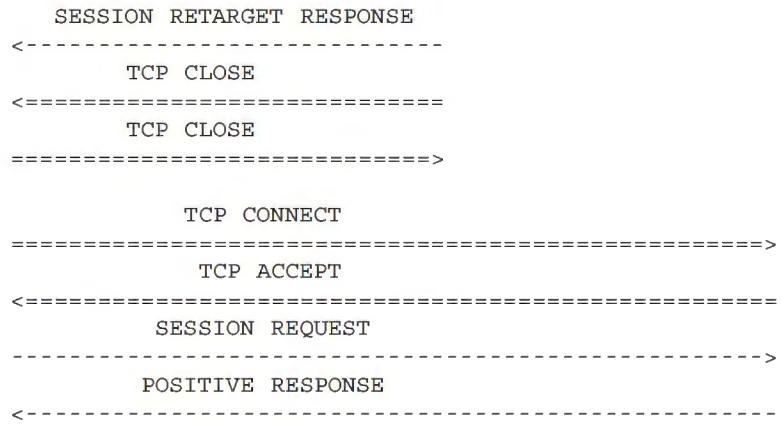
All the following diagrams assume a name query operation was successfully completed by the caller node for the listener's name.

This first diagram shows the sequence of network events used to successfully establish a session without retargetting by the listener. The TCP connection is first established with the well-known NetBIOS session service TCP port, SSN_SRVC_TCP_PORT. The caller then sends a SESSION REQUEST packet over the TCP connection requesting a session with the listener. The SESSION REQUEST contains the caller's name and the listener's name. The listener responds with a POSITIVE SESSION RESPONSE informing the caller this TCP connection is accepted as the connection for the data transfer phase of the session.

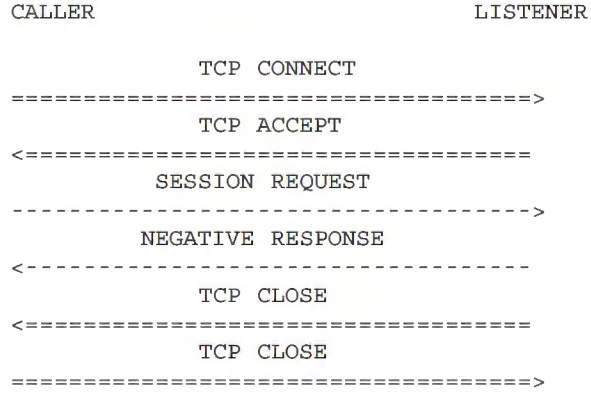


The second diagram shows the sequence of network events used to successfully establish a session when the listener does retargetting. The session establishment procedure is the same as with the first diagram up to the listener's response to the SESSION REQUEST. The listener, divided into two sections, the listen processor and the actual listener, sends a SESSION RETARGET RESPONSE to the caller. This response states the call is acceptable, but the data transfer TCP connection must be at the new IP address and TCP port. The caller then re-iterates the session establishment process anew with the new IP address and TCP port after the initial TCP connection is closed. The new listener then accepts this connection for the data transfer phase with a POSITIVE SESSION RESPONSE.

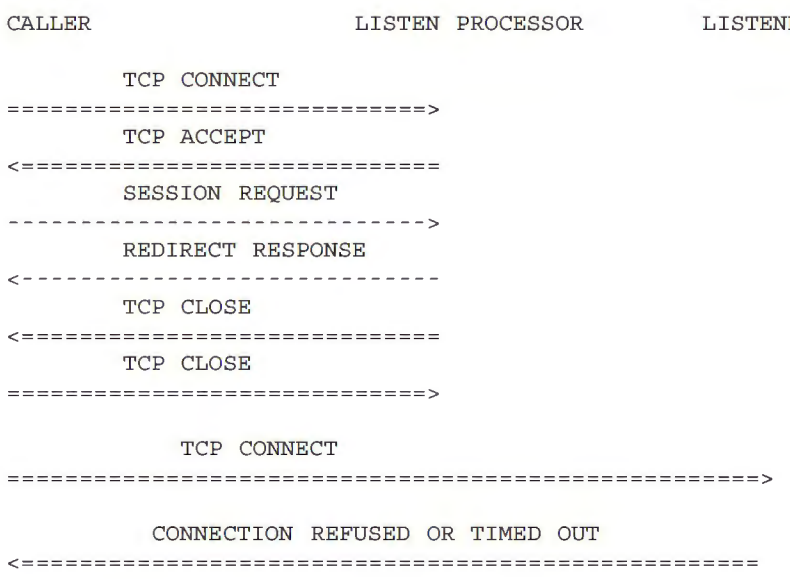




The third diagram is the sequence of network events for a rejected session request with the listener. This type of rejection could occur with either a non-retargetting listener or a retargetting listener. After the TCP connection is established at SSN_SRVC_TCP_PORT, the caller sends the SESSION REQUEST over the TCP connection. The listener does not have either a listen pending for the listener's name or the pending NetBIOS listen is specific to another caller's name. Consequently, the listener sends a NEGATIVE SESSION RESPONSE and closes the TCP connection.



The fourth diagram is the sequence of network events when session establishment fails with a retargetting listener. After being redirected, and after the initial TCP connection is closed the caller tries to establish a TCP connection with the new IP address and TCP port. The connection fails because either the port is unavailable or the target node is not active. The port unavailable race condition occurs if another caller has already acquired the TCP connection with the listener. For additional implementation suggestions, see Appendix B, "Retarget Algorithms".



16.3. SESSION DATA TRANSFER PHASE

16.3.1. DATA ENCAPSULATION

NetBIOS messages are exchanged in the steady state. Messages are sent by prepending user data with message header and sending the header and the user data over the TCP connection. The receiver removes the header and delivers the NetBIOS data to the user.

16.3.2. SESSION KEEP-ALIVES

In order to detect node failure or network partitioning, "session keep alive" packets are periodically sent in the steady state. A session keep alive packet is discarded by a peer node.

A session keep alive timer is maintained for each session. This timer is reset whenever any data is sent to, or received from, the session peer. When the timer expires, a NetBIOS session keep-alive packet is sent on the TCP connection. Sending the keep-alive packet forces data to flow on the TCP connection, thus indirectly causing TCP to detect whether the connection is still active.

Since many TCP implementations provide a parallel TCP "keep- alive" mechanism, the NetBIOS session keep-alive is made a configurable option. It is recommended that the NetBIOS keep- alive mechanism be used only in the absence of TCP keep-alive.

Note that unlike TCP keep alives, NetBIOS session keep alives do not require a response from the NetBIOS peer -- the fact that it was

possible to send the NetBIOS session keep alive is sufficient indication that the peer, and the connection to it, are still active.

The only requirement for interoperability is that when a session keep alive packet is received, it should be discarded.

17. NETBIOS DATAGRAM SERVICE

17.1. OVERVIEW OF NetBIOS DATAGRAM SERVICE

Every NetBIOS datagram has a named destination and source. To transmit a NetBIOS datagram, the datagram service must perform a name query operation to learn the IP address and the attributes of the destination NetBIOS name. (This information may be cached to avoid the overhead of name query on subsequent NetBIOS datagrams.)

NetBIOS datagrams are carried within UDP packets. If a NetBIOS datagram is larger than a single UDP packet, it may be fragmented into several UDP packets.

End-nodes may receive NetBIOS datagrams addressed to names not held by the receiving node. Such datagrams should be discarded. If the name is unique then a DATAGRAM ERROR packet is sent to the source of that NetBIOS datagram.

17.1.1. UNICAST, MULTICAST, AND BROADCAST

NetBIOS datagrams may be unicast, multicast, or broadcast. A NetBIOS datagram addressed to a unique NetBIOS name is unicast. A NetBIOS datatgram addressed to a group NetBIOS name, whether there are zero, one, or more actual members, is multicast. A NetBIOS datagram sent using the NetBIOS "Send Broadcast Datagram" primitive is broadcast.

17.1.2. FRAGMENTATION OF NetBIOS DATAGRAMS

When the header and data of a NetBIOS datagram exceeds the maximum amount of data allowed in a UDP packet, the NetBIOS datagram must be fragmented before transmission and reassembled upon receipt.

A NetBIOS Datagram is composed of the following protocol elements:

- IP header of 20 bytes (minimum)
- UDP header of 8 bytes
- NetBIOS Datagram Header of 14 bytes
- The NetBIOS Datagram data.

The NetBIOS Datagram data section is composed of 3 parts:

- Source NetBIOS name (255 bytes maximum)
- Destination NetBIOS name (255 bytes maximum)
- The NetBIOS user's data (maximum of 512 bytes)

The two name fields are in second level encoded format (see section 14.)

A maximum size NetBIOS datagram is 1064 bytes. The minimal maximum IP datagram size is 576 bytes. Consequently, a NetBIOS Datagram may not fit into a single IP datagram. This makes it necessary to permit the fragmentation of NetBIOS Datagrams.

On networks meeting or exceeding the minimum IP datagram length requirement of 576 octets, at most two NetBIOS datagram fragments will be generated. The protocols and packet formats accommodate fragmentation into three or more parts.

When a NetBIOS datagram is fragmented, the IP, UDP and NetBIOS Datagram headers are present in each fragment. The NetBIOS Datagram data section is split among resulting UDP datagrams. The data sections of NetBIOS datagram fragments do not overlap. The only fields of the NetBIOS Datagram header that would vary are the FLAGS and OFFSET fields.

The FIRST bit in the FLAGS field indicate whether the fragment is the first in a sequence of fragments. The MORE bit in the FLAGS field indicates whether other fragments follow.

The OFFSET field is the byte offset from the beginning of the NetBIOS datagram data section to the first byte of the data section in a fragment. It is 0 for the first fragment. For each subsequent fragment, OFFSET is the sum of the bytes in the NetBIOS data sections of all preceding fragments.

If the NetBIOS datagram was not fragmented:

- FIRST = TRUE
- MORE = FALSE
- OFFSET = 0

If the NetBIOS datagram was fragmented:

- First fragment:
  - FIRST = TRUE
  - MORE = TRUE
  - OFFSET = 0
- Intermediate fragments:
  - FIRST = FALSE
  - MORE = TRUE
  - OFFSET = sum(NetBIOS data in prior fragments)
- Last fragment:
  - FIRST = FALSE
  - MORE = FALSE

- OFFSET = sum(NetBIOS data in prior fragments)

The relative position of intermediate fragments may be ascertained from OFFSET.

An NBDD must remember the destination name of the first fragment in order to relay the subsequent fragments of a single NetBIOS datagram. The name information can be associated with the subsequent fragments through the transaction ID, DGM_ID, and the SOURCE_IP, fields of the packet. This information can be purged by the NBDD after the last fragment has been processed or FRAGMENT_TO time has expired since the first fragment was received.

17.2. NetBIOS DATAGRAMS BY B NODES

For NetBIOS datagrams with a named destination (i.e. non- broadcast), a B node performs a name discovery for the destination name before sending the datagram. (Name discovery may be bypassed if information from a previous discovery is held in a cache.) If the name type returned by name discovery is UNIQUE, the datagram is unicast to the sole owner of the name. If the name type is GROUP, the datagram is broadcast to the entire broadcast area using the destination IP address BROADCAST_ADDRESS.

A receiving node always filters datagrams based on the destination name. If the destination name is not owned by the node or if no RECEIVE DATAGRAM user operations are pending for the name, then the datagram is discarded. For datagrams with a UNIQUE name destination, if the name is not owned by the node then the receiving node sends a DATAGRAM ERROR packet. The error packet originates from the DGM_SRVC_UDP_PORT and is addressed to the SOURCE_IP and SOURCE_PORT from the bad datagram. The receiving node quietly discards datagrams with a GROUP name destination if the name is not owned by the node.

Since broadcast NetBIOS datagrams do not have a named destination, the B node sends the DATAGRAM SERVICE packet(s) to the entire broadcast area using the destination IP address BROADCAST_ADDRESS. In order for the receiving nodes to distinguish this datagram as a broadcast NetBIOS datagram, the NetBIOS name used as the destination name is '*' (hexadecimal 2A) followed by 15 bytes of hexidecimal 00. The NetBIOS scope identifier is appended to the name before it is converted into second-level encoding. For example, if the scope identifier is "NETBIOS.SCOPE" then the first-level encoded name would be:

CKAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA.NETBIOS.SCOPE

According to [2], a user may not provide a NetBIOS name beginning with "*".

For each node in the broadcast area that receives the NetBIOS

broadcast datagram, if any RECEIVE BROADCAST DATAGRAM user operations are pending then the data from the NetBIOS datagram is replicated and delivered to each. If no such operations are pending then the node silently discards the datagram.

17.3. NetBIOS DATAGRAMS BY P AND M NODES

P and M nodes do not use IP broadcast to distribute NetBIOS datagrams.

Like B nodes, P and M nodes must perform a name discovery or use cached information to learn whether a destination name is a group or a unique name.

Datagrams to unique names are unicast directly to the destination by P and M nodes, exactly as they are by B nodes.

Datagrams to group names and NetBIOS broadcast datagrams are unicast to the NBDD. The NBDD then relays the datagrams to each of the nodes specified by the destination name.

An NBDD may not be capable of sending a NetBIOS datagram to a particular NetBIOS name, including the broadcast NetBIOS name ("*") defined above. A query mechanism is available to the end- node to determine if a NBDD will be able to relay a datagram to a given name. Before a datagram, or its fragments, are sent to the NBDD the P or M node may send a DATAGRAM QUERY REQUEST packet to the NBDD with the DESTINATION_NAME from the DATAGRAM SERVICE packet(s). The NBDD will respond with a DATAGRAM POSITIVE QUERY RESPONSE if it will relay datagrams to the specified destination name. After a positive response the end-node unicasts the datagram to the NBDD. If the NBDD will not be able to relay a datagram to the destination name specified in the query, a DATAGRAM NEGATIVE QUERY RESPONSE packet is returned. If the NBDD can not distribute a datagram, the end-node then has the option of getting the name's owner list from the NBNS and sending the datagram directly to each of the owners.

An NBDD must be able to respond to DATAGRAM QUERY REQUEST packets. The response may always be positive. However, the usage or implementation of the query mechanism by a P or M node is optional. An implementation may always unicast the NetBIOS datagram to the NBDD without asking if it will be relayed. Except for the datagram query facility described above, an NBDD provides no feedback to indicate whether it forwarded a datagram.

18. NODE CONFIGURATION PARAMETERS

- B NODES:
  - Node's permanent unique name
  - Whether IGMP is in use
  - Broadcast IP address to use

        - Whether NetBIOS session keep-alives are needed
        - Usable UDP data field length (to control fragmentation)
    - P NODES:
        - Node's permanent unique name
        - IP address of NBNS
        - IP address of NBDD
        - Whether NetBIOS session keep-alives are needed
        - Usable UDP data field length (to control fragmentation)
    - M NODES:
        - Node's permanent unique name
        - Whether IGMP is in use
        - Broadcast IP address to use
        - IP address of NBNS
        - IP address of NBDD
        - Whether NetBIOS session keep-alives are needed
        - Usable UDP data field length (to control fragmentation)

19. MINIMAL CONFORMANCE

To ensure multi-vendor interoperability, a minimally conforming implementation based on this specification must observe the following rules:

a) A node designed to work only in a broadcast area must conform to the B node specification.

b) A node designed to work only in an internet must conform to the P node specification.

REFERENCES

[1] "Protocol Standard For a NetBIOS Service on a TCP/UDP Transport: Detailed Specifications", RFC 1002, March 1987.

[2] IBM Corp., "IBM PC Network Technical Reference Manual", No. 6322916, First Edition, September 1984.

[3] J. Postel (Ed.), "Transmission Control Protocol", RFC 793, September 1981.

[4] MIL-STD-1778

[5] J. Postel, "User Datagram Protocol", RFC 768, 28 August 1980.

[6] J. Reynolds, J. Postel, "Assigned Numbers", RFC 990, November 1986.

[7] J. Postel, "Internet Protocol", RFC 791, September 1981.

[8] J. Mogul, "Internet Subnets", RFC 950, October 1984

[9] J. Mogul, "Broadcasting Internet Datagrams in the Presence of Subnets", RFC 922, October 1984.

[10] J. Mogul, "Broadcasting Internet Datagrams", RFC 919, October 1984.

[11] P. Mockapetris, "Domain Names - Concepts and Facilities", RFC 882, November 1983.

[12] P. Mockapetris, "Domain Names - Implementation and Specification", RFC 883, November 1983.

[13] P. Mockapetris, "Domain System Changes and Observations", RFC 973, January 1986.

[14] C. Partridge, "Mail Routing and the Domain System", RFC 974, January 1986.

[15] S. Deering, D. Cheriton, "Host Groups: A Multicast Extension to the Internet Protocol", RFC 966, December 1985.

[16] S. Deering, "Host Extensions for IP Multicasting", RFC 988, July 1986.

APPENDIX A

This appendix contains supporting technical discussions. It is not an integral part of the NetBIOS-over-TCP specification.

INTEGRATION WITH INTERNET GROUP MULTICASTING

The Netbios-over-TCP system described in this RFC may be easily integrated with the Internet Group Multicast system now being developed for the internet.

In the main body of the RFC, the notion of a broadcast area was considered to be a single MAC-bridged "B-LAN". However, the protocols defined will operate over an extended broadcast area resulting from the creation of a permanent Internet Multicast Group.

Each separate broadcast area would be based on a separate permanent Internet Multicast Group. This multicast group address would be used by B and M nodes as their BROADCAST_ADDRESS.

In order to base the broadcast area on a multicast group certain additional procedures are required and certain constraints must be met.

A-1. ADDITIONAL PROTOCOL REQUIRED IN B AND M NODES

All B or M nodes operating on an IGMP based broadcast area must have IGMP support in their IP layer software. These nodes must perform an IGMP join operation to enter the IGMP group before engaging in NetBIOS activity.

A-2. CONSTRAINTS

Broadcast Areas may overlap. For this reason, end-nodes must be careful to examine the NetBIOS scope identifiers in all received broadcast packets.

The NetBIOS broadcast protocols were designed for a network that exhibits a low average transit time and low rate of packet loss. An IGMP based broadcast area must exhibit these characteristics. In practice this will tend to constrain IGMP broadcast areas to a campus of networks interconnected by high-speed routers and inter-router links. It is unlikely that transcontinental broadcast areas would exhibit the required characteristics.

APPENDIX B

This appendix contains supporting technical discussions. It is not an integral part of the NetBIOS-over-TCP specification.

IMPLEMENTATION CONSIDERATIONS

B-1. IMPLEMENTATION MODELS

On any participating system, there must be some sort of NetBIOS Service to coordinate access by NetBIOS applications on that system.

To analyze the impact of the NetBIOS-over-TCP architecture, we use the following three models of how a NetBIOS service might be implemented:

1. Combined Service and Application Model

   The NetBIOS service and application are both contained within a single process. No interprocess communication is assumed within the system; all communication is over the network. If multiple applications require concurrent access to the NetBIOS service, they must be folded into this monolithic process.

2. Common Kernel Element Model

   The NetBIOS Service is part of the operating system (perhaps as a device driver or a front-end processor). The NetBIOS applications are normal operating system application processes. The common element NetBIOS service contains all the information, such as the name and listen tables, required to co-ordinate the activities of the applications.

3. Non-Kernel Common Element Model

   The NetBIOS Service is implemented as an operating system application process. The NetBIOS applications are other operating system application processes. The service and the applications exchange data via operating system interprocess communication. In a multi-processor (e.g. network) operating system, each module may reside on a different cpu. The NetBIOS service process contains all the shared information required to coordinate the activities of the NetBIOS applications. The applications may still require a subroutine library to facilitate access to the NetBIOS service.

For any of the implementation models, the TCP/IP service can be located in the operating system or split among the NetBIOS applications and the NetBIOS service processes.

B-1.1 MODEL INDEPENDENT CONSIDERATIONS

The NetBIOS name service associates a NetBIOS name with a host. The NetBIOS session service further binds the name to a specific TCP port for the duration of the session.

The name service does not need to be informed of every Listen initiation and completion. Since the names are not bound to any TCP port in the name service, the session service may use a different tcp port for each session established with the same local name.

The TCP port used for the data transfer phase of a NetBIOS session can be globally well-known, locally well-known, or ephemeral. The choice is a local implementation issue. The RETARGET mechanism allows the binding of the NetBIOS session to a TCP connection to any TCP port, even to another IP node.

An implementation may use the session service's globally well- known TCP port for the data transfer phase of the session by not using the RETARGET mechanism and, rather, accepting the session on the initial TCP connection. This is permissible because the caller always uses an ephemeral TCP port.

The complexity of the called end RETARGET mechanism is only required if a particular implementation needs it. For many real system environments, such as an in-kernel NetBIOS service implementation, it will not be necessary to retarget incoming calls. Rather, all NetBIOS sessions may be multiplexed through the single, well-known, NetBIOS session service port. These implementations will not be burdened by the complexity of the RETARGET mechanism, nor will their callers be required to jump through the retargetting hoops.

Nevertheless, all callers must be ready to process all possible SESSION RETARGET RESPONSEs.

B-1.2 SERVICE OPERATION FOR EACH MODEL

It is possible to construct a NetBIOS service based on this specification for each of the above defined implementation models.

For the common kernel element model, all the NetBIOS services, name, datagram, and session, are simple. All the information is contained within a single entity and can therefore be accessed or modified easily. A single port or multiple ports for the NetBIOS sessions can be used without adding any significant complexity to the session establishment procedure. The only penalty is the amount of overhead incurred to get the NetBIOS messages and operation requests/responses

through the user and operating system boundary.

The combined service and application model is very similar to the common kernel element model in terms of its requirements on the NetBIOS service. The major difficulty is the internal coordination of the multiple NetBIOS service and application processes existing in a system of this type.

The NetBIOS name, datagram and session protocols assume that the entities at the end-points have full control of the various well-known TCP and UDP ports. If an implementation has multiple NetBIOS service entities, as would be the case with, for example, multiple applications each linked into a NetBIOS library, then that implementation must impose some internal coordination. Alternatively, use of the NetBIOS ports could be periodically assigned to one application or another.

For the typical non-kernel common element mode implementation, three permanent system-wide NetBIOS service processes would exist:

- The name server
- the datagram server
- and session server

Each server would listen for requests from the network on a UDP or TCP well-known port. Each application would have a small piece of the NetBIOS service built-in, possibly a library. Each application's NetBIOS support library would need to send a message to the particular server to request an operation, such as add name or send a datagram or set-up a listen.

The non-kernel common element model does not require a TCP connection be passed between the two processes, session server and application. The RETARGET operation for an active NetBIOS Listen could be used by the session server to redirect the session to another TCP connection on a port allocated and owned by the application's NetBIOS support library. The application with either a built-in or a kernel-based TCP/IP service could then accept the RETARGETed connection request and process it independently of the session server.

On Unix(tm) or POSIX(tm), the NetBIOS session server could create sub-processes for incoming connections. The open sessions would be passed through "fork" and "exec" to the child as an open file descriptor. This approach is very limited, however. A pre- existing process could not receive an incoming call. And all call-ed processes would have to be sub-processes of the session server.

B-2. CASUAL AND RESTRICTED NetBIOS APPLICATIONS

Because NetBIOS was designed to operate in the open system environment of the typical personal computer, it does not have the

concept of privileged or unprivileged applications. In many multi-user or multi-tasking operating systems applications are assigned privilege capabilities. These capabilities limit the applications ability to acquire and use system resources. For these systems it is important to allow casual applications, those with limited system privileges, and privileged applications, those with 'super-user' capabilities but access to them and their required resources is restricted, to access NetBIOS services. It is also important to allow a systems administrator to restrict certain NetBIOS resources to a particular NetBIOS application. For example, a file server based on the NetBIOS services should be able to have names and TCP ports for sessions only it can use.

A NetBIOS application needs at least two local resources to communicate with another NetBIOS application, a NetBIOS name for itself and, typically, a session. A NetBIOS service cannot require that NetBIOS applications directly use privileged system resources. For example, many systems require privilege to use TCP and UDP ports with numbers less than 1024. This RFC requires reserved ports for the name and session servers of a NetBIOS service implementation. It does not require the application to have direct access these reserved ports.

For the name service, the manager of the local name table must have access to the NetBIOS name service's reserved UDP port. It needs to listen for name service UDP packets to defend and define its local names to the network. However, this manager need not be a part of a user application in a system environment which has privilege restrictions on reserved ports.

The internal name server can require certain privileges to add, delete, or use a certain name, if an implementer wants the restriction. This restriction is independent of the operation of the NetBIOS service protocols and would not necessarily prevent the interoperation of that implementation with another implementation.

The session server is required to own a reserved TCP port for session establishment. However, the ultimate TCP connection used to transmit and receive data does not have to be through that reserved port. The RETARGET procedure the NetBIOS session to be shifted to another TCP connection, possibly through a different port at the called end. This port can be an unprivileged resource, with a value greater than 1023. This facilitates casual applications.

Alternately, the RETARGET mechanism allows the TCP port used for data transmission and reception to be a reserved port. Consequently, an application wishing to have access to its ports maintained by the system administrator can use these restricted TCP ports. This facilitates privileged applications.

A particular implementation may wish to require further special

privileges for session establishment, these could be associated with internal information. It does not have to be based solely on TCP port allocation. For example, a given NetBIOS name may only be used for sessions by applications with a certain system privilege level.

The decision to use reserved or unreserved ports or add any additional name registration and usage authorization is a purely local implementation decision. It is not required by the NetBIOS protocols specified in the RFC.

B-3. TCP VERSUS SESSION KEEP-ALIVES

The KEEP-ALIVE is a protocol element used to validate the existence of a connection. A packet is sent to the remote connection partner to solicit a response which shows the connection is still functioning. TCP KEEP-ALIVES are used at the TCP level on TCP connections while session KEEP-ALIVES are used on NetBIOS sessions. These protocol operations are always transparent to the connection user. The user will only find out about a KEEP-ALIVE operation if it fails, therefore, if the connection is lost.

The NetBIOS specification[2] requires the NetBIOS service to inform the session user if a session is lost when it is in a passive or active state. Therefore,if the session user is only waiting for a receive operation and the session is dropped the NetBIOS service must inform the session user. It cannot wait for a session send operation before it informs the user of the loss of the connection.

This requirement stems from the management of scarce or volatile resources by a NetBIOS application. If a particular user terminates a session with a server application by destroying the client application or the NetBIOS service without a NetBIOS Hang Up, the server application will want to clean-up or free allocated resources. This server application if it only receives and then sends a response requires the notification of the session abort in the passive state.

The standard definition of a TCP service cannot detect loss of a connection when it is in a passive state, waiting for a packet to arrive. Some TCP implementations have added a KEEP-ALIVE operation which is interoperable with implementations without this feature. These implementations send a packet with an invalid sequence number to the connection partner. The partner, by specification, must respond with a packet showing the correct sequence number of the connection. If no response is received from the remote partner within a certain time interval then the TCP service assumes the connection is lost.

Since many TCP implementations do not have this KEEP-ALIVE function an optional NetBIOS KEEP-ALIVE operation has been added to the NetBIOS session protocols. The NetBIOS KEEP-ALIVE uses the properties of TCP to solicit a response from the remote connection

partner. A NetBIOS session message called KEEP-ALIVE is sent to the remote partner. Since this results in TCP sending an IP packet to the remote partner, the TCP connection is active. TCP will discover if the TCP connection is lost if the remote TCP partner does not acknowledge the IP packet. Therefore, the NetBIOS session service does not send a response to a session KEEP ALIVE message. It just throws it away. The NetBIOS session service that transmits the KEEP ALIVE is informed only of the failure of the TCP connection. It does not wait for a specific response message.

A particular NetBIOS implementation should use KEEP-ALIVES if it is concerned with maintaining compatibility with the NetBIOS interface specification[2]. Compatibility is especially important if the implementation wishes to support existing NetBIOS applications, which typically require the session loss detection on their servers, or future applications which were developed for implementations with session loss detection.

B-4. RETARGET ALGORITHMS

This section contains 2 suggestions for RETARGET algorithms. They are called the "straight" and "stack" methods. The algorithm in the body of the RFC uses the straight method. Implementation of either algorithm must take into account the Session establishment maximum retry count. The retry count is the maximum number of TCP connect operations allowed before a failure is reported.

The straight method forces the session establishment procedure to begin a retry after a retargetting failure with the initial node returned from the name discovery procedure. A retargetting failure is when a TCP connection attempt fails because of a time- out or a NEGATIVE SESSION RESPONSE is received with an error code specifying NOT LISTENING ON CALLED NAME. If any other failure occurs the session establishment procedure should retry from the call to the name discovery procedure.

A minimum of 2 retries, either from a retargetting or a name discovery failure. This will give the session service a chance to re-establish a NetBIOS Listen or, more importantly, allow the NetBIOS scope, local name service or the NBNS, to re-learn the correct IP address of a NetBIOS name.

The stack method operates similarly to the straight method. However, instead of retrying at the initial node returned by the name discovery procedure, it restarts with the IP address of the last node which sent a SESSION RETARGET RESPONSE prior to the retargetting failure. To limit the stack method, any one host can only be tried a maximum of 2 times.

B-5. NBDD SERVICE

If the NBDD does not forward datagrams then don't provide Group and Broadcast NetBIOS datagram services to the NetBIOS user. Therefore, ignore the implementation of the query request and, when get a negative response, acquiring the membership list of IP addresses and sending the datagram as a unicast to each member.

B-6. APPLICATION CONSIDERATIONS

B-6.1 USE OF NetBIOS DATAGRAMS

Certain existing NetBIOS applications use NetBIOS datagrams as a foundation for their own connection-oriented protocols. This can cause excessive NetBIOS name query activity and place a substantial burden on the network, server nodes, and other end- nodes. It is recommended that this practice be avoided in new applications.

Appendix G

RFC 1002

This appendix reproduces, in full and unedited, RFC 1002, Protocol Standard for a NetBIOS Service on a TCP/UDP Transport: Detailed Specifications.

Network Working Group
Request for Comments: 1002 March, 1987

PROTOCOL STANDARD FOR A NetBIOS SERVICE ON A TCP/UDP TRANSPORT: DETAILED SPECIFICATIONS

ABSTRACT

This RFC defines a proposed standard protocol to support NetBIOS services in a TCP/IP environment. Both local network and internet operation are supported. Various node types are defined to accommodate local and internet topologies and to allow operation with or without the use of IP broadcast.

This RFC gives the detailed specifications of the NetBIOS-over-TCP packets, protocols, and defined constants and variables. A more general overview is found in a companion RFC, "Protocol Standard For a NetBIOS Service on a TCP/UDP Transport: Concepts and Methods".

TABLE OF CONTENTS

PROTOCOL STANDARD FOR A NetBIOS SERVICE ON A TCP/UDP TRANSPORT: DETAILED SPECIFICATIONS

1. STATUS OF THIS MEMO

This RFC specifies a proposed standard for the DARPA Internet community. Since this topic is new to the Internet community, discussions and suggestions are specifically requested.

Please send written comments to:

Karl Auerbach
Epilogue Technology Corporation
P.O. Box 5432
Redwood City, CA 94063

Please send online comments to:

Avnish Aggarwal
Internet: mtxinu!excelan!avnish@ucbvax.berkeley.edu
Usenet: ucbvax!mtxinu!excelan!avnish

Distribution of this memorandum is unlimited.

2. ACKNOWLEDGEMENTS

This RFC has been developed under the auspices of the Internet Activities Board.

The following individuals have contributed to the development of this RFC:

Avnish Aggarwal	Arvind Agrawal	Lorenzo Aguilar
Geoffrey Arnold	Karl Auerbach	K. Ramesh Babu
Keith Ball	Amatzia Ben-Artzi	Vint Cerf
Richard Cherry	David Crocker	Steve Deering
Greg Ennis	Steve Holmgren	Jay Israel
David Kaufman	Lee LaBarre	James Lau
Dan Lynch	Gaylord Miyata	David Stevens
Steve Thomas	Ishan Wu	

The system proposed by this RFC does not reflect any existing Netbios-over-TCP implementation. However, the design incorporates considerable knowledge obtained from prior implementations. Special thanks goes to the following organizations which have provided this invaluable information:

CMC/Syros Excelan Sytek Ungermann-Bass

3. INTRODUCTION

This RFC contains the detailed packet formats and protocol specifications for NetBIOS-over-TCP. This RFC is a companion to RFC 1001, "Protocol Standard For a NetBIOS Service on a TCP/UDP Transport: Concepts and Methods" [1].

4. PACKET DESCRIPTIONS

Bit and byte ordering are defined by the most recent version of "Assigned Numbers" [2].

4.1. NAME FORMAT

The NetBIOS name representation in all NetBIOS packets (for NAME, SESSION, and DATAGRAM services) is defined in the Domain Name Service RFC 883[3] as "compressed" name messages. This format is called "second-level encoding" in the section entitled "Representation of NetBIOS Names" in the Concepts and Methods document.

For ease of description, the first two paragraphs from page 31, the section titled "Domain name representation and compression", of RFC 883 are replicated here:

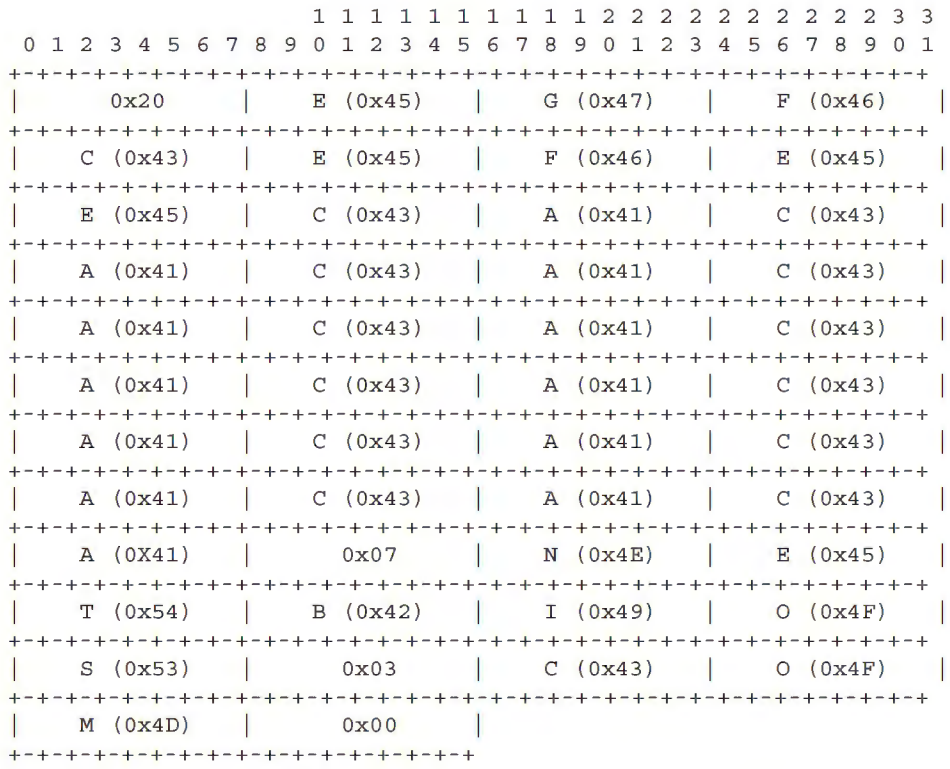
> Domain names messages are expressed in terms of a sequence of labels. Each label is represented as a one octet length field followed by that number of octets. Since every domain name ends with the null label of the root, a compressed domain name is terminated by a length byte of zero. The high order two bits of the length field must be zero, and the remaining six bits of the length field limit the label to 63 octets or less.
>
> To simplify implementations, the total length of label octets and label length octets that make up a domain name is restricted to 255 octets or less.

The following is the uncompressed representation of the NetBIOS name "FRED ", which is the 4 ASCII characters, F, R, E, D, followed by 12 space characters (0x20). This name has the SCOPE_ID: "NETBIOS.COM"

EGFCEFEECACACACACACACACACACACACA.NETBIOS.COM

This uncompressed representation of names is called "first-level encoding" in the section entitled "Representation of NetBIOS Names" in the Concepts and Methods document.

The following is a pictographic representation of the compressed representation of the previous uncompressed Domain Name representation.



Each section of a domain name is called a label [7 (page 31)]. A label can be a maximum of 63 bytes. The first byte of a label in compressed representation is the number of bytes in the label. For the above example, the first 0x20 is the number of bytes in the left-most label, EGFCEFEECACACACACACACACACACACA, of the domain name. The bytes following the label length count are the characters of the label. The following labels are in sequence after the first label, which is the encoded NetBIOS name, until a zero (0x00) length count. The zero length count represents the root label, which is always null.

A label length count is actually a 6-bit field in the label length field. The most significant 2 bits of the field, bits 7 and 6, are flags allowing an escape from the above compressed representation. If bits 7 and 6 are both set (11), the following 14 bits are an offset pointer into the full message to the actual label string from another domain name that belongs in this name. This label pointer allows for a further compression of a domain name in a packet.

NetBIOS implementations can only use label string pointers in Name Service packets. They cannot be used in Session or Datagram Service packets.

The other two possible values for bits 7 and 6 (01 and 10) of a label length field are reserved for future use by RFC 883[2 (page 32)].

Note that the first octet of a compressed name must contain one of the following bit patterns. (An "x" indicates a bit whose value may be either 0 or 1.):

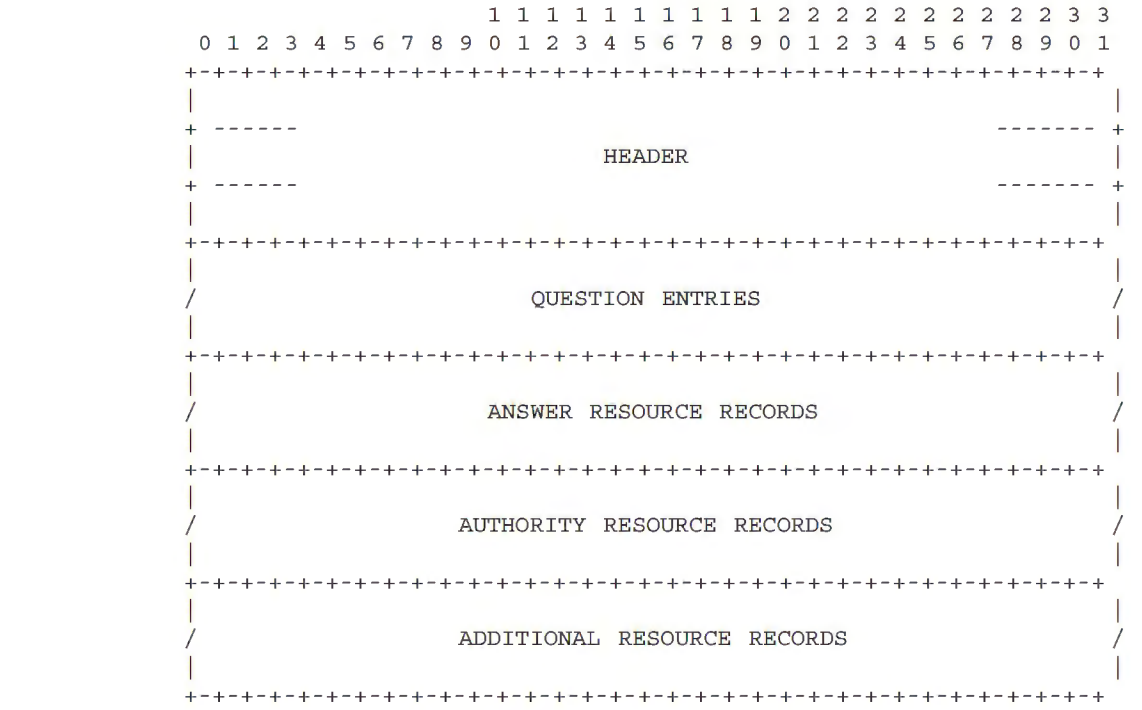
```
00100000 -  Netbios name, length must be 32 (decimal)
11xxxxxx -  Label string pointer
10xxxxxx -  Reserved
01xxxxxx -  Reserved
```

4.2. NAME SERVICE PACKETS

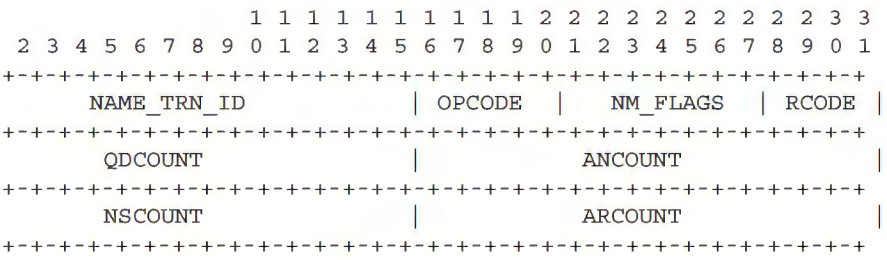
4.2.1. GENERAL FORMAT OF NAME SERVICE PACKETS

The NetBIOS Name Service packets follow the packet structure defined in the Domain Name Service (DNS) RFC 883 [7 (pg 26-31)]. The structures are compatible with the existing DNS packet formats, however, additional types and codes have been added to work with NetBIOS.

If Name Service packets are sent over a TCP connection they are preceded by a 16 bit unsigned integer representing the length of the Name Service packet.

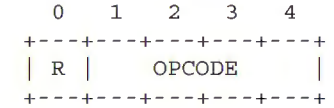


4.2.1.1. HEADER



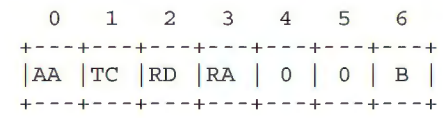
Field	Description
NAME_TRN_ID	Transaction ID for Name Service Transaction. Requestor places a unique value for each active transaction. Responder puts NAME_TRN_ID value from request packet in response packet.
OPCODE	Packet type code, see table below.
NM_FLAGS	Flags for operation, see table below.
RCODE	Result codes of request. Table of RCODE values for each response packet below.
QDCOUNT	Unsigned 16 bit integer specifying the number of entries in the question section of a Name Service packet. Always zero (0) for responses. Must be non-zero for all NetBIOS Name requests.
ANCOUNT	Unsigned 16 bit integer specifying the number of resource records in the answer section of a Name Service packet.
NSCOUNT	Unsigned 16 bit integer specifying the number of resource records in the authority section of a Name Service packet.
ARCOUNT	Unsigned 16 bit integer specifying the number of resource records in the additional records section of a Name Service packet.

The OPCODE field is defined as:



Symbol	Bit(s)	Description
OPCODE	1-4	Operation specifier: 0 = query 5 = registration 6 = release 7 = WACK 8 = refresh
R	0	RESPONSE flag: if bit == 0 then request packet if bit == 1 then response packet.

The NM_FLAGS field is defined as:



Symbol	Bit(s)	Description
B	6	Broadcast Flag. = 1: packet was broadcast or multicast = 0: unicast
RA	3	Recursion Available Flag. Only valid in responses from a NetBIOS Name Server -- must be zero in all other responses. If one (1) then the NBNS supports recursive query, registration, and release. If zero (0) then the end-node must iterate for query and challenge for registration.
RD	2	Recursion Desired Flag. May only be set on a request to a NetBIOS Name Server. The NBNS will copy its state into the response packet. If one (1) the NBNS will iterate on the query, registration, or release.
TC	1	Truncation Flag.

Set if this message was truncated because the datagram carrying it would be greater than 576 bytes in length. Use TCP to get the information from the NetBIOS Name Server.

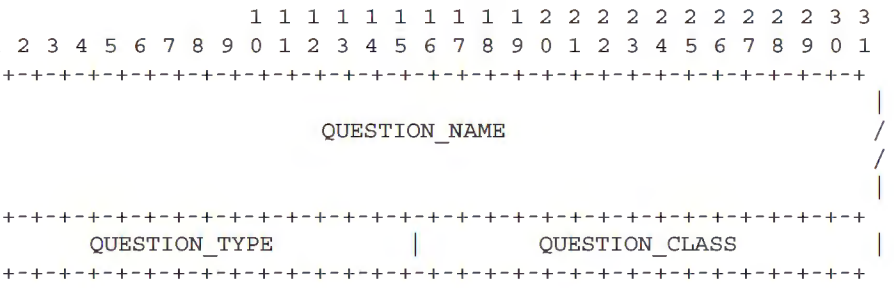
AA 0 Authoritative Answer flag.

Must be zero (0) if R flag of OPCODE is zero (0).

If R flag is one (1) then if AA is one (1) then the node responding is an authority for the domain name.

End nodes responding to queries always set this bit in responses.

4.2.1.2. QUESTION SECTION



Field	Description
QUESTION_NAME	The compressed name representation of the NetBIOS name for the request.
QUESTION_TYPE	The type of request. The values for this field are specified for each request.
QUESTION_CLASS	The class of the request. The values for this field are specified for each request.

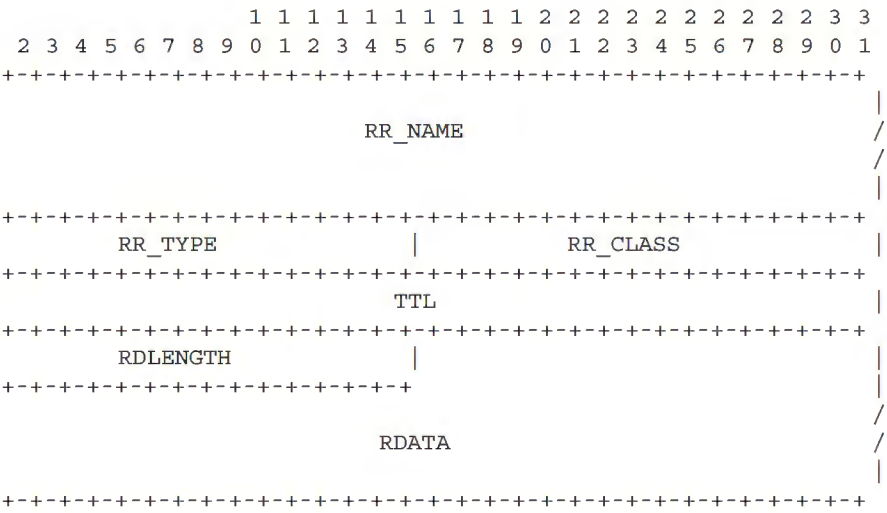
QUESTION_TYPE is defined as:

Symbol	Value	Description:
NB	0x0020	NetBIOS general Name Service Resource Record
NBSTAT	0x0021	NetBIOS NODE STATUS Resource Record (See NODE STATUS REQUEST)

QUESTION_CLASS is defined as:

Symbol	Value	Description:
IN	0x0001	Internet class

4.2.1.3. RESOURCE RECORD



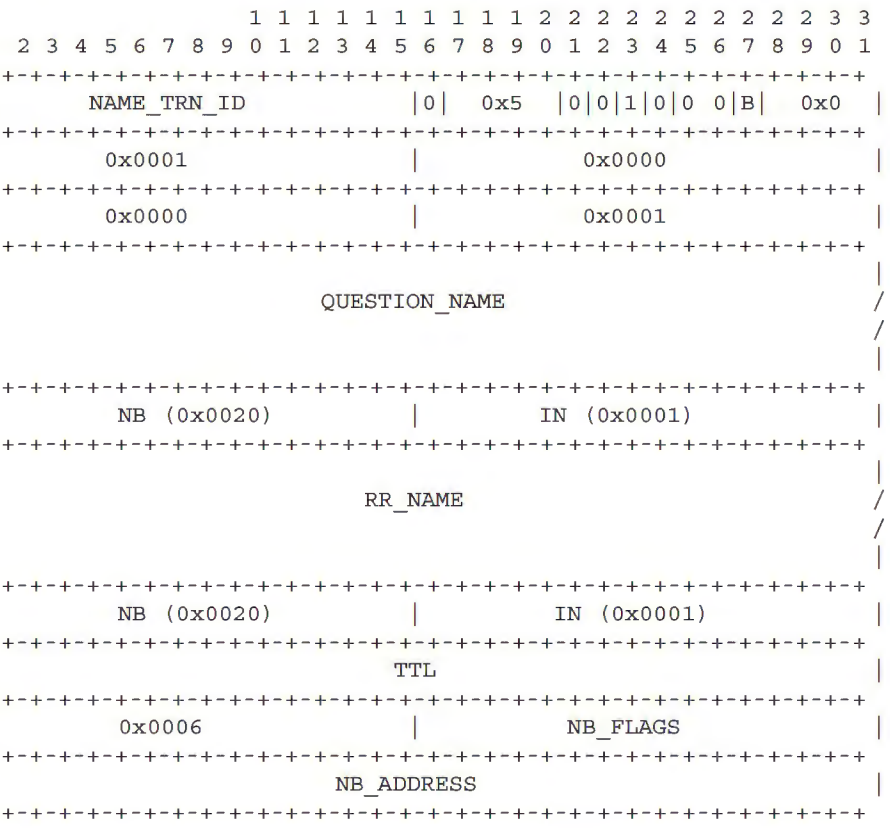
Field	Description
RR_NAME	The compressed name representation of the NetBIOS name corresponding to this resource record.
RR_TYPE	Resource record type code
RR_CLASS	Resource record class code
TTL	The Time To Live of a the resource record's name.
RDLENGTH	Unsigned 16 bit integer that specifies the number of bytes in the RDATA field.
RDATA	RR_CLASS and RR_TYPE dependent field. Contains the resource information for the NetBIOS name.

RESOURCE RECORD RR_TYPE field definitions:

Symbol	Value	Description:
A	0x0001	IP address Resource Record (See REDIRECT NAME QUERY RESPONSE)
NS	0x0002	Name Server Resource Record (See REDIRECT

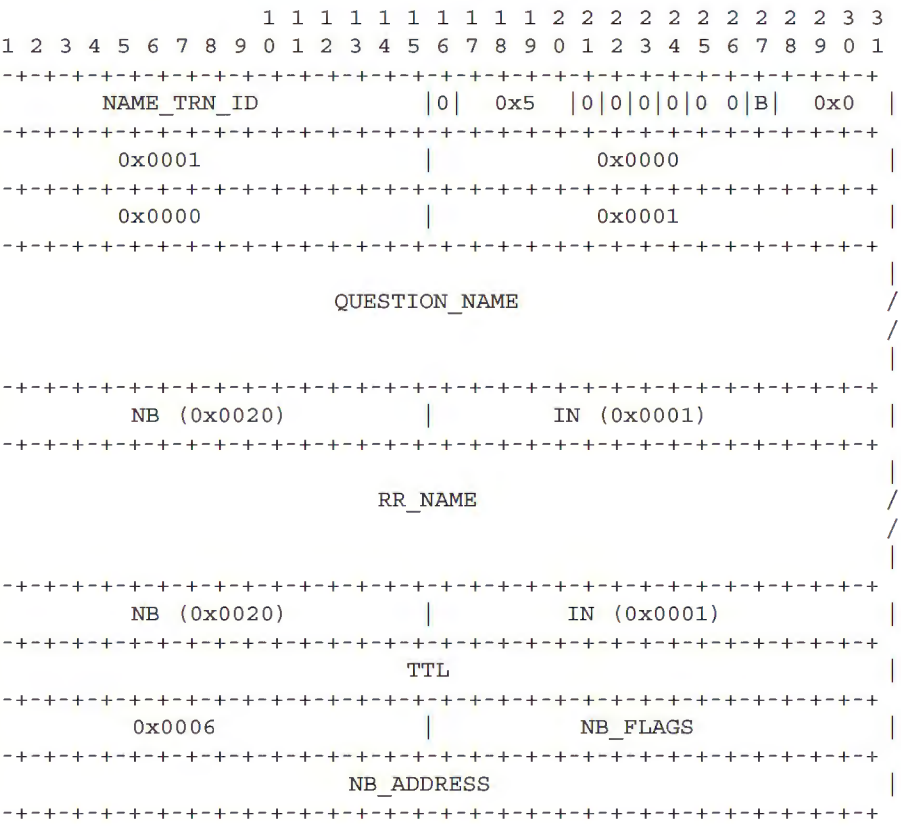
```
                        NAME QUERY RESPONSE)
   NULL         0x000A  NULL Resource Record (See WAIT FOR
                        ACKNOWLEDGEMENT RESPONSE)
   NB           0x0020  NetBIOS general Name Service Resource Record
                        (See NB_FLAGS and NB_ADDRESS, below)
   NBSTAT       0x0021  NetBIOS NODE STATUS Resource Record (See NODE
                        STATUS RESPONSE)

   RESOURCE RECORD RR_CLASS field definitions:

   Symbol       Value   Description:

   IN           0x0001  Internet class

   NB_FLAGS field of the RESOURCE RECORD RDATA field for RR_TYPE of
   "NB":

                                                 1   1   1   1   1   1
     0   1   2   3   4   5   6   7   8   9     0   1   2   3   4   5
   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
   | G |  ONT  |                RESERVED                                   |
   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

   Symbol       Bit(s)  Description:

   RESERVED      3-15   Reserved for future use.  Must be zero (0).
   ONT            1,2   Owner Node Type:
                           00 = B node
                           01 = P node
                           10 = M node
                           11 = Reserved for future use
                        For registration requests this is the
                        claimant's type.
                        For responses this is the actual owner's
                        type.

   G                0   Group Name Flag.
                        If one (1) then the RR_NAME is a GROUP
                        NetBIOS name.
                        If zero (0) then the RR_NAME is a UNIQUE
                        NetBIOS name.

   The NB_ADDRESS field of the RESOURCE RECORD RDATA field for
   RR_TYPE of "NB" is the IP address of the name's owner.
```

4.2.2. NAME REGISTRATION REQUEST

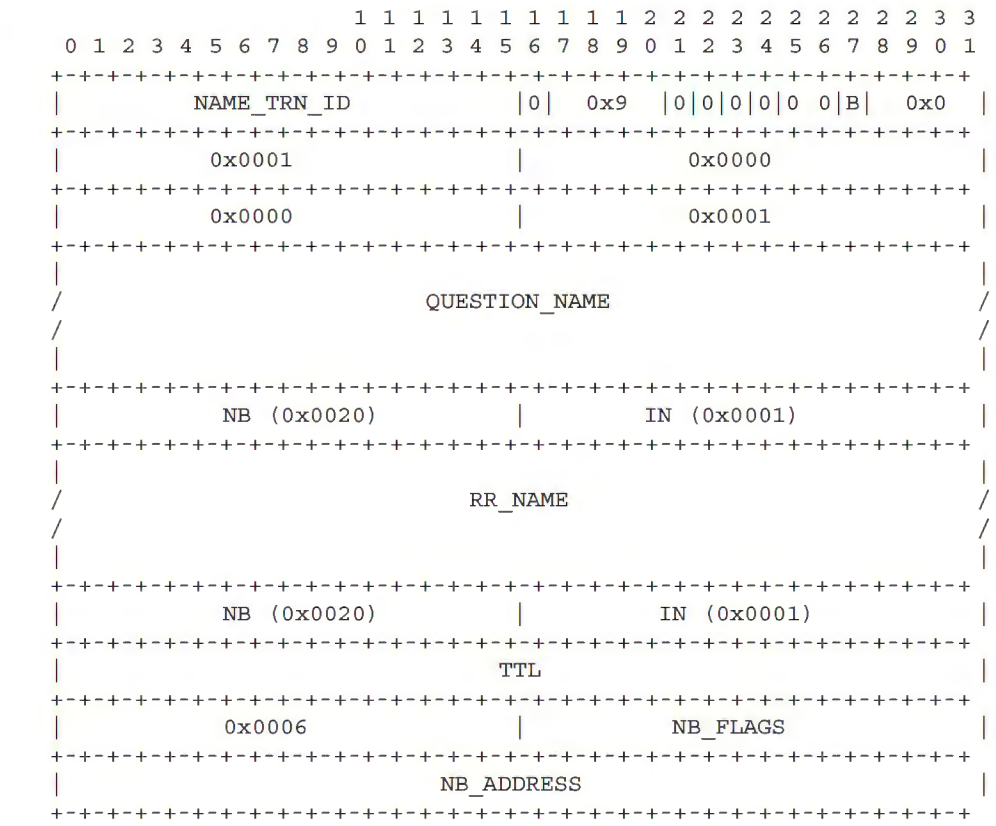


Since the RR_NAME is the same name as the QUESTION_NAME, the RR_NAME representation must use pointers to the QUESTION_NAME name's labels to guarantee the length of the datagram is less than the maximum 576 bytes. See section above on name formats and also page 31 and 32 of RFC 883, Domain Names - Implementation and Specification, for a complete description of compressed name label pointers.

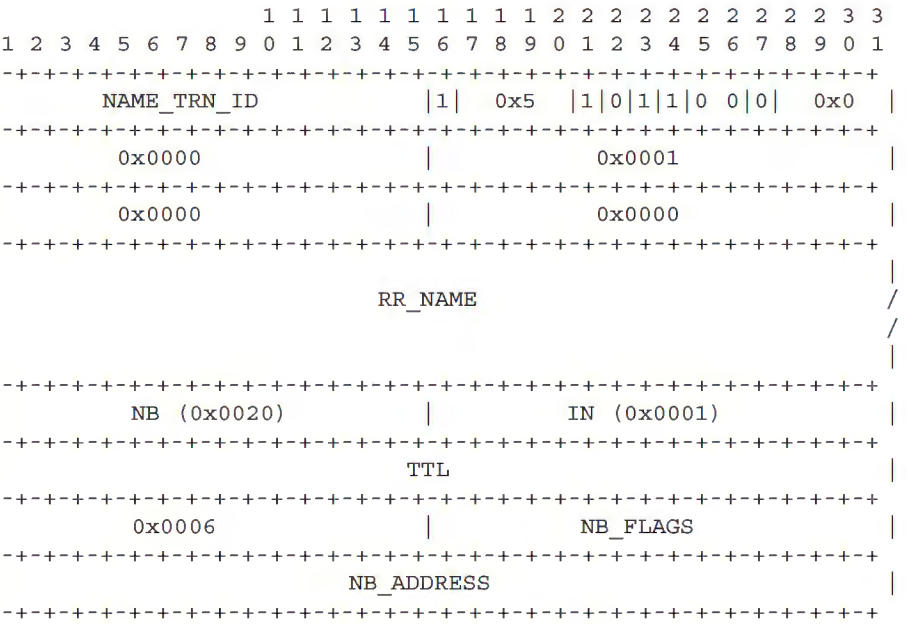
4.2.3. NAME OVERWRITE REQUEST & DEMAND



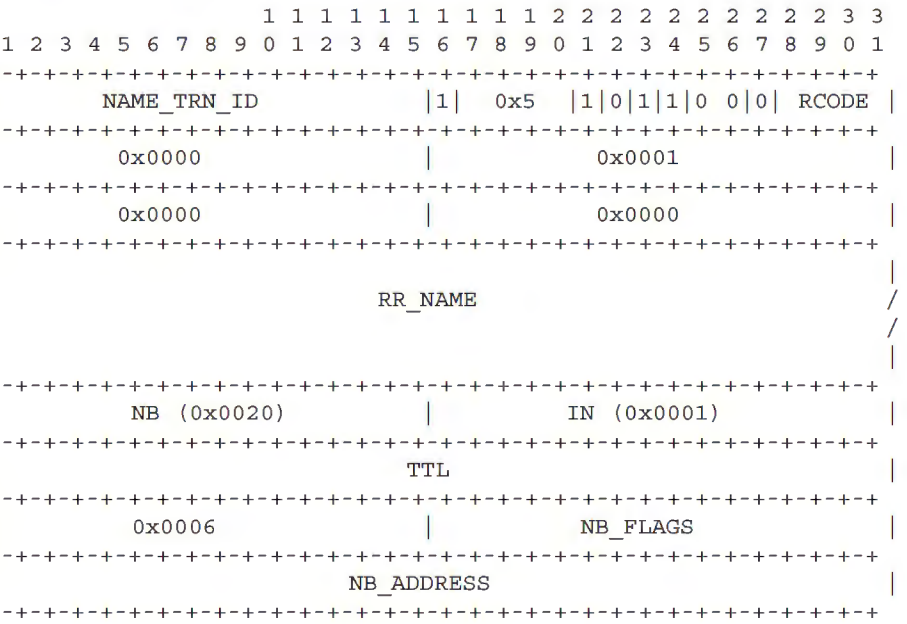
4.2.4. NAME REFRESH REQUEST



4.2.5. POSITIVE NAME REGISTRATION RESPONSE



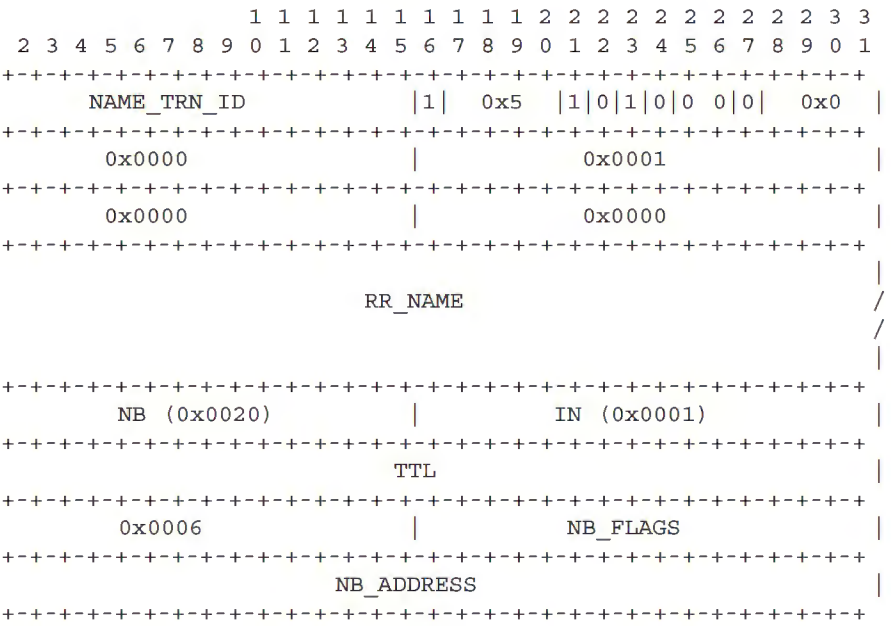
4.2.6. NEGATIVE NAME REGISTRATION RESPONSE



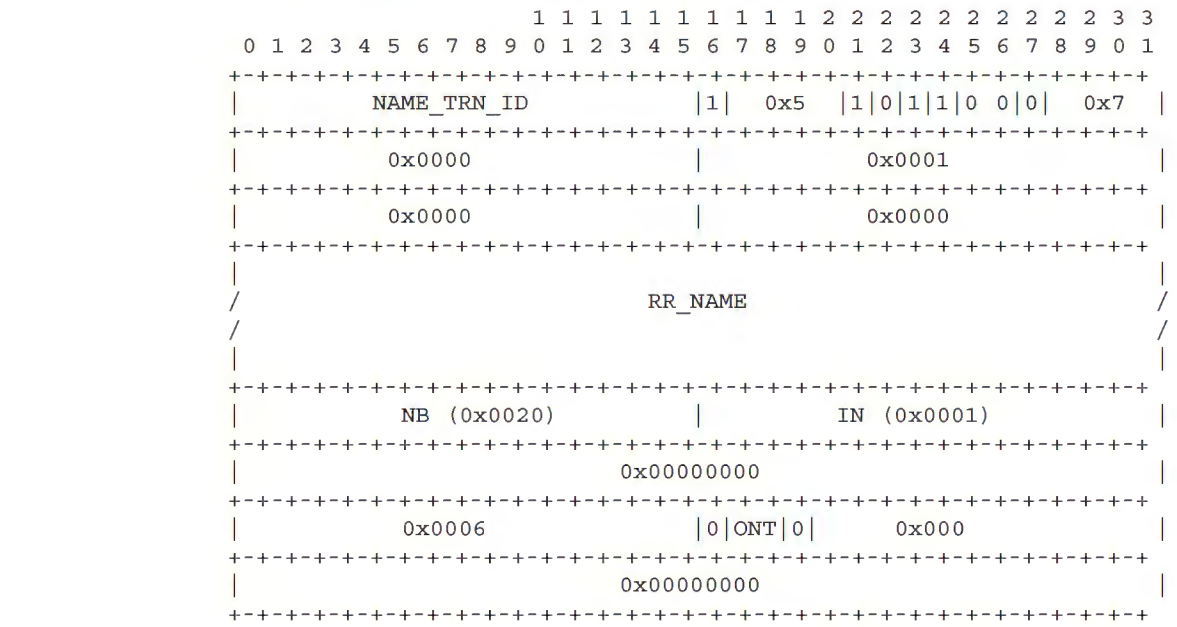
RCODE field values:

Symbol	Value	Description:
FMT_ERR	0x1	Format Error. Request was invalidly formatted.
SRV_ERR	0x2	Server failure. Problem with NBNS, cannot process name.
IMP_ERR	0x4	Unsupported request error. Allowable only for challenging NBNS when gets an Update type registration request.
RFS_ERR	0x5	Refused error. For policy reasons server will not register this name from this host.
ACT_ERR	0x6	Active error. Name is owned by another node.
CFT_ERR	0x7	Name in conflict error. A UNIQUE name is owned by more than one node.

4.2.7. END-NODE CHALLENGE REGISTRATION RESPONSE

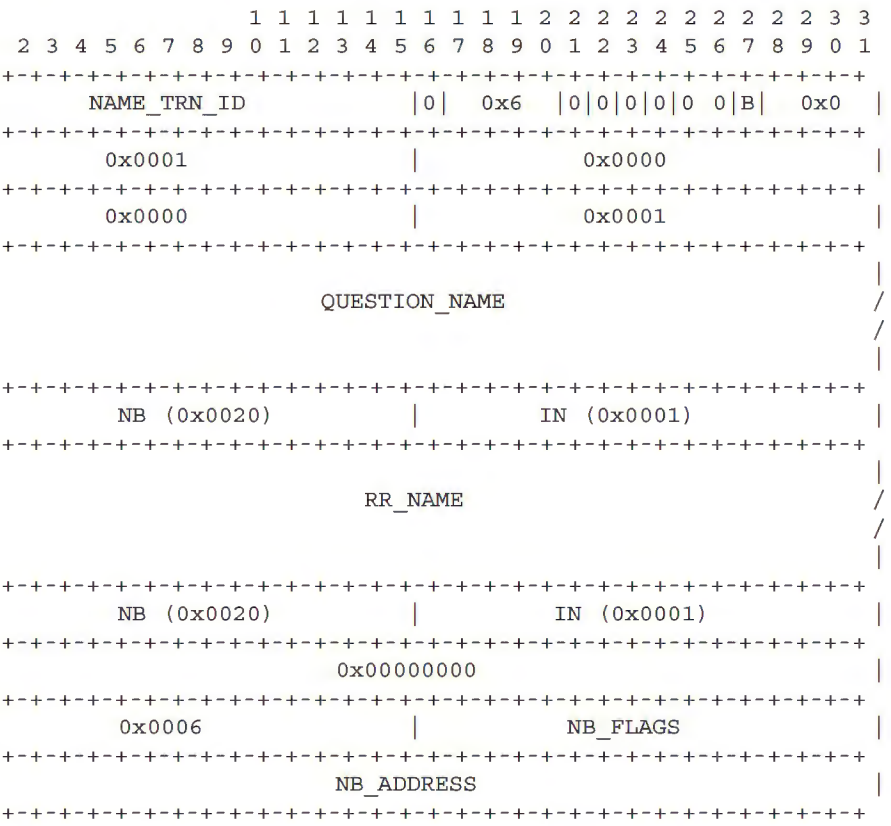


4.2.8. NAME CONFLICT DEMAND



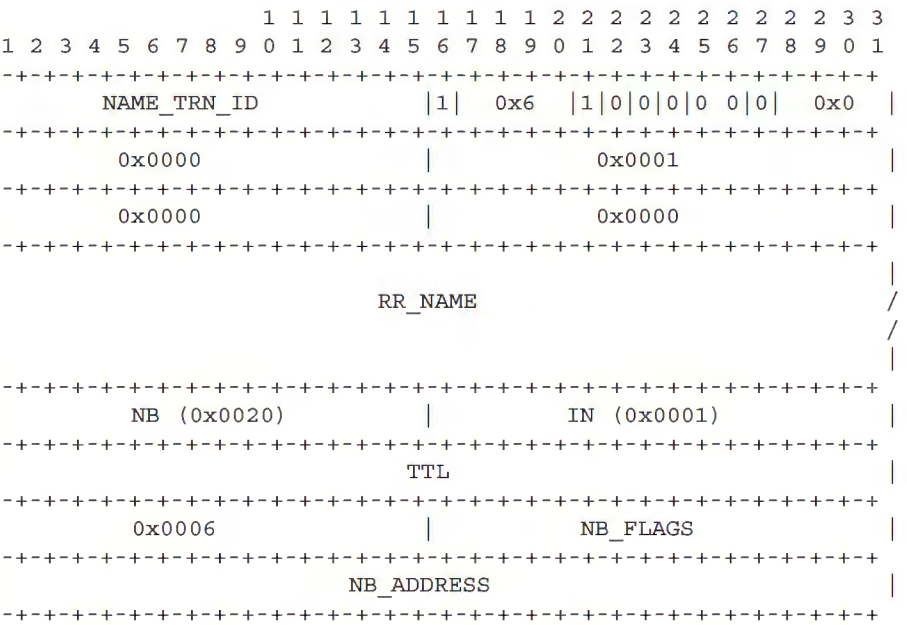
This packet is identical to a NEGATIVE NAME REGISTRATION RESPONSE with RCODE = CFT_ERR.

4.2.9. NAME RELEASE REQUEST & DEMAND

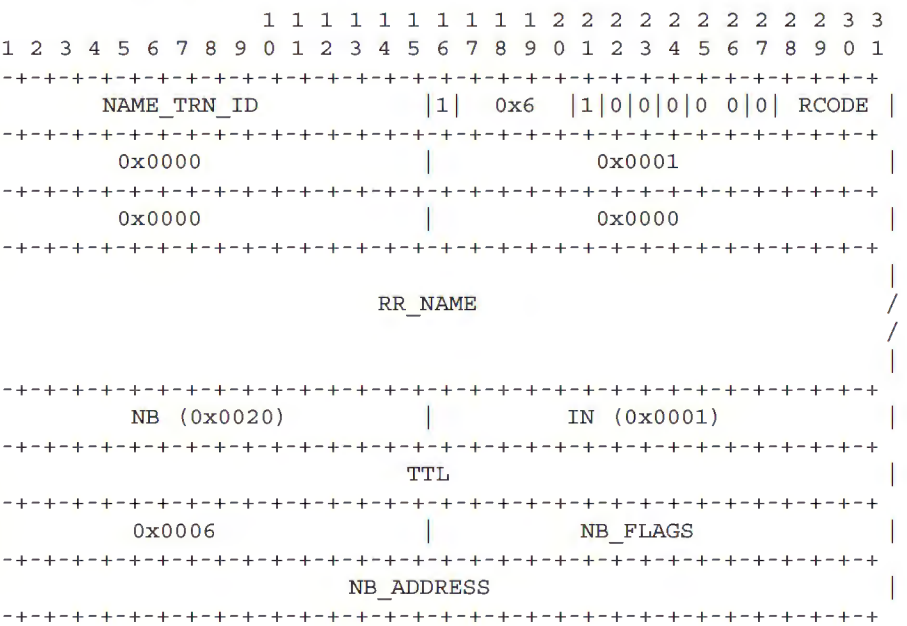


Since the RR_NAME is the same name as the QUESTION_NAME, the RR_NAME representation must use label string pointers to the QUESTION_NAME labels to guarantee the length of the datagram is less than the maximum 576 bytes. This is the same condition as with the NAME REGISTRATION REQUEST.

4.2.10. POSITIVE NAME RELEASE RESPONSE



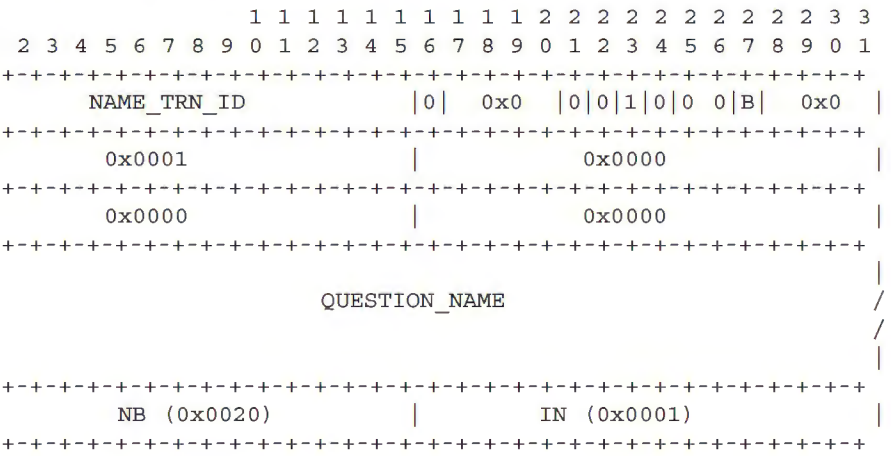
4.2.11. NEGATIVE NAME RELEASE RESPONSE



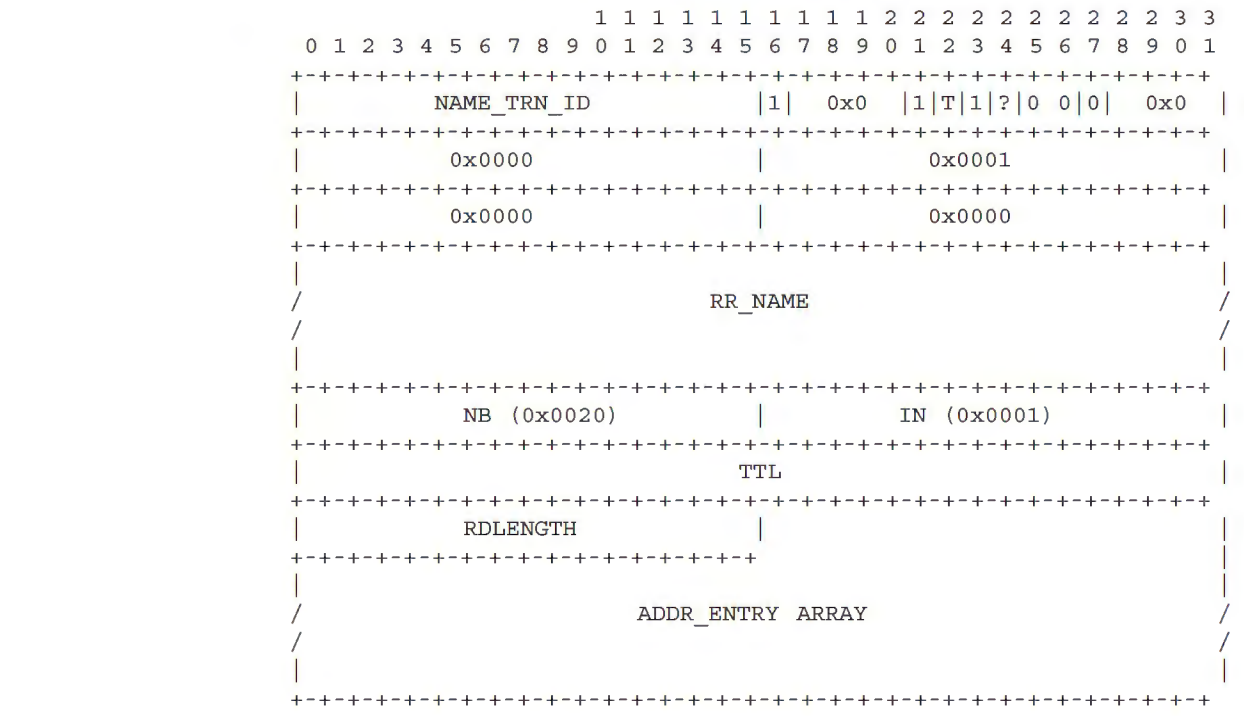
RCODE field values:

Symbol	Value	Description:
FMT_ERR	0x1	Format Error. Request was invalidly formatted.
SRV_ERR	0x2	Server failure. Problem with NBNS, cannot process name.
RFS_ERR	0x5	Refused error. For policy reasons server will not release this name from this host.
ACT_ERR	0x6	Active error. Name is owned by another node. Only that node may release it. A NetBIOS Name Server can optionally allow a node to release a name it does not own. This would facilitate detection of inactive names for nodes that went down silently.

4.2.12. NAME QUERY REQUEST

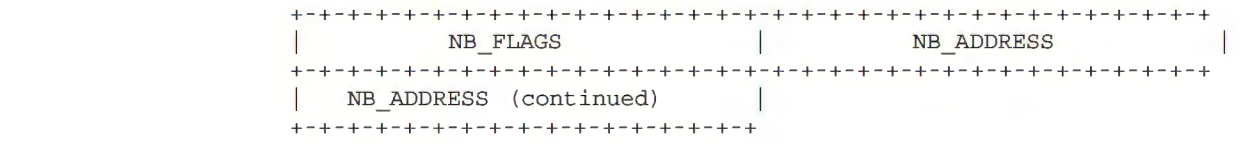


4.2.13. POSITIVE NAME QUERY RESPONSE

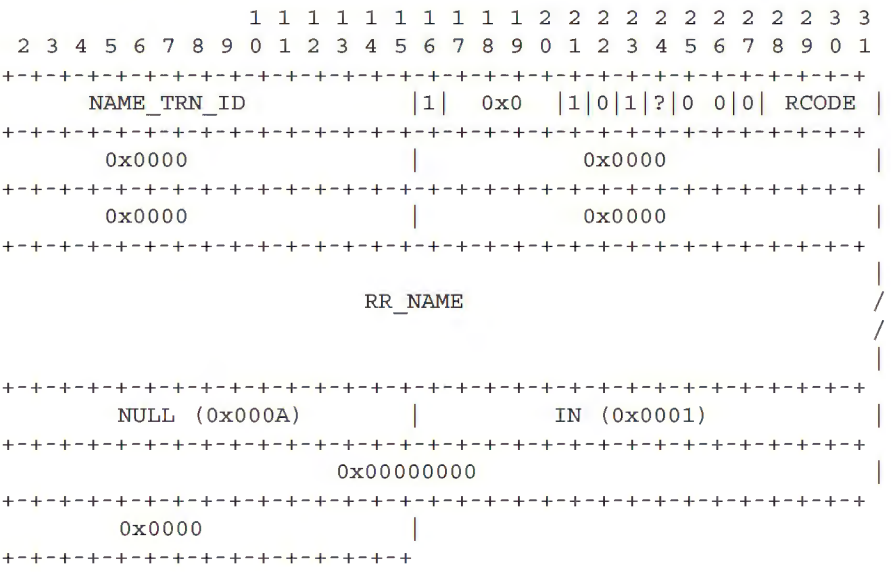


The ADDR_ENTRY ARRAY a sequence of zero or more ADDR_ENTRY records. Each ADDR_ENTRY record represents an owner of a name. For group names there may be multiple entries. However, the list may be incomplete due to packet size limitations. Bit 22, "T", will be set to indicate truncated data.

Each ADDR_ENTRY has the following format:



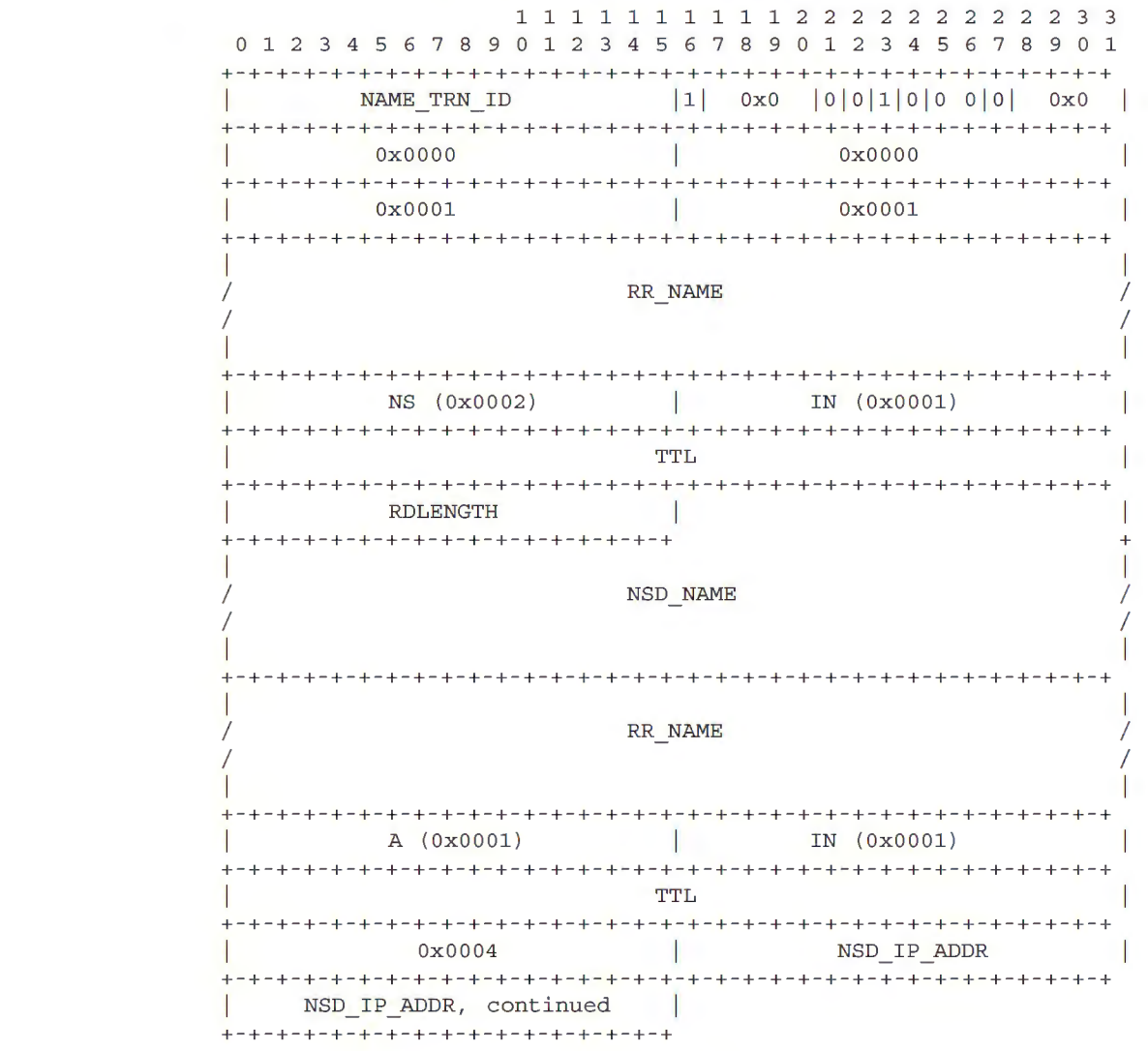
4.2.14. NEGATIVE NAME QUERY RESPONSE



RCODE field values:

Symbol	Value	Description
FMT_ERR	0x1	Format Error. Request was invalidly formatted.
SRV_ERR	0x2	Server failure. Problem with NBNS, cannot process name.
NAM_ERR	0x3	Name Error. The name requested does not exist.
IMP_ERR	0x4	Unsupported request error. Allowable only for challenging NBNS when gets an Update type registration request.
RFS_ERR	0x5	Refused error. For policy reasons server will not register this name from this host.

4.2.15. REDIRECT NAME QUERY RESPONSE



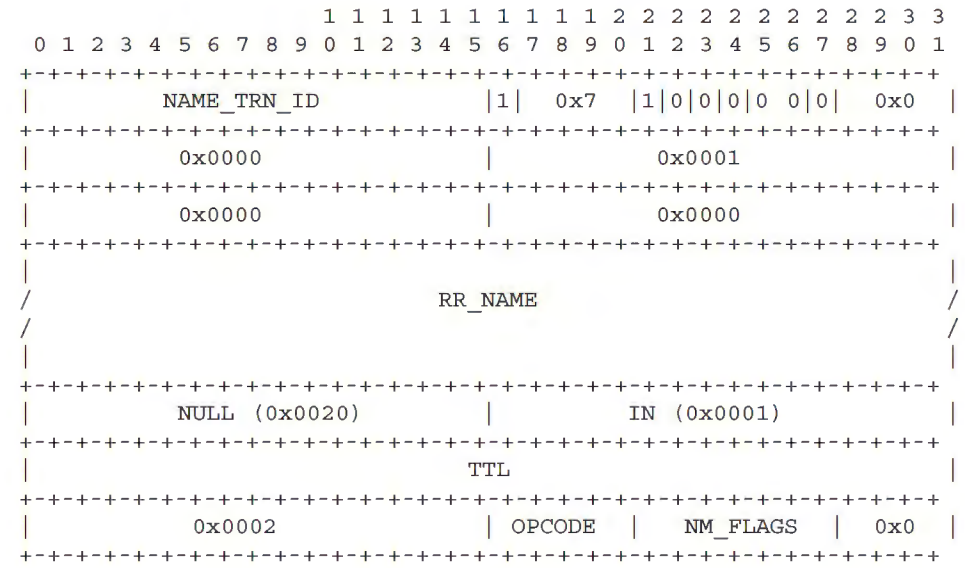
An end node responding to a NAME QUERY REQUEST always responds with the AA and RA bits set for both the NEGATIVE and POSITIVE NAME QUERY RESPONSE packets. An end node never sends a REDIRECT NAME QUERY RESPONSE packet.

When the requestor receives the REDIRECT NAME QUERY RESPONSE it must reiterate the NAME QUERY REQUEST to the NBNS specified by the NSD_IP_ADDR field of the A type RESOURCE RECORD in the ADDITIONAL section of the response packet. This is an optional packet for the NBNS.

The NSD_NAME and the RR_NAME in the ADDITIONAL section of the response packet are the same name. Space can be optimized if label string pointers are used in the RR_NAME which point to the labels in the NSD_NAME.

The RR_NAME in the AUTHORITY section is the name of the domain the NBNS called by NSD_NAME has authority over.

4.2.16. WAIT FOR ACKNOWLEDGEMENT (WACK) RESPONSE

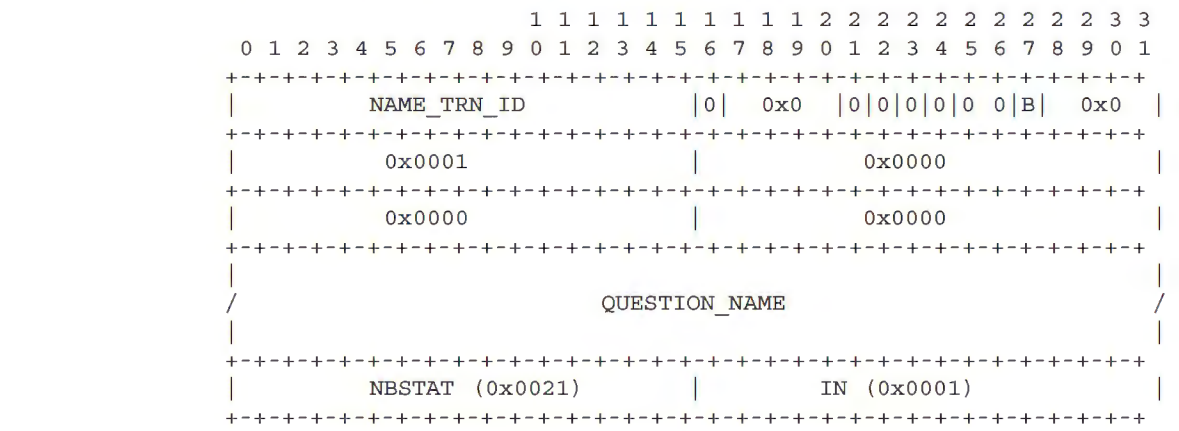


The NAME_TRN_ID of the WACK RESPONSE packet is the same NAME_TRN_ID of the request that the NBNS is telling the requestor to wait longer to complete. The RR_NAME is the name from the request, if any. If no name is available from the request then it is a null name, single byte of zero.

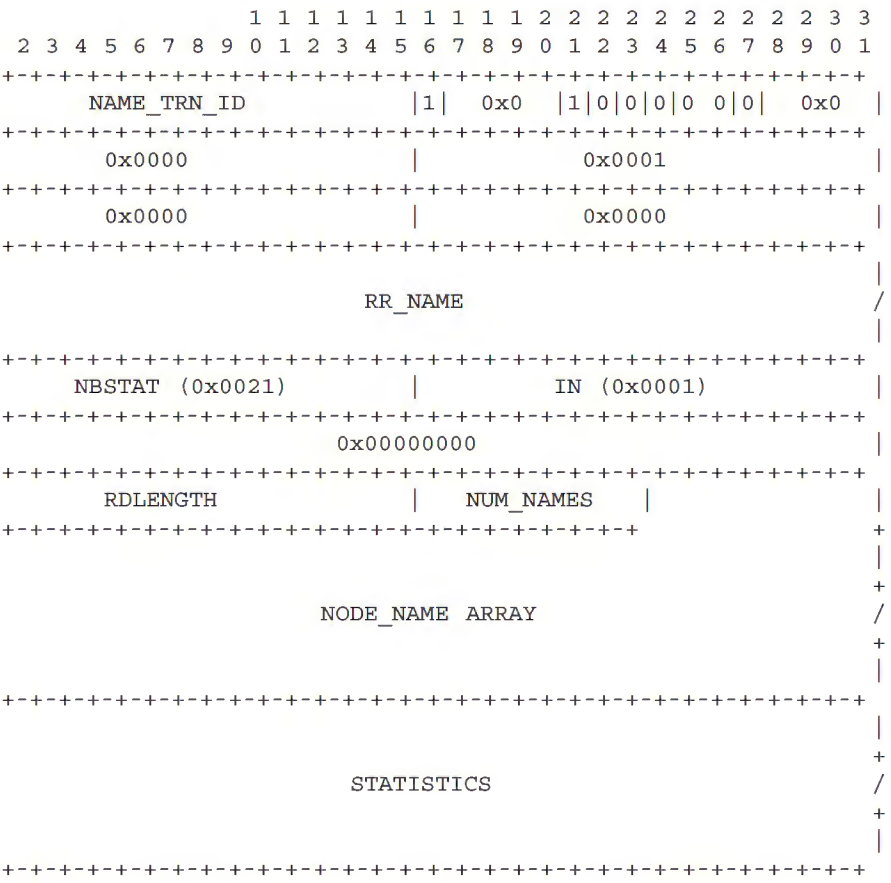
The TTL field of the ResourceRecord is the new time to wait, in seconds, for the request to complete. The RDATA field contains the OPCODE and NM_FLAGS of the request.

A TTL value of 0 means that the NBNS can not estimate the time it may take to complete a response.

4.2.17. NODE STATUS REQUEST

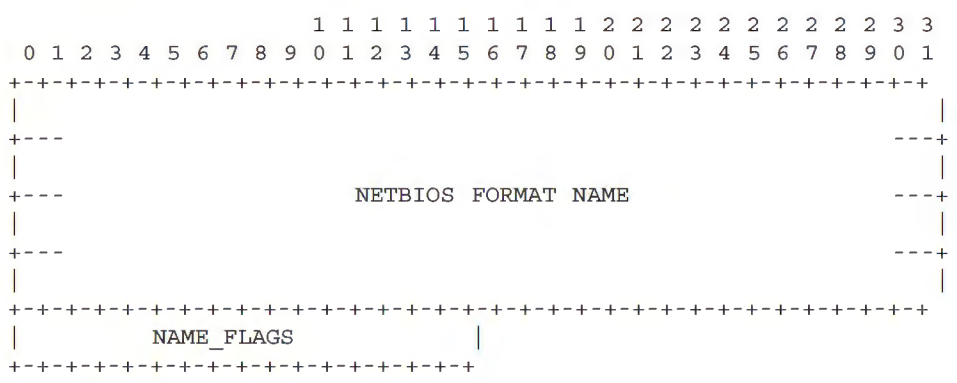


4.2.18. NODE STATUS RESPONSE

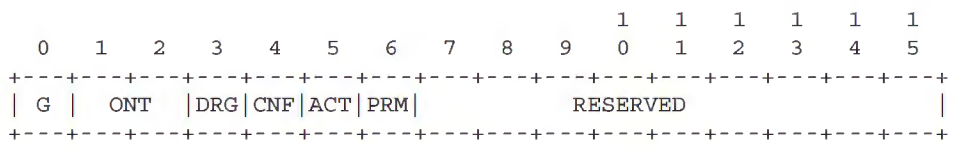


The NODE_NAME ARRAY is an array of zero or more NUM_NAMES entries of NODE_NAME records. Each NODE_NAME entry represents an active name in the same NetBIOS scope as the requesting name in the local name table of the responder. RR_NAME is the requesting name.

NODE_NAME Entry:



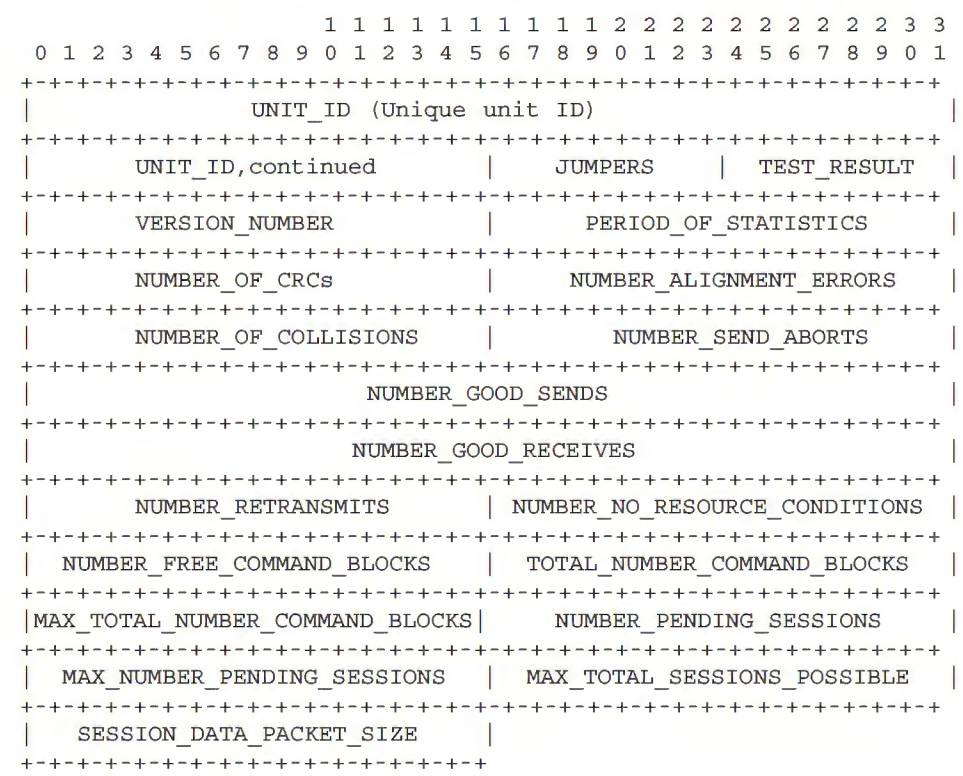
The NAME_FLAGS field:



The NAME_FLAGS field is defined as:

Symbol	Bit(s)	Description:
RESERVED	7-15	Reserved for future use. Must be zero (0).
PRM	6	Permanent Name Flag. If one (1) then entry is for the permanent node name. Flag is zero (0) for all other names.
ACT	5	Active Name Flag. All entries have this flag set to one (1).
CNF	4	Conflict Flag. If one (1) then name on this node is in conflict.
DRG	3	Deregister Flag. If one (1) then this name is in the process of being deleted.
ONT	1,2	Owner Node Type: 00 = B node 01 = P node 10 = M node 11 = Reserved for future use
G	0	Group Name Flag. If one (1) then the name is a GROUP NetBIOS name. If zero (0) then it is a UNIQUE NetBIOS name.

STATISTICS Field of the NODE STATUS RESPONSE:

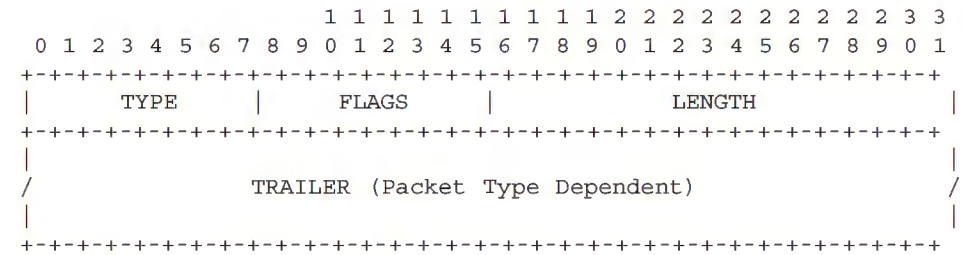


4.3. SESSION SERVICE PACKETS

4.3.1. GENERAL FORMAT OF SESSION PACKETS

All session service messages are sent over a TCP connection.

All session packets are of the following general structure:



The TYPE, FLAGS, and LENGTH fields are present in every session packet.

The LENGTH field is the number of bytes following the LENGTH field. In other words, LENGTH is the combined size of the TRAILER field(s). For example, the POSITIVE SESSION RESPONSE packet always has a LENGTH field value of zero (0000) while the RETARGET SESSION RESPONSE always has a LENGTH field value of six (0006).

One of the bits of the FLAGS field acts as an additional, high-order bit for the LENGTH field. Thus the cumulative size of the trailer field(s) may range from 0 to 128K bytes.

Session Packet Types (in hexidecimal):

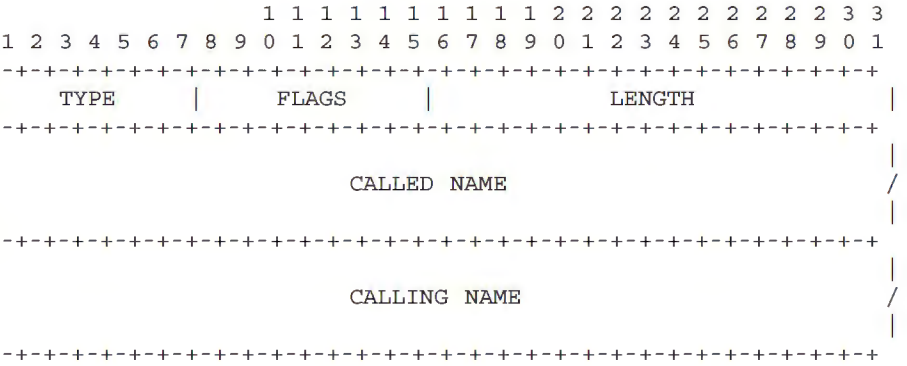
```
00 -  SESSION MESSAGE
81 -  SESSION REQUEST
82 -  POSITIVE SESSION RESPONSE
83 -  NEGATIVE SESSION RESPONSE
84 -  RETARGET SESSION RESPONSE
85 -  SESSION KEEP ALIVE
```

Bit definitions of the FLAGS field:

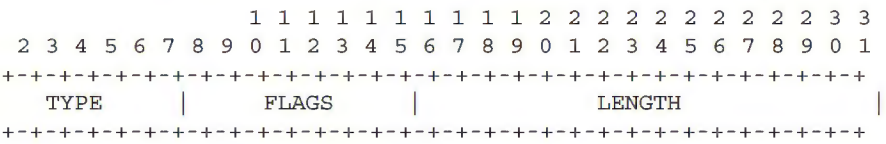
```
  0   1   2   3   4   5   6   7
+---+---+---+---+---+---+---+---+
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | E |
+---+---+---+---+---+---+---+---+
```

Symbol	Bit(s)	Description
E	7	Length extension, used as an additional, high-order bit on the LENGTH field.
RESERVED	0-6	Reserved, must be zero (0)

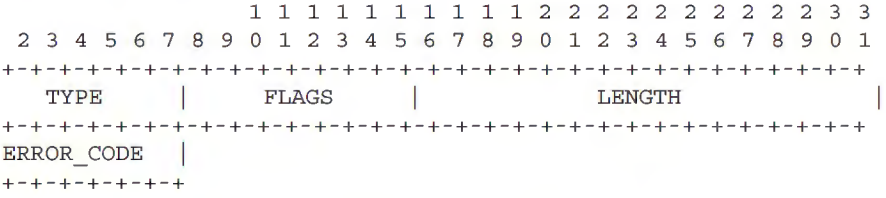
4.3.2. SESSION REQUEST PACKET



4.3.3. POSITIVE SESSION RESPONSE PACKET



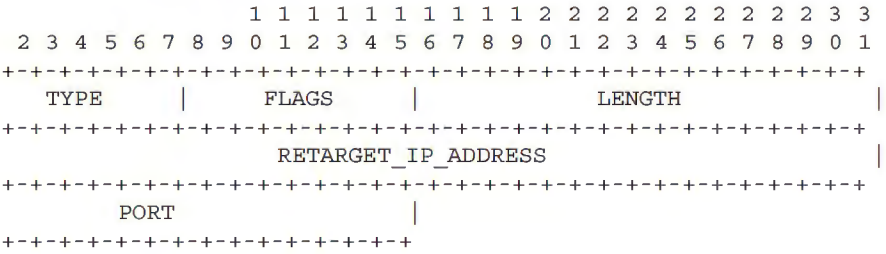
4.3.4. NEGATIVE SESSION RESPONSE PACKET



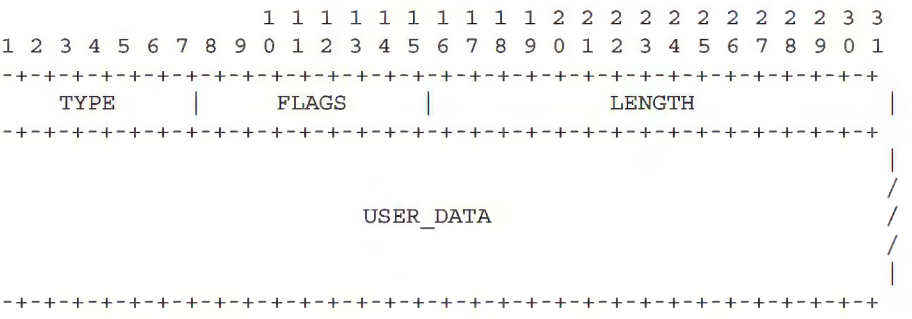
NEGATIVE SESSION RESPONSE packet error code values (in hexidecimal):

- 80 - Not listening on called name
- 81 - Not listening for calling name
- 82 - Called name not present
- 83 - Called name present, but insufficient resources
- 8F - Unspecified error

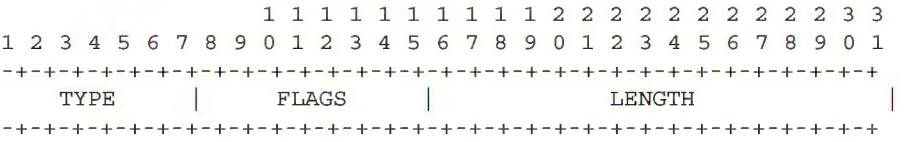
4.3.5. SESSION RETARGET RESPONSE PACKET



4.3.6. SESSION MESSAGE PACKET

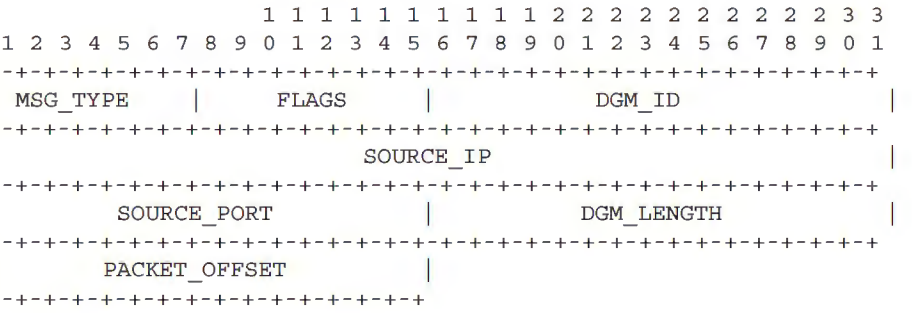


4.3.7. SESSION KEEP ALIVE PACKET



4.4. DATAGRAM SERVICE PACKETS

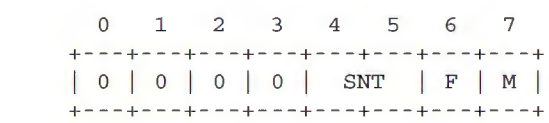
4.4.1. NetBIOS DATAGRAM HEADER



MSG_TYPE values (in hexidecimal):

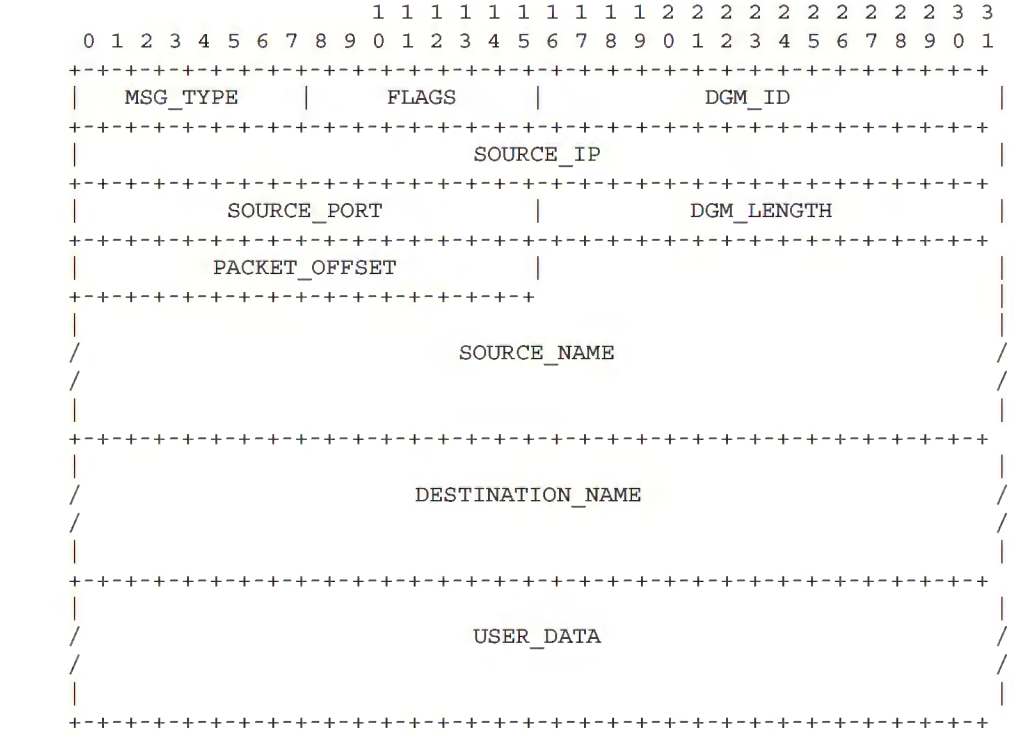
10 - DIRECT_UNIQUE DATAGRAM
11 - DIRECT_GROUP DATAGRAM
12 - BROADCAST DATAGRAM
13 - DATAGRAM ERROR
14 - DATAGRAM QUERY REQUEST
15 - DATAGRAM POSITIVE QUERY RESPONSE
16 - DATAGRAM NEGATIVE QUERY RESPONSE

Bit definitions of the FLAGS field:

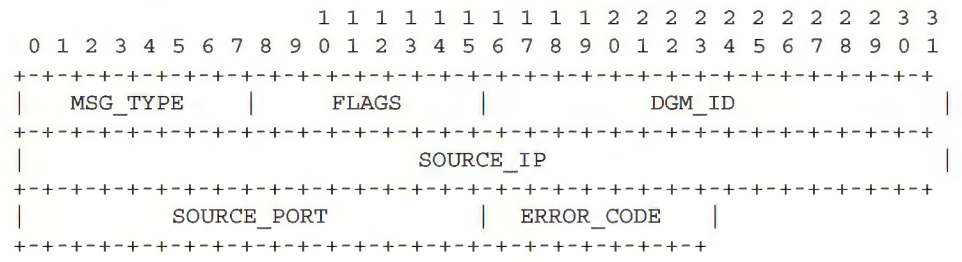


Symbol	Bit(s)	Description
M	7	MORE flag, If set then more NetBIOS datagram fragments follow.
F	6	FIRST packet flag, If set then this is first (and possibly only) fragment of NetBIOS datagram
SNT	4,5	Source End-Node type: 00 = B node 01 = P node 10 = M node 11 = NBDD
RESERVED	0-3	Reserved, must be zero (0)

4.4.2. DIRECT_UNIQUE, DIRECT_GROUP, & BROADCAST DATAGRAM



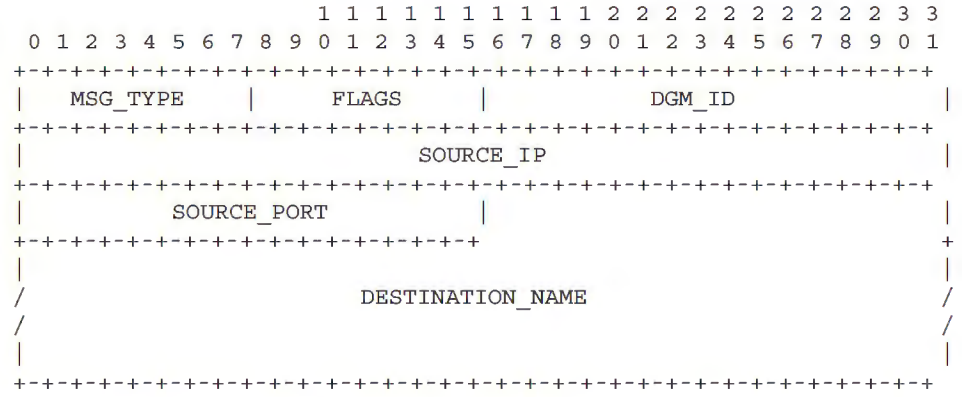
4.4.3. DATAGRAM ERROR PACKET



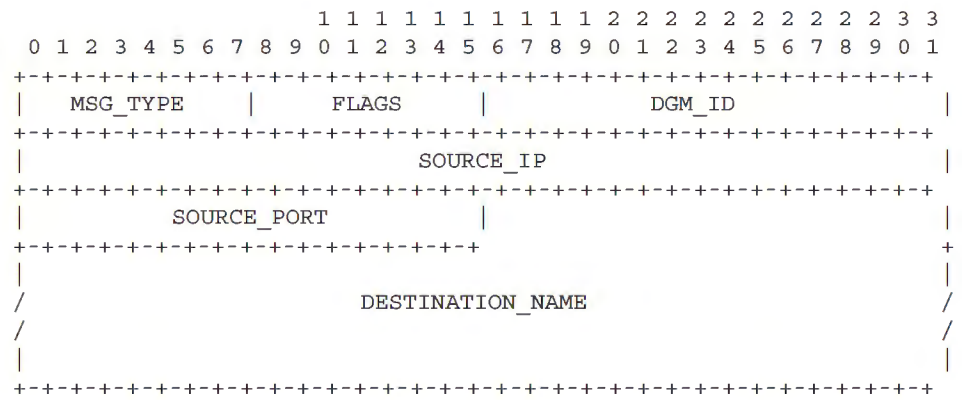
ERROR_CODE values (in hexidecimal):

82 - DESTINATION NAME NOT PRESENT
83 - INVALID SOURCE NAME FORMAT
84 - INVALID DESTINATION NAME FORMAT

4.4.4. DATAGRAM QUERY REQUEST



4.4.5. DATAGRAM POSITIVE AND NEGATIVE QUERY RESPONSE



5. PROTOCOL DESCRIPTIONS

5.1. NAME SERVICE PROTOCOLS

A REQUEST packet is always sent to the well known UDP port - NAME_SERVICE_UDP_PORT. The destination address is normally either the IP broadcast address or the address of the NBNS - the address of the NBNS server it set up at initialization time. In rare cases, a request packet will be sent to an end node, e.g. a NAME QUERY REQUEST sent to "challenge" a node.

A RESPONSE packet is always sent to the source UDP port and source IP address of the request packet.

A DEMAND packet must always be sent to the well known UDP port - NAME_SERVICE_UDP_PORT. There is no restriction on the target IP address.

Terms used in this section:

tid - Transaction ID. This is a value composed from the requestor's IP address and a unique 16 bit value generated by the originator of the transaction.

5.1.1. B-NODE ACTIVITY

5.1.1.1. B-NODE ADD NAME

```
PROCEDURE add_name(newname)

/*
 * Host initiated processing for a B node
 */
BEGIN

     REPEAT

          /* build name service packet */

          ONT = B_NODE; /* broadcast node */
          G = UNIQUE;   /* unique name */
          TTL = 0;

          broadcast NAME REGISTRATION REQUEST packet;

          /*
           * remote node(s) will send response packet
           * if applicable
           */
```

```
          pause(BCAST_REQ_RETRY_TIMEOUT);

     UNTIL response packet is received or
          retransmit count has been exceeded

     IF no response packet was received THEN
     BEGIN /* no response */
          /*
           * build packet
           */

          ONT = B_NODE; /* broadcast node */
          G = UNIQUE;   /* unique name */
          TTL = 0;

          /*
           * Let other nodes known you have the name
           */

          broadcast NAME UPDATE REQUEST packet;
          /* name can be added to local name table */
          return success;
     END /* no response */
     ELSE
     BEGIN /* got response */

          /*
           * Match return transaction id
           * against tid sent in request
           */

         IF NOT response tid = request tid THEN
         BEGIN
          ignore response packet;
         END
         ELSE
         CASE packet type OF

         NEGATIVE NAME REGISTRATION RESPONSE:

              return failure; /* name cannot be added */

         POSITIVE NAME REGISTRATION RESPONSE:
         END-NODE CHALLENGE NAME REGISTRATION RESPONSE:

              /*
               * B nodes should normally not get this
               * response.
               */

               ignore packet;
```

```
            END /* case */;
        END /* got response */
    END /* procedure */
```

5.1.1.2. B-NODE ADD_GROUP NAME

```
    PROCEDURE add_group_name(newname)

    /*
     * Host initiated processing for a B node
     */

    BEGIN
         /*
          * same as for a unique name with the
          * exception that the group bit (G) must
          * be set in the request packets.
          */

         ...
         G = GROUP;
         ...
         ...

         /*
          * broadcast request ...
          */


    END
```

5.1.1.3. B-NODE FIND_NAME

```
    PROCEDURE find_name(name)

    /*
     * Host initiated processing for a B node
     */

    BEGIN

         REPEAT
              /*
               * build packet
               */
              ONT = B;
              TTL = 0;
              G = DONT CARE;

              broadcast NAME QUERY REQUEST packet;
```

```
            /*
             * a node might send response packet
             */

            pause(BCAST_REQ_RETRY_TIMEOUT);
        UNTIL response packet received OR
            max transmit threshold exceeded

        IF no response packet received THEN
            return failure;
        ELSE
        IF NOT response tid = request tid THEN
            ignore packet;
        ELSE
        CASE packet type OF
        POSITIVE NAME QUERY RESPONSE:
            /*
             * Start a timer to detect conflict.
             *
             * Be prepared to detect conflict if
             * any more response packets are received.
             *
             */

            save response as authoritative response;
            start_timer(CONFLICT_TIMER);
            return success;

        NEGATIVE NAME QUERY RESPONSE:
        REDIRECT NAME QUERY RESPONSE:

            /*
             * B Node should normally not get either
             * response.
             */

             ignore response packet;

        END /* case */
    END /* procedure */
```

5.1.1.4. B NODE NAME RELEASE

```
    PROCEDURE delete_name (name)
    BEGIN

        REPEAT

            /*
             * build packet
             */
```

```
            ...

            /*
             * send request
             */

            broadcast NAME RELEASE REQUEST packet;

            /*
             * no response packet expected
             */

            pause(BCAST_REQ_RETRY_TIMEOUT);

       UNTIL retransmit count has been exceeded
  END /* procedure */
```

5.1.1.5. B-NODE INCOMING PACKET PROCESSING

Following processing is done when broadcast or unicast packets are received at the NAME_SERVICE_UDP_PORT.

```
PROCEDURE process_incoming_packet(packet)

/*
 * Processing initiated by incoming packets for a B node
 */

BEGIN
     /*
      * Note: response packets are always sent
      * to:
      * source IP address of request packet
      * source UDP port of request packet
      */

     CASE packet type OF

     NAME REGISTRATION REQUEST (UNIQUE):
          IF name exists in local name table THEN
               send NEGATIVE NAME REGISTRATION RESPONSE ;
     NAME REGISTRATION REQUEST (GROUP):
          IF name exists in local name table THEN
          BEGIN
               IF local entry is a unique name THEN
                    send NEGATIVE NAME REGISTRATION RESPONSE ;
          END
     NAME QUERY REQUEST:
          IF name exists in local name table THEN
          BEGIN
               build response packet;
```

```
                send POSITIVE NAME QUERY RESPONSE;
          POSITIVE NAME QUERY RESPONSE:
               IF name conflict timer is not active THEN
               BEGIN
                    /*
                     * timer has expired already...  ignore this
                     * packet
                     */

                    return;
               END
               ELSE /* timer is active */
               IF a response for this name has previously been
                    received THEN
               BEGIN /* existing entry */

                    /*
                     * we sent out a request packet, and
                     * have already received (at least)
                     * one response
                     *
                     * Check if conflict exists.
                     * If so, send out a conflict packet.
                     *
                     * Note: detecting conflict does NOT
                     * affect any existing sessions.
                     *
                     */

                    /*
                     * Check for name conflict.
                     * See "Name Conflict" in Concepts and Methods
                     */
                    check saved authoritative response against
                         information in this response packet;
                    IF conflict detected THEN
                    BEGIN
                         unicast NAME CONFLICT DEMAND packet;
                         IF entry exists in cache THEN
                         BEGIN
                              remove entry from cache;
                         END
                    END
               END /* existing entry */
               ELSE
               BEGIN
                    /*
                     * Note: If this was the first response
                     * to a name query, it would have been
                     * handled in the
                     * find_name() procedure.
```

```
                */

                ignore packet;
           END
      NAME CONFLICT DEMAND:
           IF name exists in local name table THEN
           BEGIN
                mark name as conflict detected;

                /*
                 * a name in the state "conflict detected"
                 * does not "logically" exist on that node.
                 * No further session will be accepted on
                 * that name.
                 * No datagrams can be sent against that name.
                 * Such an entry will not be used for
                 * purposes of processing incoming request
                 * packets.
                 * The only valid user NetBIOS operation
                 * against such a name is DELETE NAME.
                 */
           END
      NAME RELEASE REQUEST:
           IF caching is being done THEN
           BEGIN
                remove entry from cache;
           END
      NAME UPDATE REQUEST:
           IF caching is being done THEN
           BEGIN
                IF entry exists in cache already,
                     update cache;
                ELSE IF name is "interesting" THEN
                BEGIN
                     add entry to cache;
                END
           END

      NODE STATUS REQUEST:
           IF name exists in local name table THEN
           BEGIN
                /*
                 * send only those names that are
                 * in the same scope as the scope
                 * field in the request packet
                 */

                send NODE STATUS RESPONSE;
           END
  END
```

5.1.2. P-NODE ACTIVITY

All packets sent or received by P nodes are unicast UDP packets. A P node sends name service requests to the NBNS node that is specified in the P-node configuration.

5.1.2.1. P-NODE ADD_NAME

```
PROCEDURE add_name(newname)

/*
 * Host initiated processing for a P node
 */

BEGIN

     REPEAT
          /*
           * build packet
           */

          ONT = P;
          G = UNIQUE;
          ...

          /*
           * send request
           */

          unicast NAME REGISTRATION REQUEST packet;

          /*
           * NBNS will send response packet
           */

          IF receive a WACK RESPONSE THEN
               pause(time from TTL field of response);
          ELSE
               pause(UCAST_REQ_RETRY_TIMEOUT);
     UNTIL response packet is received OR
          retransmit count has been exceeded

     IF no response packet was received THEN
     BEGIN /* no response */
          /*
           * NBNS is down.  Cannot claim name.
           */

          return failure; /* name cannot be claimed */
     END /* no response */
     ELSE
```

```
BEGIN /* response */
    IF NOT response tid = request tid THEN
    BEGIN
     /*  Packet may belong to another transaction  */
     ignore response packet;
    END
    ELSE
    CASE packet type OF

    POSITIVE NAME REGISTRATION RESPONSE:

         /*
          * name can be added
          */

         adjust refresh timeout value, TTL, for this name;
         return success;       /* name can be added */

    NEGATIVE NAME REGISTRATION RESPONSE:
         return failure; /* name cannot be added */

    END-NODE CHALLENGE REGISTRATION REQUEST:
    BEGIN /* end node challenge */

         /*
          * The response packet has in it the
          * address of the presumed owner of the
          * name.  Challenge that owner.
          * If owner either does not
          * respond or indicates that he no longer
          * owns the name, claim the name.
          * Otherwise, the name cannot be claimed.
          *
          */

         REPEAT
          /*
           * build packet
           */
          ...

          unicast NAME QUERY REQUEST packet to the
               address contained in the END NODE
               CHALLENGE RESPONSE packet;

          /*
           * remote node may send response packet
           */

          pause(UCAST_REQ_RETRY_TIMEOUT);
```

```
UNTIL response packet is received or
    retransmit count has been exceeded
IF no response packet is received OR
      NEGATIVE NAME QUERY RESPONSE packet
      received THEN
BEGIN /* update */

 /*
  * name can be claimed
  */

 REPEAT

     /*
      * build packet
      */
      ...

     unicast NAME UPDATE REQUEST to NBNS;

     /*
      * NBNS node will send response packet
      */

     IF receive a WACK RESPONSE THEN
           pause(time from TTL field of response);
     ELSE
           pause(UCAST_REQ_RETRY_TIMEOUT);
 UNTIL response packet is received or
     retransmit count has been exceeded
 IF no response packet received THEN
 BEGIN /* no response */

      /*
       * name could not be claimed
       */

      return failure;
 END /* no response */
 ELSE
 CASE packet type OF
      POSITIVE NAME REGISTRATION RESPONSE:
           /*
            * add name
            */
           return success;
      NEGATIVE NAME REGISTRATION RESPONSE:

           /*
            * you lose  ...
            */
```

```
                        return failure;
                    END /* case */
                END /* update */
                ELSE

                /*
                 * received a positive response to the "challenge"
                 * Remote node still has name
                 */

                 return failure;
            END /* end node challenge */
        END /* response */
    END /* procedure */
```

5.1.2.2. P-NODE ADD GROUP NAME

```
    PROCEDURE add_group_name(newname)

    /*
     * Host initiated processing for a P node
     */

    BEGIN
         /*
          * same as for a unique name, except that the
          * request packet must indicate that a
          * group name claim is being made.
          */

         ...
         G = GROUP;
         ...

         /*
          * send packet
          */
          ...


    END
```

5.1.2.3. P-NODE FIND NAME

```
    PROCEDURE find_name(name)

    /*
     * Host initiated processing for a P node
     */

    BEGIN
```

```
        REPEAT
             /*
              * build packet
              */

             ONT = P;
             G = DONT CARE;

             unicast NAME QUERY REQUEST packet;

             /*
              * a NBNS node might send response packet
              */

             IF receive a WACK RESPONSE THEN
                  pause(time from TTL field of response);
             ELSE
                  pause(UCAST_REQ_RETRY_TIMEOUT);
        UNTIL response packet received OR
             max transmit threshold exceeded

        IF no response packet received THEN
             return failure;
        ELSE
        IF NOT response tid = request tid THEN
             ignore packet;
        ELSE
        CASE packet type OF
        POSITIVE NAME QUERY RESPONSE:
             return success;

        REDIRECT NAME QUERY RESPONSE:

             /*
              * NBNS node wants this end node
              * to use some other NBNS node
              * to resolve the query.
              */

              repeat query with NBNS address
                  in the response packet;
        NEGATIVE NAME QUERY RESPONSE:
             return failure;

        END /* case */
   END /* procedure */
```

5.1.2.4. P-NODE DELETE_NAME

```
   PROCEDURE delete_name (name)
```

```
   /*
    * Host initiated processing for a P node
    */

   BEGIN

        REPEAT

             /*
              * build packet
              */
             ...

             /*
              * send request
              */

             unicast NAME RELEASE REQUEST packet;
             IF receive a WACK RESPONSE THEN
                  pause(time from TTL field of response);
             ELSE
                  pause(UCAST_REQ_RETRY_TIMEOUT);
        UNTIL retransmit count has been exceeded
             or response been received

        IF response has been received THEN
        CASE packet type OF
        POSITIVE NAME RELEASE RESPONSE:
             return success;
        NEGATIVE NAME RELEASE RESPONSE:

             /*
              * NBNS does want node to delete this
              * name !!!
              */

             return failure;
        END /* case */
   END /* procedure */
```

5.1.2.5. P-NODE INCOMING PACKET PROCESSING

Processing initiated by reception of packets at a P node

```
   PROCEDURE process_incoming_packet(packet)

   /*
    * Processing initiated by incoming packets at a P node
    */

   BEGIN
```

```
/*
 * always ignore UDP broadcast packets
 */

IF packet was sent as a broadcast THEN
BEGIN
     ignore packet;
     return;
END
CASE packet type of

NAME CONFLICT DEMAND:
     IF name exists in local name table THEN
          mark name as in conflict;
     return;

NAME QUERY REQUEST:
     IF name exists in local name table THEN
     BEGIN /* name exists */

          /*
           * build packet
           */
          ...

          /*
           * send response to the IP address and port
           * number from which the request was received.
           */

          send POSITIVE NAME QUERY RESPONSE ;
          return;
     END /* exists */
     ELSE
     BEGIN /* does not exist */

          /*
           * send response to the requestor
           */

          send NEGATIVE NAME QUERY RESPONSE ;
          return;
     END /* does not exist */
NODE STATUS REQUEST:
     /*
      * Name of "*" may be used for force node to
      * divulge status for administrative purposes
      */
     IF name in local name table OR name = "*" THEN
     BEGIN
          /*
```

```
                    * Build response packet and
                    * send to requestor node
                    * Send only those names that are
                    * in the same scope as the scope
                    * in the request packet.
                    */

                   send NODE STATUS RESPONSE;
              END

         NAME RELEASE REQUEST:
              /*
               * This will be received if the NBNS wants to flush the
               * name from the local name table, or from the local
               * cache.
               */

              IF name exists in the local name table THEN
              BEGIN
                   delete name from local name table;
                   inform user that name has been deleted;
              END
              ELSE
                   IF name has been cached locally THEN
                   BEGIN
                        remove entry from cache:
                   END

         END /* case */
    END /* procedure */
```

5.1.2.6. P-NODE TIMER INITIATED PROCESSING

Processing initiated by timer expiration.

```
PROCEDURE timer_expired()
/*
 * Processing initiated by the expiration of a timer on a P node
 */
BEGIN
     /*
      * Send a NAME REFRESH REQUEST for each name which the
      * TTL which has expired.
      */
     REPEAT
          build NAME REFRESH REQUEST packet;
          REPEAT
               send packet to NBNS;

               IF receive a WACK RESPONSE THEN
                    pause(time from TTL field of response);
```

```
                    ELSE
                         pause(UCAST_REQ_RETRY_TIMEOUT);
               UNTIL response packet is received or
                    retransmit count has been exceeded

               CASE packet type OF
                 POSITIVE NAME REGISTRATION RESPONSE:
                    /* successfully refreshed */
                    reset TTL timer for this name;

                 NEGATIVE NAME REGISTRATION RESPONSE:
                    /*
                     * refused, can't keep name
                     * assume in conflict
                     */
                    mark name as in conflict;
               END /* case */

          UNTIL request sent for all names for which TTL
               has expired
     END /* procedure */
```

5.1.3. M-NODE ACTIVITY

M nodes behavior is similar to that of P nodes with the addition of some B node-like broadcast actions. M node name service proceeds in two steps:

1. Use broadcast UDP based name service. Depending on the operation, goto step 2.

2. Use directed UDP name service.

The following code for M nodes is exactly the same as for a P node, with the exception that broadcast operations are done before P type operation is attempted.

5.1.3.1. M-NODE ADD NAME

```
PROCEDURE add_name(newname)

/*
 * Host initiated processing for a M node
 */

BEGIN

     /*
      * check if name exists on the
      * broadcast area
      */
```

```
REPEAT
    /* build packet */

    ....
    broadcast NAME REGISTRATION REQUEST packet;
    pause(BCAST_REQ_RETRY_TIMEOUT);

UNTIL response packet is received or
     retransmit count has been  exceeded

IF valid response received THEN
BEGIN
     /* cannot claim name */

     return failure;
END

/*
 * No objections received within the
 * broadcast area.
 * Send request to name server.
 */

REPEAT
     /*
      * build packet
      */

     ONT = M;
     ...

     unicast NAME REGISTRATION REQUEST packet;

     /*
      * remote NBNS will send response packet
      */

     IF receive a WACK RESPONSE THEN
          pause(time from TTL field of response);
     ELSE
          pause(UCAST_REQ_RETRY_TIMEOUT);

UNTIL response packet is received or
     retransmit count has been exceeded

IF no response packet was received THEN
BEGIN /* no response */
     /*
      * NBNS is down.  Cannot claim name.
      */
```

```
          return failure; /* name cannot be claimed */
     END /* no response */
     ELSE
     BEGIN /* response */
         IF NOT response tid = request tid THEN
         BEGIN
          ignore response packet;
         END
         ELSE
         CASE packet type OF
         POSITIVE NAME REGISTRATION RESPONSE:

              /*
               * name can be added
               */

              adjust refresh timeout value, TTL;
              return success;       /* name can be added */

         NEGATIVE NAME REGISTRATION RESPONSE:
              return failure; /* name cannot be added */

         END-NODE CHALLENGE REGISTRATION REQUEST:
         BEGIN /* end node challenge */

              /*
               * The response packet has in it the
               * address of the presumed owner of the
               * name.  Challenge that owner.
               * If owner either does not
               * respond or indicates that he no longer
               * owns the name, claim the name.
               * Otherwise, the name cannot be claimed.
               *
               */

              REPEAT
               /*
                * build packet
                */
               ...

               /*
                * send packet to address contained in the
                * response packet
                */

               unicast NAME QUERY REQUEST packet;

               /*
                * remote node may send response packet
```

```
 */

pause(UCAST_REQ_RETRY_TIMEOUT);

UNTIL response packet is received or
    retransmit count has been exceeded
IF no response packet is received THEN
BEGIN /* no response */

 /*
  * name can be claimed
  */
 REPEAT

     /*
      * build packet
      */
      ...

     unicast NAME UPDATE REQUEST to NBNS;

     /*
      * NBNS node will send response packet
      */

     IF receive a WACK RESPONSE THEN
          pause(time from TTL field of response);
 ELSE
      pause(UCAST_REQ_RETRY_TIMEOUT);

 UNTIL response packet is received or
     retransmit count has been exceeded
 IF no response packet received THEN
 BEGIN /* no response */

      /*
       * name could not be claimed
       */

      return failure;
 END /* no response */
 ELSE
 CASE packet type OF
 POSITIVE NAME REGISTRATION RESPONSE:
      /*
       * add name
       */

      return success;
 NEGATIVE NAME REGISTRATION RESPONSE:
```

```
                        /*
                         * you lose  ...
                         */

                        return failure;
                    END /* case */
                  END /* no response */
                  ELSE
                  IF NOT response tid = request tid THEN
                  BEGIN
                   ignore response packet;
                  END

                  /*
                   * received a response to the "challenge"
                   * packet
                   */

                  CASE packet type OF
                  POSITIVE NAME QUERY:

                   /*
                    * remote node still has name.
                    */

                   return failure;
                  NEGATIVE NAME QUERY:

                   /*
                    * remote node no longer has name
                    */

                   return success;
                  END /* case */
              END /* end node challenge */
              END /* case */
         END /* response */
   END /* procedure */
```

5.1.3.2. M-NODE ADD GROUP NAME

```
   PROCEDURE add_group_name(newname)

   /*
    * Host initiated processing for a P node
    */

   BEGIN
        /*
         * same as for a unique name, except that the
         * request packet must indicate that a
```

```
         * group name claim is being made.
         */

        ...
        G = GROUP;
        ...

        /*
         * send packet
         */
         ...


   END
```

5.1.3.3. M-NODE FIND NAME

```
   PROCEDURE find_name(name)

   /*
    * Host initiated processing for a M node
    */

   BEGIN
        /*
         * check if any node on the broadcast
         * area has the name
         */

        REPEAT
             /* build packet */
             ...

             broadcast NAME QUERY REQUEST packet;
             pause(BCAST_REQ_RETRY_TIMEOUT);
        UNTIL response packet received OR
             max transmit threshold exceeded

        IF valid response received THEN
        BEGIN
             save response as authoritative response;
             start_timer(CONFLICT_TIMER);
             return success;
        END

        /*
         * no valid response on the b'cast segment.
         * Try the name server.
         */

        REPEAT
```

```
                /*
                 * build packet
                 */

                ONT = M;
                G = DONT CARE;

                unicast NAME QUERY REQUEST packet to NBNS;

                /*
                 * a NBNS node might send response packet
                 */

                IF receive a WACK RESPONSE THEN
                     pause(time from TTL field of response);
                ELSE
                     pause(UCAST_REQ_RETRY_TIMEOUT);
           UNTIL response packet received OR
                max transmit threshold exceeded

           IF no response packet received THEN
                return failure;
           ELSE
           IF NOT response tid = request tid THEN
                ignore packet;
           ELSE
           CASE packet type OF
           POSITIVE NAME QUERY RESPONSE:
                return success;

           REDIRECT NAME QUERY RESPONSE:

                /*
                 * NBNS node wants this end node
                 * to use some other NBNS node
                 * to resolve the query.
                 */

                 repeat query with NBNS address
                     in the response packet;
           NEGATIVE NAME QUERY RESPONSE:
                return failure;

           END /* case */
      END /* procedure */
```

5.1.3.4. M-NODE DELETE NAME

```
   PROCEDURE delete_name (name)

   /*
```

```
    * Host initiated processing for a P node
    */

   BEGIN
        /*
         * First, delete name on NBNS
         */

        REPEAT

             /*
              * build packet
              */
             ...

             /*
              * send request
              */

             unicast NAME RELEASE REQUEST packet to NBNS;

             IF receive a WACK RESPONSE THEN
                  pause(time from TTL field of response);
             ELSE
                  pause(UCAST_REQ_RETRY_TIMEOUT);
        UNTIL retransmit count has been exceeded
             or response been received

        IF response has been received THEN
        CASE packet type OF
        POSITIVE NAME RELEASE RESPONSE:
             /*
              * Deletion of name on b'cast segment is deferred
              * until after NBNS has deleted the name
              */

             REPEAT
                  /* build packet */

                  ...
                  broadcast NAME RELEASE REQUEST;
                  pause(BCAST_REQ_RETRY_TIMEOUT);
             UNTIL rexmt threshold exceeded

             return success;
        NEGATIVE NAME RELEASE RESPONSE:

             /*
              * NBNS does want node to delete this
              * name
              */
```

```
            return failure;
        END /* case */
    END /* procedure */
```

5.1.3.5. M-NODE INCOMING PACKET PROCESSING

Processing initiated by reception of packets at a M node

```
PROCEDURE process_incoming_packet(packet)

/*
 * Processing initiated by incoming packets at a M node
 */

BEGIN
     CASE packet type of

     NAME CONFLICT DEMAND:
          IF name exists in local name table THEN
               mark name as in conflict;
          return;

     NAME QUERY REQUEST:
          IF name exists in local name table THEN
          BEGIN /* name exists */

               /*
                * build packet
                */
               ...

               /*
                * send response to the IP address and port
                * number from which the request was received.
                */

               send POSITIVE NAME QUERY RESPONSE ;
               return;
          END /* exists */
          ELSE
          BEGIN /* does not exist */

               /*
                * send response to the requestor
                */

               IF request NOT broadcast THEN
                    /*
                     * Don't send negative responses to
                     * queries sent by B nodes
                     */
```

```
                    send NEGATIVE NAME QUERY RESPONSE ;
               return;
          END /* does not exist */
     NODE STATUS REQUEST:
          BEGIN
          /*
           * Name of "*" may be used for force node to
           * divulge status for administrative purposes
           */
          IF name in local name table OR name = "*" THEN
               /*
                * Build response packet and
                * send to requestor node
                * Send only those names that are
                * in the same scope as the scope
                * in the request packet.
                */

               send NODE STATUS RESPONSE;
          END

     NAME RELEASE REQUEST:
          /*
           * This will be received if the NBNS wants to flush the
           * name from the local name table, or from the local
           * cache.
           */

          IF name exists in the local name table THEN
          BEGIN
               delete name from local name table;
               inform user that name has been deleted;
          END
          ELSE
               IF name has been cached locally THEN
               BEGIN
                    remove entry from cache:
               END

     NAME REGISTRATION REQUEST (UNIQUE):
          IF name exists in local name table THEN
               send NEGATIVE NAME REGISTRATION RESPONSE ;
     NAME REGISTRATION REQUEST (GROUP):
          IF name exists in local name table THEN
          BEGIN
               IF local entry is a unique name THEN
                   send NEGATIVE NAME REGISTRATION RESPONSE ;
          END
     END /* case */
END /* procedure */
```

5.1.3.6. M-NODE TIMER INITIATED PROCESSING

Processing initiated by timer expiration:

```
PROCEDURE timer_expired()
/*
 * Processing initiated by the expiration of a timer on a M node
 */
BEGIN
     /*
      * Send a NAME REFRESH REQUEST for each name which the
      * TTL which has expired.
      */
     REPEAT
          build NAME REFRESH REQUEST packet;
          REPEAT
               send packet to NBNS;

               IF receive a WACK RESPONSE THEN
                    pause(time from TTL field of response);
               ELSE
                    pause(UCAST_REQ_RETRY_TIMEOUT);
          UNTIL response packet is received or
               retransmit count has been exceeded

          CASE packet type OF
            POSITIVE NAME REGISTRATION RESPONSE:
               /* successfully refreshed */
               reset TTL timer for this name;

            NEGATIVE NAME REGISTRATION RESPONSE:
               /*
                * refused, can't keep name
                * assume in conflict
                */
               mark name as in conflict;
          END /* case */

     UNTIL request sent for all names for which TTL
          has expired
END /* procedure */
```

5.1.4. NBNS ACTIVITY

A NBNS node will receive directed packets from P and M nodes. Reply packets are always sent as directed packets to the source IP address and UDP port number. Received broadcast packets must be ignored.

5.1.4.1. NBNS INCOMING PACKET PROCESSING

```
PROCEDURE process_incoming_packet(packet)

/*
 * Incoming packet processing on a NS node
 */

BEGIN
     IF packet was sent as a broadcast THEN
     BEGIN
          discard packet;
          return;
     END
     CASE packet type of

     NAME REGISTRATION REQUEST (UNIQUE):
          IF unique name exists in data base THEN
          BEGIN /* unique name exists */
               /*
                * NBNS node may be a "passive"
                * server in that it expects the
                * end node to do the challenge
                * server.  Such a NBNS node is
                * called a "non-secure" server.
                * A "secure" server will do the
                * challenging before it sends
                * back a response packet.
                */

               IF non-secure THEN
               BEGIN
                    /*
                     * build response packet
                     */
                    ...


                    /*
                     * let end node do the challenge
                     */

                    send END-NODE CHALLENGE NAME REGISTRATION
                         RESPONSE;
                    return;
               END
               ELSE
               /*
                * secure server - do the name
                * challenge operation
                */
```

```
REPEAT
    send NAME QUERY REQUEST;
    pause(UCAST_REQ_RETRY_TIMEOUT);
UNTIL response has been received or
     retransmit count has been exceeded
IF no response was received THEN
BEGIN

     /* node down */

     update data base - remove entry;
     update data base - add new entry;
     send POSITIVE NAME REGISTRATION RESPONSE;
     return;
END
ELSE
BEGIN /* challenged node replied */
    /*
     * challenged node replied with
     * a response packet
     */

    CASE packet type

    POSITIVE NAME QUERY RESPONSE:

     /*
      * name still owned by the
      * challenged node
      *
      * build packet and send response
      */
      ...


     /*
      * Note: The NBNS will need to
      * keep track (based on transaction id) of
      * the IP address and port number
      * of the original requestor.
      */

     send NEGATIVE NAME REGISTRATION RESPONSE;
     return;
    NEGATIVE NAME QUERY RESPONSE:

     update data base - remove entry;
     update data base - add new  entry;

     /*
      * build response packet and send
```

```
                    * response
                    */
                   send POSITIVE NAME REGISTRATION RESPONSE;
                   return;
                  END /* case */
              END /* challenged node replied */
         END /* unique name exists in data base */
         ELSE
         IF group name exists in data base THEN
         BEGIN /* group names exists */

              /*
               * Members of a group name are NOT
               * challenged.
               * Make the assumption that
               * at least some of the group members
               * are still alive.
               * Refresh mechanism will
               * allow the NBNS to detect when all
               * members of a group no longer use that
               * name
               */

               send NEGATIVE NAME REGISTRATION RESPONSE;
         END /* group name exists */
         ELSE
         BEGIN /* name does not exist */

              /*
               * Name does not exist in data base
               *
               * This code applies to both non-secure
               * and secure server.
               */

              update data base - add new entry;
              send POSITIVE NAME REGISTRATION RESPONSE;
              return;
         END

    NAME QUERY REQUEST:
         IF name exists in data base THEN
         BEGIN
              /*
               * build response packet and send to
               * requestor
               */
               ...

              send POSITIVE NAME QUERY RESPONSE;
              return;
```

```
            ELSE
            BEGIN
                 /*
                  * build response packet and send to
                  * requestor
                  */
                  ...

                 send NEGATIVE NAME QUERY RESPONSE;
                 return;
            END

       NAME REGISTRATION REQUEST (GROUP):
            IF name exists in data base THEN
            BEGIN
                 IF local entry is a unique name THEN
                 BEGIN /* local is unique */

                     IF non-secure THEN
                     BEGIN
                      send  END-NODE CHALLENGE NAME
                           REGISTRATION RESPONSE;
                      return;
                     END

                     REPEAT
                      send NAME QUERY REQUEST;
                      pause(UCAST_REQ_RETRY_TIMEOUT);
                     UNTIL response received or
                          retransmit count exceeded
                     IF no response received or
                          NEGATIVE NAME QUERY RESPONSE
                           received THEN
                     BEGIN
                      update data base - remove entry;
                      update data base - add new entry;
                      send POSITIVE NAME REGISTRATION RESPONSE;
                      return;
                     END
                     ELSE
                     BEGIN
                      /*
                       * name still being held
                       * by challenged node
                       */

                       send NEGATIVE NAME REGISTRATION RESPONSE;
                     END
                 END /* local is unique */
                 ELSE
                 BEGIN /* local is group  */
```

```
                    /*
                     * existing entry is a group name
                     */

                    update data base - remove entry;
                    update data base - add new entry;
                    send POSITIVE NAME REGISTRATION RESPONSE;
                    return;
               END /* local is group */
          END /* names exists */
          ELSE
          BEGIN /* does not exist */

               /* name does not exist in data base */

               update data base - add new entry;
               send POSITIVE NAME REGISTRATION RESPONSE;
               return;
          END /* does not exist */

     NAME RELEASE REQUEST:

          /*
           * secure server may choose to disallow
           * a node from deleting a name
           */

          update data base - remove entry;
          send POSITIVE NAME RELEASE RESPONSE;
          return;

     NAME UPDATE REQUEST:

          /*
           * End-node completed a successful challenge,
           * no update database
           */

          IF secure server THEN
               send NEGATIVE NAME REGISTRATION RESPONSE;
          ELSE
          BEGIN /* new entry */
               IF entry already exists THEN
                    update data base - remove entry;
               update data base - add new entry;
               send POSITIVE NAME REGISTRATION RESPONSE;
               start_timer(TTL);
          END

     NAME REFRESH REQUEST:
          check for consistency;
```

```
            IF node not allowed to have name THEN
            BEGIN

                 /*
                  * tell end node that it can't have name
                  */
                 send NEGATIVE NAME REGISTRATION RESPONSE;
            END
            ELSE
            BEGIN

                 /*
                  * send confirmation response to the
                  * end node.
                  */
                 send POSITIVE NAME REGISTRATION;
                 start_timer(TTL);
            END
            return;
       END /* case */
  END /* procedure */
```

5.1.4.2. NBNS TIMER INITIATED PROCESSING

A NS node uses timers to flush out entries from the data base. Each entry in the data base is removed when its timer expires. This time value is a multiple of the refresh TTL established when the name was registered.

```
PROCEDURE timer_expired()

/*
 * processing initiated by expiration of TTL for a given name
 */

BEGIN
     /*
      * NBNS can (optionally) ensure
      * that the node is actually down
      * by sending a NODE STATUS REQUEST.
      * If such a request is sent, and
      * no response is received, it can
      * be assumed that the node is down.
      */
     remove entry from data base;
END
```

5.2. SESSION SERVICE PROTOCOLS

The following are variables and should be configurable by the NetBIOS user. The default values of these variables is found in "Defined Constants and Variables" in the Detailed Specification.):

- SSN_RETRY_COUNT - The maximum number TCP connection attempts allowable per a single NetBIOS call request.

- SSN_CLOSE_TIMEOUT is the time period to wait when closing the NetBIOS session before killing the TCP connection if session sends are outstanding.

The following are Defined Constants for the NetBIOS Session Service. (See "Defined Constants and Variables" in the Detailed Specification for the value of these constants):

- SSN_SRVC_TCP_PORT - is the globally well-known TCP port allocated for the NetBIOS Session Service. The service accepts TCP connections on this port to establish NetBIOS Sessions. The TCP connection established to this port by the caller is initially used for the exchange of NetBIOS control information. The actual NetBIOS data connection may also pass through this port or, through the retargetting facility, through another port.

5.2.1. SESSION ESTABLISHMENT PROTOCOLS

5.2.1.1. USER REQUEST PROCESSING

```
PROCEDURE listen(listening name, caller name)
/*
 * User initiated processing for B, P and M nodes
 *
 * This procedure assumes that an incoming session will be
 * retargetted here by a session server.
 */
BEGIN
     Do TCP listen; /* Returns TCP port used */
     Register listen with Session Service, give names and
          TCP port;

     Wait for TCP connection to open;   /* Incoming call */

     Read SESSION REQUEST packet from connection

     Process session request (see section on
          processing initiated by the reception of session
          service packets);
```

```
        Inform Session Service that NetBIOS listen is complete;

        IF session established THEN
             return success and session information to user;
        ELSE
             return failure;
   END /* procedure */

   PROCEDURE call(calling name, called name)
   /*
    * user initiated processing for B, P and M nodes
    */

   /*
    * This algorithm assumes that the called name is a unique name.
    * If the called name is a group name, the call() procedure
    * needs to cycle through the members of the group
    * until either (retry_count == SSN_RETRY_COUNT) or
    * the list has been exhausted.
    */
   BEGIN
        retry_count = 0;
        retarget = FALSE;    /* TRUE: caller is being retargetted */
        name_query = TRUE;   /* TRUE: caller must begin again with */
                             /*       name query. */

        REPEAT
             IF name_query THEN
             BEGIN
                  do name discovery, returns IP address;
                  TCP port = SSN_SRVC_TCP_PORT;

                  IF name discovery fails THEN
                       return failure;
                  ELSE
                       name_query = FALSE;
             END

             /*
              * now have IP address and TCP port of
              * remote party.
              */

             establish TCP connection with remote party, use an
                  ephemeral port as source TCP port;
             IF connection refused THEN
             BEGIN
                  IF retarget THEN
                  BEGIN
                       /* retry */
                       retarget = FALSE;
```

```
                    use original IP address and TCP port;
                    goto LOOP;
               END

               /* retry for just missed TCP listen */

               pause(SESSION_RETRY_TIMER);
               establish TCP connection, again use ephemeral
                    port as source TCP port;

               IF connection refused OR
                  connection timed out THEN
                    return failure;
          END
          ELSE
          IF connection timed out THEN
          BEGIN
               IF retarget THEN
               BEGIN
                    /* retry */
                    retarget = FALSE;
                    use original IP address and TCP port;
                    goto LOOP;
               END
               ELSE
               BEGIN
                    /*
                     * incorrect name discovery was done,
                     * try again
                     */

                    inform name discovery process of
                         possible error;
                    name_query = TRUE;
                    goto LOOP;
               END
          END

          /*
           * TCP connection has been established
           */

          wait for session response packet;
          CASE packet type OF

             POSITIVE SESSION RESPONSE:
               return success and session established
                    information;

             NEGATIVE SESSION RESPONSE:
             BEGIN
```

```
                    CASE error OF
                       NOT LISTENING ON CALLED NAME:
                       NOT LISTENING FOR CALLING NAME:
                       BEGIN
                         kill TCP connection;
                         return failure;
                       END

                       CALLED NAME NOT PRESENT:
                       BEGIN
                         /*
                          * called name does not exist on
                          * remote node
                          */

                         inform name discovery procedure
                              of possible error;

                         IF this is a P or M node THEN
                         BEGIN
                              /*
                               * Inform NetBIOS Name Server
                               * it has returned incorrect
                               * information.
                               */
                              send NAME RELEASE REQUEST for called
                                name and IP address to
                                NetBIOS Name Server;
                         END
                         /* retry from beginning */
                         retarget = FALSE;
                         name_query = TRUE;
                         goto LOOP;
                       END /* called name not present */
                    END /* case */
                  END /* negative response */

                  RETARGET SESSION RESPONSE:
                  BEGIN
                    close TCP connection;
                    extract IP address and TCP port from
                         response;
                    retarget = TRUE;
                  END /* retarget response */
               END /* case */

LOOP:          retry_count = retry_count + 1;

     UNTIL (retry_count > SSN_RETRY_COUNT);
     return failure;
END /* procedure */
```

5.2.1.2. RECEIVED PACKET PROCESSING

These are packets received on a TCP connection before a session has been established. The listen routines attached to a NetBIOS user process need not implement the RETARGET response section. The user process version, separate from a shared Session Service, need only accept (POSITIVE SESSION RESPONSE) or reject (NEGATIVE SESSION RESPONSE) a session request.

```
PROCEDURE session_packet(packet)
/*
 * processing initiated by receipt of a session service
 * packet for a session in the session establishment phase.
 * Assumes the TCP connection has been accepted.
 */
BEGIN
     CASE packet type

        SESSION REQUEST:
        BEGIN
          IF called name does not exist on node THEN
          BEGIN
               send NEGATIVE SESSION RESPONSE with CALLED
                    NAME NOT PRESENT error code;
               close TCP connection;
          END

          Search for a listen with CALLING NAME for CALLED
               NAME;
          IF matching listen is found THEN
          BEGIN
               IF port of listener process is port TCP
                  connection is on THEN
               BEGIN
                    send POSITIVE SESSION RESPONSE;

                    Hand off connection to client process
                         and/or inform user session is
                         established;
               END
               ELSE
               BEGIN
                    send RETARGET SESSION RESPONSE with
                         listener's IP address and
                         TCP port;
                    close TCP connection;
               END
          END
          ELSE
          BEGIN
               /* no matching listen pending */
```

```
                send NEGATIVE SESSION RESPONSE with either
                     NOT LISTENING ON CALLED NAME or NOT
                     LISTENING FOR CALLING NAME error
                     code;
                close TCP connection;
            END
          END /* session request */
       END /* case */
   END /* procedure */
```

5.2.2. SESSION DATA TRANSFER PROTOCOLS

5.2.2.1. USER REQUEST PROCESSING

```
   PROCEDURE send_message(user_message)
   BEGIN
        build SESSION MESSAGE header;
        send SESSION MESSAGE header;
        send user_message;
        reset and restart keep-alive timer;
        IF send fails THEN
        BEGIN
             /*
              * TCP connection has failed */
              */
             close NetBIOS session;
             inform user that session is lost;
             return failure;
        END
        ELSE
             return success;
   END
```

5.2.2.2. RECEIVED PACKET PROCESSING

These are packets received after a session has been established.

```
   PROCEDURE session_packet(packet)
   /*
    * processing initiated by receipt of a session service
    * packet for a session in the data transfer phase.
    */
   BEGIN
        CASE packet type OF

           SESSION  MESSAGE:
           BEGIN
             process message header;
             read in user data;
             reset and restart keep-alive timer;
             deliver data to user;
```

```
          END /* session message */

          SESSION KEEP ALIVE:
            discard packet;

       END /* case */
  END /* procedure */
```

5.2.2.3. PROCESSING INITIATED BY TIMER

```
  PROCEDURE session_ka_timer()
  /*
   * processing initiated when session keep alive timer expires
   */
  BEGIN
           send SESSION KEEP ALIVE, if configured;
           IF send fails THEN
           BEGIN
            /* remote node, or path to it, is down */

            abort TCP connection;
            close NetBIOS session;
            inform user that session is lost;
            return;
           END
  END /* procedure */
```

5.2.3. SESSION TERMINATION PROTOCOLS

5.2.3.1. USER REQUEST PROCESSING

```
  PROCEDURE close_session()

  /* initiated by a user request to close a session */

  BEGIN
       close gracefully the TCP connection;

       WAIT for the connection to close or SSN_CLOSE_TIMEOUT
            to expire;

       IF time out expired THEN
            abort TCP connection;
  END /* procedure */
```

5.2.3.2. RECEPTION INDICATION PROCESSING

```
  PROCEDURE close_indication()
  /*
   * initiated by a TCP indication of a close request from
   * the remote connection partner.
```

```
 */
BEGIN
     close gracefully TCP connection;

     close NetBIOS session;

     inform user session closed by remote partner;
END /* procedure */
```

5.3. NetBIOS DATAGRAM SERVICE PROTOCOLS

The following are GLOBAL variables and should be NetBIOS user configurable:

- SCOPE_ID: the non-leaf section of the domain name preceded by a '.' which represents the domain of the NetBIOS scope for the NetBIOS name. The following protocol description only supports single scope operation.

- MAX_DATAGRAM_LENGTH: the maximum length of an IP datagram. The minimal maximum length defined in for IP is 576 bytes. This value is used when determining whether to fragment a NetBIOS datagram. Implementations are expected to be capable of receiving unfragmented NetBIOS datagrams up to their maximum size.

- BROADCAST_ADDRESS: the IP address B-nodes use to send datagrams with group name destinations and broadcast datagrams. The default is the IP broadcast address for a single IP network.

The following are Defined Constants for the NetBIOS Datagram Service:

- DGM_SRVC_UDP_PORT: the globally well-known UDP port allocated where the NetBIOS Datagram Service receives UDP packets. See section 6, "Defined Constants", for its value.

5.3.1. B NODE TRANSMISSION OF NetBIOS DATAGRAMS

```
PROCEDURE send_datagram(data, source, destination, broadcast)

/*
 * user initiated processing on B node
 */

BEGIN
     group = FALSE;

     do name discovery on destination name, returns name type and
          IP address;
```

```
IF name type is group name THEN
BEGIN
     group = TRUE;
END

/*
 * build datagram service UDP packet;
 */
convert source and destination NetBIOS names into
     half-ASCII, biased encoded name;
SOURCE_NAME = cat(source, SCOPE_ID);
SOURCE_IP = this nodes IP address;
SOURCE_PORT =  DGM_SRVC_UDP_PORT;

IF NetBIOS broadcast THEN
BEGIN
     DESTINATION_NAME = cat("*", SCOPE_ID)
END
ELSE
BEGIN
     DESTINATION_NAME = cat(destination, SCOPE_ID)
END

MSG_TYPE = select_one_from_set
     {BROADCAST, DIRECT_UNIQUE, DIRECT_GROUP}
DGM_ID = next transaction id for Datagrams;
DGM_LENGTH = length of data + length of second level encoded
     source and destination names;

IF (length of the NetBIOS Datagram, including UDP and
    IP headers, > MAX_DATAGRAM_LENGTH) THEN
BEGIN
     /*
      * fragment NetBIOS datagram into 2 UDP packets
      */
     Put names into 1st UDP packet and any data that fits
          after names;
     Set MORE and FIRST bits in 1st UDP packet's FLAGS;
     OFFSET in 1st UDP = 0;

     Replicate NetBIOS Datagram header from 1st UDP packet
          into 2nd UDP packet;
     Put rest of data in 2nd UDP packet;
     Clear MORE and FIRST bits in 2nd UDP packet's FLAGS;
     OFFSET in 2nd UDP = DGM_LENGTH - number of name and
          data bytes in 1st UDP;
END
BEGIN
     /*
      * Only need one UDP packet
      */
```

```
            USER_DATA = data;
            Clear MORE bit and set FIRST bit in FLAGS;
            OFFSET = 0;
       END

       IF (group == TRUE) OR (NetBIOS broadcast) THEN
       BEGIN
            send UDP packet(s) to BROADCAST_ADDRESS;
       END
       ELSE
       BEGIN
            send UDP packet(s) to IP address returned by name
               discovery;
       END
  END /* procedure */
```

5.3.2. P AND M NODE TRANSMISSION OF NetBIOS DATAGRAMS

```
  PROCEDURE send_datagram(data, source, destination, broadcast)

  /*
   * User initiated processing on P and M node.
   *
   * This processing is the same as for B nodes except for
   * sending broadcast and multicast NetBIOS datagrams.
   */

  BEGIN
       group = FALSE;

       do name discovery on destination name, returns name type
            and IP address;
       IF name type is group name THEN
       BEGIN
            group = TRUE;
       END

       /*
        * build datagram service UDP packet;
        */
       convert source and destination NetBIOS names into
            half-ASCII, biased encoded name;
       SOURCE_NAME = cat(source, SCOPE_ID);
       SOURCE_IP = this nodes IP address;
       SOURCE_PORT =  DGM_SRVC_UDP_PORT;

       IF NetBIOS broadcast THEN
       BEGIN
            DESTINATION_NAME = cat("*", SCOPE_ID)
       END
       ELSE
```

```
BEGIN
     DESTINATION_NAME = cat(destination, SCOPE_ID)
END

MSG_TYPE = select_one_from_set
     {BROADCAST, DIRECT_UNIQUE, DIRECT_GROUP}
DGM_ID = next transaction id for Datagrams;
DGM_LENGTH = length of data + length of second level encoded
     source and destination names;

IF (length of the NetBIOS Datagram, including UDP and
    IP headers, > MAX_DATAGRAM_LENGTH) THEN
BEGIN
     /*
      * fragment NetBIOS datagram into 2 UDP packets
      */
     Put names into 1st UDP packet and any data that fits
          after names;
     Set MORE and FIRST bits in 1st UDP packet's FLAGS;

     OFFSET in 1st UDP = 0;

     Replicate NetBIOS Datagram header from 1st UDP packet
          into 2nd UDP packet;
     Put rest of data in 2nd UDP packet;
     Clear MORE and FIRST bits in 2nd UDP packet's FLAGS;
     OFFSET in 2nd UDP = DGM_LENGTH - number of name and
          data bytes in 1st UDP;
END
BEGIN
     /*
      * Only need one UDP packet
      */
     USER_DATA = data;
     Clear MORE bit and set FIRST bit in FLAGS;
     OFFSET = 0;
END

IF (group == TRUE) OR (NetBIOS broadcast) THEN
BEGIN
     /*
      * Sending of following query is optional.
      * Node may send datagram to NBDD immediately
      * but NBDD may discard the datagram.
      */
     send DATAGRAM QUERY REQUEST to NBDD;
     IF response is POSITIVE QUERY RESPONSE THEN
          send UDP packet(s) to NBDD Server IP address;
     ELSE
     BEGIN
          get list of destination nodes from NBNS;
```

```
                FOR EACH node in list
                BEGIN
                     send UDP packet(s) to this node's
                          IP address;
                END
           END
      END
      ELSE
      BEGIN
           send UDP packet(s) to IP address returned by name
              discovery;
END /* procedure */
```

5.3.3. RECEPTION OF NetBIOS DATAGRAMS BY ALL NODES

The following algorithm discards out of order NetBIOS Datagram fragments. An implementation which reassembles out of order NetBIOS Datagram fragments conforms to this specification. The fragment discard timer is initialized to the value FRAGMENT_TO. This value should be user configurable. The default value is given in Section 6, "Defined Constants and Variables".

```
PROCEDURE datagram_packet(packet)

/*
 * processing initiated by datagram packet reception
 * on B, P and M nodes
 */
BEGIN
     /*
      * if this node is a P node, ignore
      * broadcast packets.
      */

     IF this is a P node AND incoming packet is
          a broadcast packet THEN
     BEGIN
          discard packet;
     END

     CASE packet type OF

        DATAGRAM SERVICE:
        BEGIN
          IF FIRST bit in FLAGS is set THEN
          BEGIN
               IF MORE bit in FLAGS is set THEN
               BEGIN
                    Save 1st UDP packet of the Datagram;
                    Set this Datagram's fragment discard
                      timer to FRAGMENT_TO;
```

```
                return;
           END
           ELSE
                Datagram is composed of a single
                  UDP packet;
      END
      ELSE
      BEGIN
           /* Have the second fragment of a Datagram */

           Search for 1st fragment by source IP address
              and DGM_ID;
           IF found 1st fragment THEN
                Process both UDP packets;
           ELSE
           BEGIN
                discard 2nd fragment UDP packet;
                return;
           END
      END

      IF DESTINATION_NAME is '*' THEN
      BEGIN
           /* NetBIOS broadcast */

           deliver USER_DATA from UDP packet(s) to all
                outstanding receive broadcast
                datagram requests;
           return;
      END
      ELSE
      BEGIN /* non-broadcast */
           /* Datagram for Unique or Group Name */

           IF DESTINATION_NAME is not present in the
              local name table THEN
           BEGIN
                /* destination not present */
                build DATAGRAM ERROR packet, clear
                     FIRST and MORE bit, put in
                     this nodes IP and PORT, set
                     ERROR_CODE;
                send DATAGRAM ERROR packet to
                     source IP address and port
                     of UDP;
                discard UDP packet(s);
                return;
           END
           ELSE
           BEGIN /* good */
                /*
```

```
                        * Replicate received NetBIOS datagram for
                        * each recipient
                        */
                       FOR EACH pending NetBIOS user's receive
                            datagram operation
                       BEGIN
                            IF source name of operation
                               matches destination name
                               of packet THEN
                            BEGIN
                               deliver USER_DATA from UDP
                                 packet(s);
                            END
                       END /* for each */
                       return;
                  END /* good */
             END /* non-broadcast */
            END /* datagram service */

          DATAGRAM ERROR:
          BEGIN
               /*
                * name service returned incorrect information
                */

               inform local name service that incorrect
                 information was provided;

               IF this is a P or M node THEN
               BEGIN
                    /*
                     * tell NetBIOS Name Server that it may
                     * have given incorrect information
                     */

                    send NAME RELEASE REQUEST with name
                      and incorrect IP address to NetBIOS
                      Name Server;
               END
          END /* datagram error */

     END /* case */
END
```

5.3.4. PROTOCOLS FOR THE NBDD

The key to NetBIOS Datagram forwarding service is the packet delivered to the destination end node must have the same NetBIOS header as if the source end node sent the packet directly to the destination end node. Consequently, the NBDD does not reassemble NetBIOS Datagrams. It forwards the UDP packet as is.

```
PROCEDURE  datagram_packet(packet)

/*
 * processing initiated by a incoming datagram service
 * packet on a NBDD node.
 */

BEGIN
     CASE packet type OF

        DATAGRAM SERVICE:
        BEGIN
             IF packet was sent as a directed
                NetBIOS datagram THEN
             BEGIN
               /*
                * provide group forwarding service
                *
                * Forward datagram to each member of the
                * group.  Can forward via:
                *   1) get list of group members and send
                *   the DATAGRAM SERVICE packet unicast
                *   to each
                *   2) use Group Multicast, if available
                *   3) combination of 1) and 2)
                */

               ...

             END

             ELSE
             BEGIN
               /*
                * provide broadcast forwarding service
                *
                * Forward datagram to every node in the
                * NetBIOS scope.  Can forward via:
                *   1) get list of group members and send
                *   the DATAGRAM SERVICE packet unicast
                *   to each
                *   2) use Group Multicast, if available
                *   3) combination of 1) and 2)
                */

               ...

             END
        END /* datagram service */

        DATAGRAM ERROR:
```

```
            BEGIN
              /*
               * Should never receive these because Datagrams
               * forwarded have source end node IP address and
               * port in NetBIOS header.
               */

              send DELETE NAME REQUEST with incorrect name and
                   IP address to NetBIOS Name Server;

            END /* datagram error */

            DATAGRAM QUERY REQUEST:
            BEGIN
              IF can send packet to DESTINATION_NAME THEN
              BEGIN
                   /*
                    * NBDD is able to relay Datagrams for
                    * this name
                    */

                   send POSITIVE DATAGRAM QUERY RESPONSE to
                     REQUEST source IP address and UDP port
                     with request's DGM_ID;
              END
              ELSE
              BEGIN
                   /*
                    * NBDD is NOT able to relay Datagrams for
                    * this name
                    */

                   send NEGATIVE DATAGRAM QUERY RESPONSE to
                     REQUEST source IP address and UDP port

                     with request's DGM_ID;
              END
            END /* datagram query request */

       END /* case */
  END /* procedure */
```

6. DEFINED CONSTANTS AND VARIABLES

GENERAL:

SCOPE_ID	The name of the NetBIOS scope. This is expressed as a character string meeting the requirements of the domain name system and without a leading or trailing "dot". An implementation may elect to make this a single global value for the node or allow it to be specified with each separate NetBIOS name (thus permitting cross-scope references.)
BROADCAST_ADDRESS	An IP address composed of the nodes's network and subnetwork numbers with all remaining bits set to one. I.e. "Specific subnet" broadcast addressing according to section 2.3 of RFC 950.
BCAST_REQ_RETRY_TIMEOUT	250 milliseconds. An adaptive timer may be used.
BCAST_REQ_RETRY_COUNT	3
UCAST_REQ_RETRY_TIMEOUT	5 seconds An adaptive timer may be used.
UCAST_REQ_RETRY_COUNT	3
MAX_DATAGRAM_LENGTH	576 bytes (default)

NAME SERVICE:

REFRESH_TIMER	Negotiated with NBNS for each name.
CONFLICT_TIMER	1 second Implementations may chose a longer value.
NAME_SERVICE_TCP_PORT	137 (decimal)

NAME_SERVICE_UDP_PORT	137 (decimal)
INFINITE_TTL	0

SESSION SERVICE:

SSN_SRVC_TCP_PORT	139 (decimal)
SSN_RETRY_COUNT	4 (default) Re-configurable by user.
SSN_CLOSE_TIMEOUT	30 seconds (default) Re-configurable by user.
SSN_KEEP_ALIVE_TIMEOUT	60 seconds, recommended, may be set to a higher value. (Session keep-alives are used only if configured.)

DATAGRAM SERVICE:

DGM_SRVC_UDP_PORT	138 (decimal)
FRAGMENT_TO	2 seconds (default)

REFERENCES

[1] "Protocol Standard For a NetBIOS Service on a TCP/UDP Transport: Concepts and Methods", RFC 1001, March 1987.

[2] J. Reynolds, J. Postel, "Assigned Numbers", RFC 990, November 1986.

[3] P. Mockapetris, "Domain Names - Implementation and Specification", RFC 883, November 1983.

Glossary

ACL
(Access Control List) A list used to control access to a file or resource. The list contains the user IDs and/or group IDs that are allowed access to the file or resource.

API
(Application Programming Interface) A published interface for software developers.

big-endian
The name of a particular byte order (coined by Danny Cohen). When looking at addresses in increasing order, the most significant byte comes first. The Internet protocols use big-endian byte order.

broadcast
The function of delivering a given packet to all hosts that are attached to the broadcasting delivery system. Broadcasting is implemented both at the hardware and the software levels.

byte
8 bits.

CAE
Common Applications Environment.

chaining
Transmission of more than one SMB request in a request.

client-server
The distributed system model where a requesting program (the client) interacts with a program that can satisfy the request (the server). The client initiates the interaction and may wait for the server to respond.

connection-oriented service
A service provided between two endpoints along which data is passed in a sequenced and reliable way.

connectionless service
In a connectionless service each packet is a separate entity containing a source and destination address; therefore, packets may be dropped or delivered out of sequence. The delivery service offered by the Internet Protocol (IP) is a connectionless service.

core
The dialect name for the basic SMB dialect described in this specification.

core plus
The dialect name for the SMB dialect that provides additional features to the core dialect.

data encapsulation
The way a lower-level protocol accepts a message from a higher-level protocol and places it in the data portion of the low-level frame.

daemon
A process that is not associated with any user. This sort of process performs system-wide functions; for example, administration, control of networks and execution-dependent activities.

datagram
A packet sent independently of the others in the network. It contains the source and destination addresses as well as the data.

dialect
Used to refer to the level of protocol negotiated between the SMB redirector and the LMX server.

DES
U.S. Department of Commerce Data Encryption Standard.

EA
(Extended Attribute) An SMB protocol element supported by the extended 2.0 protocol dialect. Extended attributes can be associated with a file.

effective group ID
An attribute of a process that is used in determining various permissions, including file access permissions. This value is subject to change during the process' lifetime.

effective user ID
An attribute of a process that is used in determining various permissions, including file access permissions. This value is subject to change during the process' lifetime.

exec
The XSI system call that is used to start a process running.

extended 1.0
The dialect name for the first extended SMB protocol dialect.

extended 2.0
The dialect name for the second extended SMB protocol dialect.

Extended Attribute
See EA.

FCB
(File Control Block) The area of memory holding the file information and status. It is a term associated with DOS.

FID
(File ID) A unique number associated with a file to enable it to be identified.

fifo
(First In First Out) One of the file types supported on an XSI system. A fifo, the alternative name for a pipe, differs from a regular file because its data is transient; that is, once data is read from the pipe it cannot be read again.

fork
The XSI system call which is used to create a new process. The process created is a duplicate of the calling process.

Internet Protocol
(IP) The protocol from the Internet Protocol Suite that provides the basis for Internet communications.

interoperability
The ability of software and hardware on multiple machines and from multiple vendors to communicate effectively.

ioctl
A system call which allows a process to specify control information to control a device. This

function exists in both XSI and DOS.

IPC
(Inter-process Communication) Methods by which two or more processes can communicate; for example, formatted data streams or shared memory.

LAN
(Local Area Network) A physical network that operates at a high speed over short distances; for example, Ethernet.

little-endian
The name of a particular byte order (coined by Danny Cohen). When looking at addresses in increasing order, the least significant byte comes first.

LMX
X/Open LAN Manager Architecture. The implementation of the LAN Manager on CAE systems.

LMX Server
The system providing the LMX service.

LMX Session
The path between two communicating systems that provides a reliable, sequenced data delivery service.

MBZ
(Must Be Zero) Reserved fields are often defined MBZ.

MID
(Multiplex Identifier) A number which uniquely identifies a protocol request and response within a process.

multicast
A method by which copies of a single packet are passed to a selected subset of all destinations. Broadcast is a special case of multicast whereby the subset of destinations receiving a copy of the packet is the entire set of destinations.

named pipe
An inter-process communication mechanism defined by the extended SMB specification. Also a fifo.

NetBIOS
(Network Basic Input Output System) The *de facto* standard programmatic interface to networks for DOS systems.

NFS
(Network File System) A protocol which allows a set of computers access to each others' file systems. NFS was developed by Sun Microsystems and is used primarily on UNIX systems.

octet
8 bits.

opportunistic lock
The server will notify the client, allowing it to flush its dirty buffers and unlock the file, when another client attempts to open the file.

OSI
(Open Systems Interconnect) ISO standards for the interconnection of cooperative (open) computer systems.

packet
A block of data sent across a packet switching network.

PID
(Process ID) The number assigned to a process so that it can be uniquely identified.

responder
An entity with which an initiator wishes to establish a transport connection.

RFC
(Request for Comments) The name of a series of notes that contain surveys, measurements, ideas, techniques and observations, as well as proposed and accepted Internet protocol standards.

root (of file system)
The top directory in the directory hierarchical structure.

RPC
Remote Procedure Call.

session
See LMX Session.

SMB
(Server Message Block) A protocol which allows a set of computers to access shared resources as if they were local. The core protocol was developed by Microsoft Corporation and Intel, and the extended protocols were developed by Microsoft Corporation.

SMB redirector
The client system accessing the LMX server.

SMB request
The server message block sent from the SMB redirector to the LMX server.

SMB response
The server message block sent from the LMX server to the SMB redirector.

TBD
(To be Defined) Further detail will be provided at a later time.

TCP
(Transmission Control Protocol) The Internet standard transport level connection-oriented protocol. It provides a full duplex, reliable stream service which allows a process on one machine to send a stream of data to a process on another. Part of the Internet Protocol Suite.

TID
(Tree Connect Identifier) A numeric value passed by the LMX server to the SMB redirector to represent a location within a file system subtree.

UDP
(User Datagram Protocol) The Internet connectionless protocol. Part of the Internet Protocol Suite.

UID
(User Identifier) A token representing an authenticated *<username, password>* tuple. UIDs are registered by the redirectors.

umask
The XSI process' file mode creation mask used during file and directory creation. Bit positions that are set in the umask are cleared in the mode of the newly created file or directory. The

umask is set using the *umask*() call.

working directory
A directory, associated with a process, that is used in pathname resolution for pathnames that do not begin with a slash.

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