[MS-APDS]:
Authentication Protocol Domain Support

Revision Summary

Date	Revision History	Revision Class	Comments
02/22/2007	0.1		MCPP Milestone 3 Initial Availability
06/01/2007	2.0	Major	Updated and revised the technical content.
07/03/2007	3.0	Major	Added new protocol.
07/20/2007	3.0.1	Editorial	Revised and edited the technical content.
08/10/2007	3.0.2	Editorial	Revised and edited the technical content.
09/28/2007	4.0	Major	Updated and revised the technical content.
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06/20/2008	6.0	Major	Updated and revised the technical content.
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07/02/2009	12.0	Major	Updated and revised the technical content.
08/14/2009	13.0	Major	Updated and revised the technical content.
09/25/2009	14.0	Major	Updated and revised the technical content.
11/06/2009	15.0	Major	Updated and revised the technical content.
12/18/2009	16.0	Major	Updated and revised the technical content.
01/29/2010	17.0	Major	Updated and revised the technical content.

Date	Revision History	Revision Class	Comments
03/12/2010	17.0.1	Editorial	Revised and edited the technical content.
04/23/2010	18.0	Major	Updated and revised the technical content.
06/04/2010	19.0	Major	Updated and revised the technical content.
07/16/2010	20.0	Major	Significantly changed the technical content.
08/27/2010	20.0	No change	No changes to the meaning, language, or formatting of the technical content.
10/08/2010	21.0	Major	Significantly changed the technical content.
11/19/2010	21.1	Minor	Clarified the meaning of the technical content.
01/07/2011	21.1	No change	No changes to the meaning, language, or formatting of the technical content.
02/11/2011	22.0	Major	Significantly changed the technical content.
03/25/2011	22.0	No change	No changes to the meaning, language, or formatting of the technical content.
05/06/2011	23.0	Major	Significantly changed the technical content.
06/17/2011	23.1	Minor	Clarified the meaning of the technical content.
09/23/2011	23.1	No change	No changes to the meaning, language, or formatting of the technical content.
12/16/2011	24.0	Major	Significantly changed the technical content.
03/30/2012	24.0	No change	No changes to the meaning, language, or formatting of the technical content.
07/12/2012	24.0	No change	No changes to the meaning, language, or formatting of the technical content.
10/25/2012	25.0	Major	Significantly changed the technical content.
01/31/2013	25.1	Minor	Clarified the meaning of the technical content.
08/08/2013	26.0	Major	Significantly changed the technical content.
11/14/2013	26.1	Minor	Clarified the meaning of the technical content.
02/13/2014	27.0	Major	Significantly changed the technical content.

Contents

1 Introduction

Authentication Protocol Domain Support (APDS) provides the required communication between a server and a **domain controller (DC)** that uses Netlogon interfaces ([MS-NRPC] section 3.2) to complete an authentication sequence.

An operating system can support a number of authentication protocols, such as **NT LAN Manager (NTLM)**, **Kerberos**, **Secure Sockets Layer (SSL)**/**Transport Layer Security (TLS)**, and **Digest authentication**. Authentication Protocol Domain Support is used by NT LAN Manager (NTLM) and the **Digest validation** protocol to perform validation of the user's credentials at the domain controller. The Kerberos protocol uses Authentication Protocol Domain Support to perform the required communication for **privilege attribute certificate (PAC)** validation.

With the exception of Kerberos (which also relies on a mutually trusted third-party called **Key Distribution Center (KDC)** [MS-KILE]), all of these protocols can be supported by any server, relying only on a local user account database. Therefore, specifications for these protocols can stand entirely on their own. However, in a **domain** context, when the server is a member of a domain and relies on the **domain account** database, the domain controller contributes to the authentication and authorization processes.

Domain members use the Netlogon Remote Protocol [MS-NRPC] to communicate with the domain controller for purposes of authentication and authorization.

The implementations of these authentication protocols use a variety of methods to communicate with the domain controller in the course of their executions. These methods, collectively referred to as Authentication Protocol Domain Support, are specified in this document.

Sections 1.8, 2, and 3 of this specification are normative and can contain the terms MAY, SHOULD, MUST, MUST NOT, and SHOULD NOT as defined in RFC 2119. Sections 1.5 and 1.9 are also normative but cannot contain those terms. All other sections and examples in this specification are informative.

1.1 Glossary

The following terms are defined in [MS-GLOS]:

Active Directory
directory
domain
domain account
domain controller (DC)
domain name
interactive logon
Kerberos
Key Distribution Center (KDC)
little-endian
machine account
network logon
NT LAN Manager (NTLM) Authentication Protocol
NTOWF
principal
privilege attribute certificate (PAC)
realm

remote procedure call (RPC)
RPC transport
Secure Sockets Layer (SSL)
service
Transport Layer Security (TLS)
Unicode
user principal name (UPN)

The following terms are specific to this document:

APDS client: The Authentication Protocol Domain Support [MS-APDS] client, otherwise known as a server computer in authentication protocols that use Authentication Protocol Domain Support.

APDS server: The server side of Authentication Protocol Domain Support [MS-APDS], otherwise known as a **domain controller** in authentication protocols that use Authentication Protocol Domain Support.

Application server: The server side of Kerberos Network Authentication Service (V5) Extensions [MS-KILE].

client computer: The client machine in the **domain** topology of clients, servers, and **domain controllers**.

Digest authentication: A protocol that uses a challenge-response mechanism for authentication in which clients are able to verify their identities without sending an in-the-clear password to the server. For more information, see [RFC2617] and [RFC2831].

Digest client: The Digest Access Authentication: Microsoft Extensions [MS-DPSP] client.

Digest server: The server side of Digest Access Authentication: Microsoft Extensions [MS-DPSP].

Digest validation: A protocol to verify the **Digest authentication** challenge-response from a client to a server for a specified **domain** account.

domain controller: The **domain controller (DC)** in the **domain** topology of clients, servers, and **DCs**. The server side of Authentication Protocol Domain Support [MS-APDS].

NTLM client: The NT LAN Manager (NTLM) Authentication Protocol [MS-NLMP] client.

NTLM server: The server side of NT LAN Manager (NTLM) Authentication Protocol [MS-NLMP].

server computer: The server machine in the domain topology of clients, servers, and domain controllers.

MAY, SHOULD, MUST, SHOULD NOT, MUST NOT: These terms (in all caps) are used as described in [RFC2119]. All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2 References

References to Microsoft Open Specifications documentation do not include a publishing year because links are to the latest version of the documents, which are updated frequently. References to other documents include a publishing year when one is available.

A reference marked "(Archived)" means that the reference document was either retired and is no longer being maintained or was replaced with a new document that provides current implementation details. We archive our documents online [Windows Protocol].

1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dochelp@microsoft.com. We will assist you in finding the relevant information.

[ISO/IEC-8859-1] International Organization for Standardization, "Information Technology -- 8-Bit Single-Byte Coded Graphic Character Sets -- Part 1: Latin Alphabet No. 1", ISO/IEC 8859-1, 1998, http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=28245

Note There is a charge to download the specification.

[MS-ADA3] Microsoft Corporation, "Active Directory Schema Attributes N-Z".

[MS-ADTS] Microsoft Corporation, "Active Directory Technical Specification".

[MS-DPSP] Microsoft Corporation, "Digest Protocol Extensions".

[MS-DTYP] Microsoft Corporation, "Windows Data Types".

[MS-ERREF] Microsoft Corporation, "Windows Error Codes".

[MS-KILE] Microsoft Corporation, "Kerberos Protocol Extensions".

[MS-LSAD] Microsoft Corporation, "Local Security Authority (Domain Policy) Remote Protocol".

[MS-NLMP] Microsoft Corporation, "NT LAN Manager (NTLM) Authentication Protocol".

[MS-NRPC] Microsoft Corporation, "Netlogon Remote Protocol".

[MS-PAC] Microsoft Corporation, "Privilege Attribute Certificate Data Structure".

[MS-RCMP] Microsoft Corporation, "Remote Certificate Mapping Protocol".

[MS-RPCE] Microsoft Corporation, "Remote Procedure Call Protocol Extensions".

[MS-SAMR] Microsoft Corporation, "Security Account Manager (SAM) Remote Protocol (Client-to-Server)".

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, http://www.rfc-editor.org/rfc/rfc2119.txt

[RFC2617] Franks, J., Hallam-Baker, P., Hostetler, J., et al., "HTTP Authentication: Basic and Digest Access Authentication", RFC 2617, June 1999, http://www.ietf.org/rfc/rfc2617.txt

[RFC2831] Leach, P., and Newman, C., "Using Digest Authentication as a SASL Mechanism", RFC 2831, May 2000, http://www.ietf.org/rfc/rfc2831.txt

[RFC4757] Jaganathan, K., Zhu, L., and Brezak, J., "The RC4-HMAC Kerberos Encryption Types Used by Microsoft Windows", RFC 4757, December 2006, http://www.ietf.org/rfc/rfc4757.txt

[X509] ITU-T, "Information Technology - Open Systems Interconnection - The Directory: Public-Key and Attribute Certificate Frameworks", Recommendation X.509, August 2005, http://www.itu.int/rec/T-REC-X.509/en

Note There is a charge to download the specification.

1.2.2 Informative References

[MS-GLOS] Microsoft Corporation, "Windows Protocols Master Glossary".

[MSDN-0SUBAUTHROUTINE9] Microsoft Corporation, "Msv1_0SubAuthenticationRoutine (9 Parameters) function [Security]", http://msdn.microsoft.com/en-us/library/aa378752.aspx

[RFC2069] Franks, J., Hallam-Baker, P., Hostetler, J., et al., "An Extension to HTTP: Digest Access Authentication", RFC 2069, January 1997, http://www.ietf.org/rfc/rfc2069.txt

[RFC1994] Simpson, W., "PPP Challenge Handshake Authentication Protocol (CHAP)", RFC 1994, August 1996, http://www.ietf.org/rfc/rfc1994.txt

1.3 Overview

Authentication protocols such as NT LAN Manager (NTLM), Kerberos, Secure Sockets Layer (SSL)/Transport Layer Security (TLS), and Digest authentication are used by a variety of higher-layer protocols to provide security **services**.

The Authentication Protocol Domain Support Protocol specifies the communication between the server and the domain controller for each of the protocols.

Each of the protocols has a specific exchange with the domain controller (DC) as follows:

- Authenticating the client: NTLM and digest.
- Obtaining authorization information, such as group memberships: NTLM, digest, and SSL/TLS.
- Verifying the authorization information: The server operating system for Kerberos privilege attribute certificate (PAC) [MS-PAC].

All of these back-end, server-to-server protocols in turn use the Netlogon Remote Protocol [MS-NRPC] for their transport to the DC. Specifically, the protocols behave as follows:

- The NT LAN Manager (NTLM) Authentication Protocol [MS-NLMP] uses the Netlogon Remote Protocol [MS-NRPC] to communicate with the DC to complete the authentication of a domain account during an **interactive logon** or **network logon**. As user account information is maintained by the DC, only the DC can validate user credentials and complete the authentication sequence. The server then uses the authorization information returned by the DC to make authorization decisions.
- The server operating system uses Netlogon generic pass-through ([MS-NRPC] section 3.2) to validate the PAC [MS-PAC] that it receives in the ticket from the client. Because PAC information can be altered by the server, the operating system may contact the DC to validate the PAC and ensure its integrity.
- The Digest Protocol Extensions [MS-DPSP] is used by deployments in which users are authenticated based on user name and password by using the Digest authentication mechanism. The Digest authentication mechanism itself defines how the client authenticates the user to the server (by proving knowledge of the password), and optionally provides integrity and confidentiality of subsequent messages exchanged between the client and the server. Digest validation is performed between the server and the DC during the initial client/server Digest–based authentication as follows:

1. The server (which does not have access to the user's password) sends a Digest validation request (section 2.2.3.1) message to the domain controller by using the generic pass-through capability of the Netlogon Remote Protocol, as specified in [MS-NRPC] section 3.2.

2. The DC looks up the user's password and uses it to verify the validity of the digest input. The digest input is originally generated by the Digest client using the user's password, as specified in [RFC2617] and [RFC2831]).

3. On successful validation, the domain controller returns the PAC in the DIGEST_VALIDATION_RESP message. The PAC represents the user's identity and group memberships, suitable for making authorization decisions.

- SSL/TLS and other protocols that authenticate users via the X.509 certificates [X509] can use the Remote Certificate Mapping Protocol [MS-RCMP], which relies on the generic pass-through capability of Netlogon to retrieve authorization information associated with users. This behavior is specified in [MS-RCMP].

1.4 Relationship to Other Protocols

Each of the following protocols relies on the Netlogon Remote Protocol ([MS-NRPC]) to complete the authentication sequence and retrieve or validate authorization information associated with a user. All higher-layer protocols that use one of the protocols specified in this document (for example, NT LAN Manager (NTLM) Authentication Protocol [MS-NLMP]) leverage the functionality specified here when in a domain environment.

1.4.1 NTLM Logon

NTLM authentication ([MS-NLMP]) uses the Netlogon pass-through authentication ([MS-NRPC] section 3.2) to authenticate the user in the domain with the domain controller during an interactive logon or a network logon.

1.4.2 Kerberos PAC Validation

The server operating system uses the Netlogon generic pass-through ([MS-NRPC] section 3.2.4.1) to validate the privilege attribute certificate (PAC) with the domain controller, when required.

1.4.3 Digest Validation Protocol

The Digest validation defined in this document relies on the generic pass-through capability of the Netlogon Remote Protocol ([MS-NRPC] section 3.2.4.1) as a transport for the DIGEST_VALIDATION_REQ (section 2.2.3.1) and DIGEST_VALIDATION_RESP (section 2.2.3.2) messages.

1.5 Prerequisites/Preconditions

Each of the protocols in this specification relies on the Netlogon Remote Protocol [MS-NRPC]. [MS-NRPC] assumes that the following prerequisites are met:

- The server has a **machine account** in the domain.
- The server has established a secure connection with the domain controller (DC).

1.5.1 NTLM Logon

NTLM interactive logon and NTLM network logon have all of the prerequisites and preconditions that are defined in the NT LAN Manager (NTLM) Authentication Protocol [MS-NLMP].

1.5.2 Kerberos PAC Validation

Kerberos PAC validation assumes that the server operating system has a PAC that has been received in a ticket from the client to the **application server**. It is possible for a server operating system to require PAC validation (section 1.6.2).

1.5.3 Digest Validation Protocol

The Digest validation protocol assumes the following:

- The **DC** server has access to the user's password.
- The **Digest client** possesses the digest-response message ([RFC2617] section 3.2.2) and the initial digest-challenge message ([RFC2617] section 3.2.1) used in the Digest authentication protocol.

1.6 Applicability Statement

All protocol support for domains requires a domain authority to process the requests. These protocols are not applicable to any stand-alone machine that is not associated with a domain. Each protocol has additional applicability constraints.

1.6.1 NTLM Logon

NTLM ([MS-NLMP] section 1.6) also applies when the **NTLM server** performing the NTLM authentication is a member of a domain. Both NTLM for interactive logon and NTLM for network logon can be performed by using a domain controller (DC).<1>

1.6.2 Kerberos PAC Validation

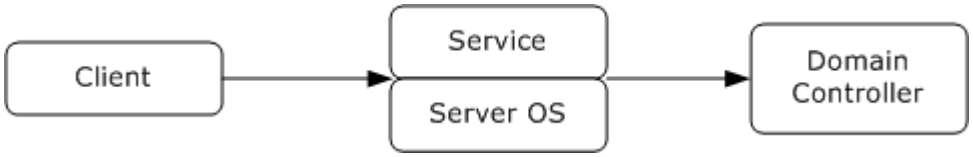


Figure 1: Kerberos PAC validation

Before Kerberos PAC validation occurs, the client has sent the privilege attribute certificate (PAC) to the service as a part of the Kerberos Protocol Extensions [MS-KILE]. The operating system on which the service runs validates the PAC to prevent PAC tampering by the service. PAC tampering can result in inappropriate elevation of privileges.

PAC validation is applicable for Kerberos applications that process and interpret the PAC and present that authorization data to additional services. It is optional for a self-contained application because the security threat that the protocol addresses is not relevant for self-contained applications.<2>

1.6.3 Digest Validation Protocol

The Digest validation protocol is appropriate for servers that are implementing Digest authentication and are acting as members in an **Active Directory**–compatible domain.

1.7 Versioning and Capability Negotiation

1.7.1 NTLM Logon

NTLM interactive logon and network logon do not have any versioning or capability negotiation.

1.7.2 Kerberos PAC Validation

Kerberos PAC validation does not have any versioning or capability negotiation.

1.7.3 Digest Validation Protocol

The DIGEST_VALIDATION_REQ and DIGEST_VALIDATION_RESP messages have a dedicated version number field. This document defines version 1 of the Digest Protocol Extensions. The Digest Protocol Extensions does not support any capability negotiation.

1.8 Vendor-Extensible Fields

1.8.1 NTLM Logon

NTLM interactive logon and network logon do not have any vendor-extensible fields.

1.8.2 Kerberos PAC Validation

Kerberos PAC validation does not have any vendor-extensible fields.

1.8.3 Digest Validation Protocol

The Digest validation protocol does not have any vendor-extensible fields. Note that the Digest validation protocol has reserved fields for future use, but these fields are not intended to carry opaque or vendor-defined data.

1.9 Standards Assignments

None.

2 Messages

2.1 Transport

Domain support for implementations of the Authentication Protocol Domain Support protocol SHOULD use Netlogon **remote procedure call (RPC)** messages in the logon interface. The Netlogon **RPC transport** is specified in [MS-NRPC].

2.2 Message Syntax

For domain support, authentication protocols MUST use an NRPC pass-through authentication ([MS-NRPC] section 3.2) method with parameters determined by the authentication protocol being used.

Interactive and network logon information, passed through the *LogonInformation* parameter, is used when calling the **NetrLogonSamLogonEx** method ([MS-NRPC] section 3.5.4.5.1). Domain controller Kerberos PAC validation and digest messages MUST be encoded as opaque blobs and transported by the generic pass-through capability of Netlogon ([MS-NRPC] section 3.2.4.1).

All message fields, including bit flags, are in the following sections in **little-endian** format. These data structures MUST be built as if they are on a little-endian machine before transmission. On reception, the messages MUST be interpreted as little-endian and transformed into the native endianness of the implementation.

The following table shows a few of the main status codes returned by these protocols. For a complete list of status codes, see [MS-ERREF].

Symbolic name	Value	Meaning
STATUS_SUCCESS	0x00000000	Requested operation succeeded.
STATUS_LOGON_FAILURE	0xC000006D	Authentication failed.
STATUS_NO_SUCH_USER	0xC0000064	Specified account does not exist.
STATUS_NO_LOGON_SERVERS	0xC000005E	None of the domain controllers are reachable to service the request.

2.2.1 NTLM Logon Message Syntax

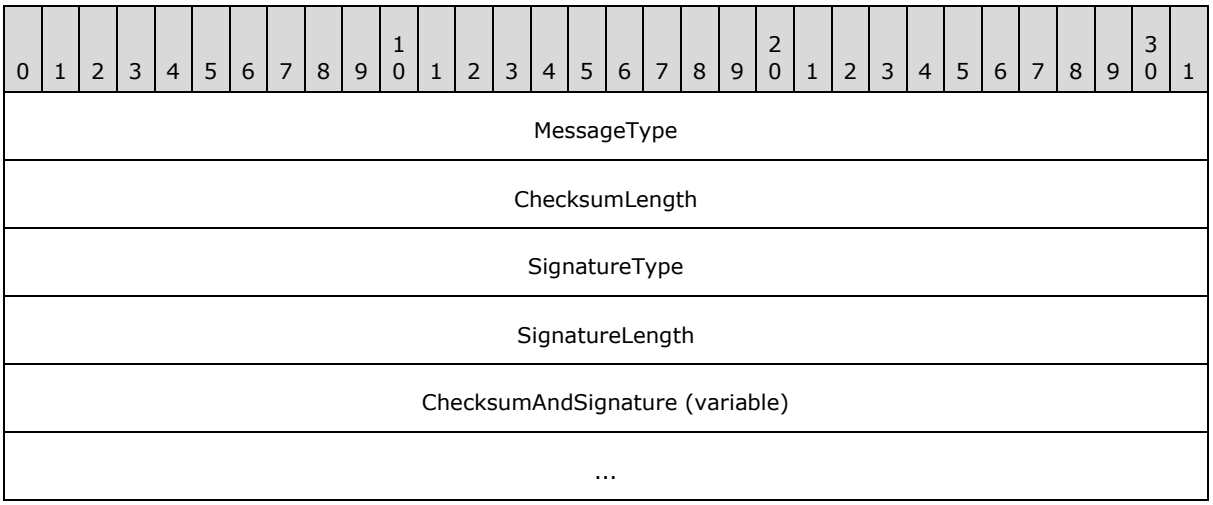
The specific message syntax for NTLM interactive logon or network logon is part of the NRPC pass-through authentication ([MS-NRPC] section 3.2). The domain support for NTLM logon is invoked by calling an NRPC pass-through authentication ([MS-NRPC] section 3.2) method.

2.2.2 Kerberos PAC Validation Message Syntax

The privilege attribute certificate (PAC) validation request message, KERB_VERIFY_PAC_REQUEST (section 2.2.2.1), MUST be encoded as a contiguous buffer. The encoded data SHOULD be sent by using the generic pass-through mechanism ([MS-NRPC] section 3.2.4.1). The encoding of the KERB_VERIFY_PAC_REQUEST is specified in section 2.2.2.1.

2.2.2.1 KERB_VERIFY_PAC_REQUEST Message

The following diagram shows the format of the message used for PAC validation.



MessageType (4 bytes): An unsigned 32-bit value describing the message type. This member MUST be set to 0x00000003.

ChecksumLength (4 bytes): An unsigned 32-bit value that MUST contain the signature length of the PAC_SIGNATURE_DATA Signature value ([MS-PAC] section 2.8) for the Server Signature ([MS-PAC] section 2.8.1) in the privilege attribute certificate (PAC).

SignatureType (4 bytes): An unsigned 32-bit value that MUST contain the PAC_SIGNATURE_DATA SignatureType value ([MS-PAC] section 2.8) for the Key Distribution Center (KDC) Signature ([MS-PAC] section 2.8.1) in the PAC.

SignatureLength (4 bytes): An unsigned 32-bit value that MUST contain the signature length of the PAC_SIGNATURE_DATA Signature value ([MS-PAC] section 2.8) in the KDC Signature ([MS-PAC] section 2.8.1) in the PAC.

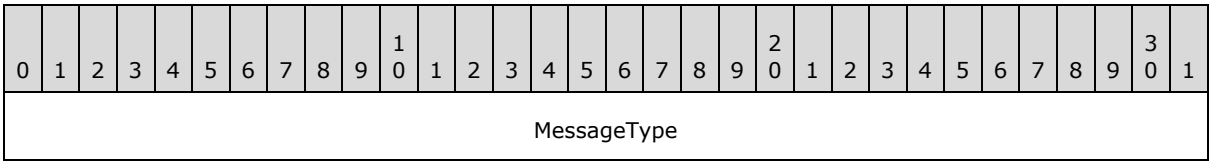
ChecksumAndSignature (variable): The PAC_SIGNATURE_DATA Signature value ([MS-PAC] section 2.8) for the Server Signature ([MS-PAC] section 2.8.1) in the PAC. It MUST be followed by the PAC_SIGNATURE_DATA Signature value ([MS-PAC] section 2.8) for the KDC Signature ([MS-PAC] section 2.8.1) in the PAC.

2.2.3 Digest Validation Message Syntax

The Digest validation protocol uses fields extracted from the digest-challenge and digest-response messages ([RFC2617] section 3.2 and [RFC2831] section 2.1) to verify the validity of the user signature (this is a hash performed with the user's password) and to retrieve the PAC for the user's account.

2.2.3.1 DIGEST_VALIDATION_REQ Message

The DIGEST_VALIDATION_REQ message defines a request to validate the input from the Digest Protocol Extensions [MS-DPSP] and retrieve user authorization information.



Version	MsgSize
DigestType	QopType
AlgType	CharsetType
CharValuesLength	NameFormat
Flags	AccountNameLength
DomainLength	ServerNameLength
Reserved3	Reserved4
Pad1	
...	
Payload (variable)	
...	

MessageType (4 bytes): A 32-bit unsigned integer that defines the Digest validation message type. This member MUST be set to 0x0000001A.

Version (2 bytes): A 16-bit unsigned integer that defines the version of the Digest validation protocol. The protocol version defined in this document is 1 (the value of this member MUST be 0x0001).

MsgSize (2 bytes): A 16-bit unsigned integer that MUST specify the total number of bytes in the DIGEST_VALIDATION_REQ message (2.2.3.1).

DigestType (2 bytes): A 16-bit unsigned integer that specifies the Digest protocol used, which MUST be one of the following:

Value	Meaning
0x0003	Using the Digest authentication mechanism [RFC2617] for the HTTP/1.1 Protocol.
0x0004	Using Digest authentication as a Simple Authentication and Security Layer (SASL) mechanism [RFC2831].

QopType (2 bytes): A 16-bit unsigned integer specifying the Quality of Protection (QoP) requested by the Digest client ([RFC2617] section 3.2.1 and [RFC2831] section 2.1.2.1) that MUST be one of the following:

Value	Meaning
0x0001	The Digest client did not specify a QoP. For backward compatibility with Digest Access authentication [RFC2069], Digest authentication ([RFC2617] made the QoP optional.

Value	Meaning
0x0002	Authentication only. Represents auth ([RFC2617] section 3.2.1 and [RFC2831] section 2.1.1).
0x0003	Authentication and integrity protection. Represents auth-int ([RFC2617] section 3.2.1 and [RFC2831] section 2.1.1).
0x0004	Authentication with integrity protection and encryption. Represents auth-conf ([RFC2831] section 2.1.1).

AlgType (2 bytes): A 16-bit unsigned integer specifying the algorithm value specified by the Digest client in the digest-challenge message ([RFC2617] section 3.2.1) that MUST be one of the following values:

Value	Meaning
0x0001	MD5 assumed; the algorithm was not present ([RFC2617] section 3.2.1).
0x0002	MD5 value to produce the digest and checksum ([RFC2617] section 2.1.1).
0x0003	MD5-sess value to produce the digest and checksum ([RFC2617] section 3.2.1 and [RFC2831] section 2.1.1).

CharsetType (2 bytes): A 16-bit unsigned integer specifying the type of encoding used for **username** and **password** fields that MUST be one of the following (as specified in [RFC2831] section 2.1.1 and [MS-DPSP] section 2.2):

Value	Meaning
0x0001	ISO8859-1 encoding is used for **username** and **password** fields.
0x0002	UTF-8 encoding is used for **username** and **password** fields.

CharValuesLength (2 bytes): A 16-bit unsigned integer that MUST specify the number of bytes in the **Payload** field of the DIGEST_VALIDATION_REQ message, and MUST NOT exceed the total size in MsgSize.

NameFormat (2 bytes): A 16-bit unsigned integer specifying the format of the user **AccountName** field (in the DIGEST_VALIDATION_REQ message), and MUST be one of the following:

Value	Meaning
0x0000	**Digest server** cannot determine the format of the user's **AccountName**.
0x0001	A format determined to be the SAM account name ([MS-ADA3] 2.222).
0x0002	A format determined to be the **user principal name (UPN)** for the account ([MS-ADA3] 2.222).
0x0003	A format determined to be NetBIOS ([MS-ADA3] 2.4).

Flags (2 bytes): A two-byte set of bit flags providing additional instructions for processing the DIGEST_VALIDATION_REQ message (section 2.2.3.1) by the DC. The **Flags** field is

constructed from one or more bit flags from the following table, with the exception of the constraint on bit C.

Note All other bits MUST be set to zero and MUST be ignored upon receipt.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
0	0	0	0	0	0	0	0	0	0	0	E	D	C	B	A

Where the bits are defined as:

Value	Description
A	The format of **Username** and **Realm** (carried in the **Payload** field of DIGEST_VALIDATION_REQ) MUST be determined by the DC.
B	The optional **Authzid** field ([RFC2831] section 2.1.2) is set and carried in the Payload buffer in the DIGEST_VALIDATION_REQ message (section 2.2.3.1).
C	Indicates that this request is from a server, so group memberships are to be expanded for the Account's PAC. This bit MUST NOT be set if this request is forwarded from a server's domain to user account's domain.
D	Indicates if a single backslash is found in the username value ([RFC2617] section 3.2.2).
E	Indicates the DC will attempt to validate the request with an un-escaped backslash ([MS-DPSP] section 2.2).

AccountNameLength (2 bytes): A 16-bit unsigned integer that MUST specify the length of the **AccountName** field in the Payload buffer.

DomainLength (2 bytes): A 16-bit unsigned integer that MUST specify the length of the Domain field in the Payload buffer.

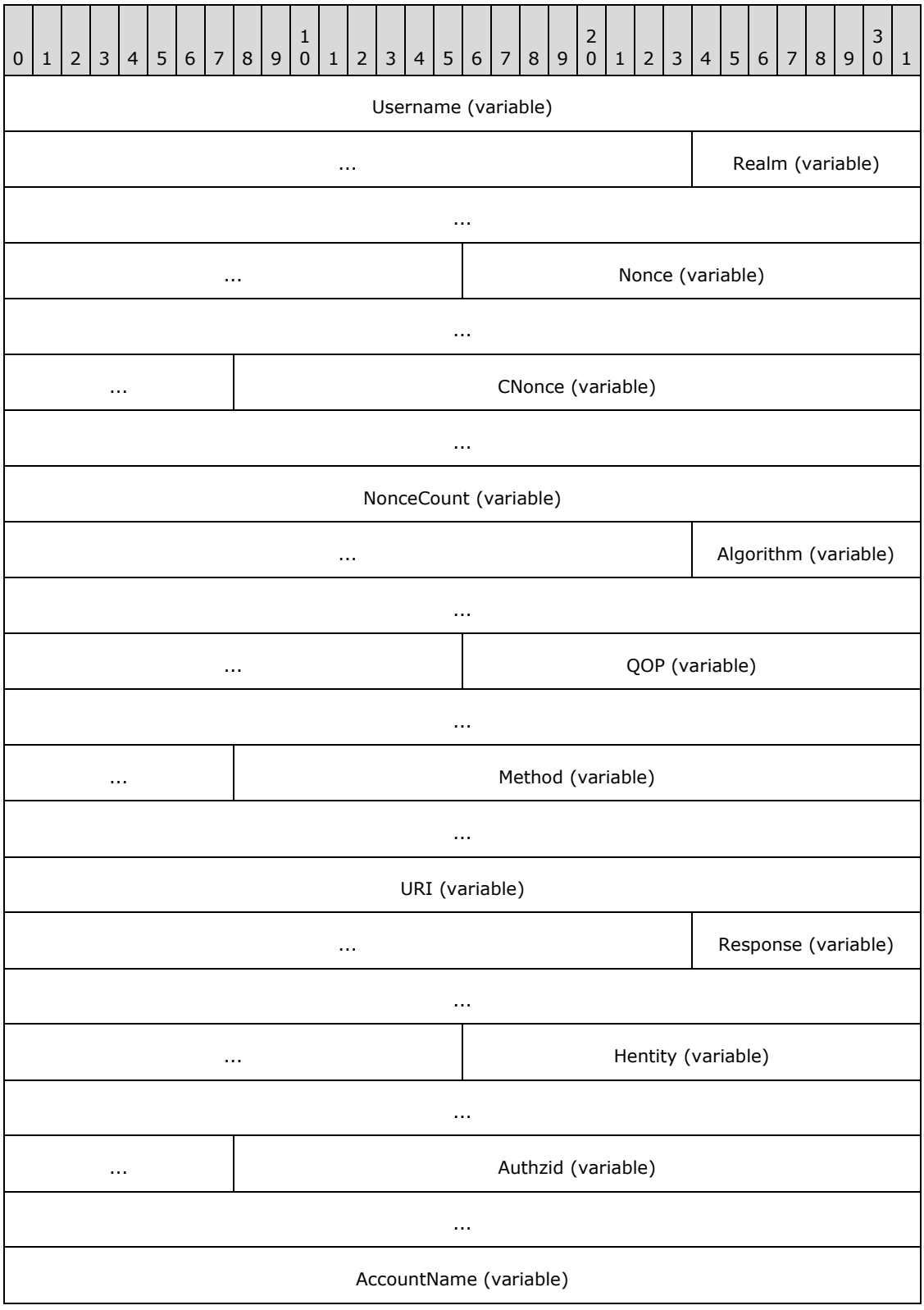
ServerNameLength (2 bytes): A 16-bit unsigned integer that MUST specify the length of the **ServerName** field in the Payload buffer.

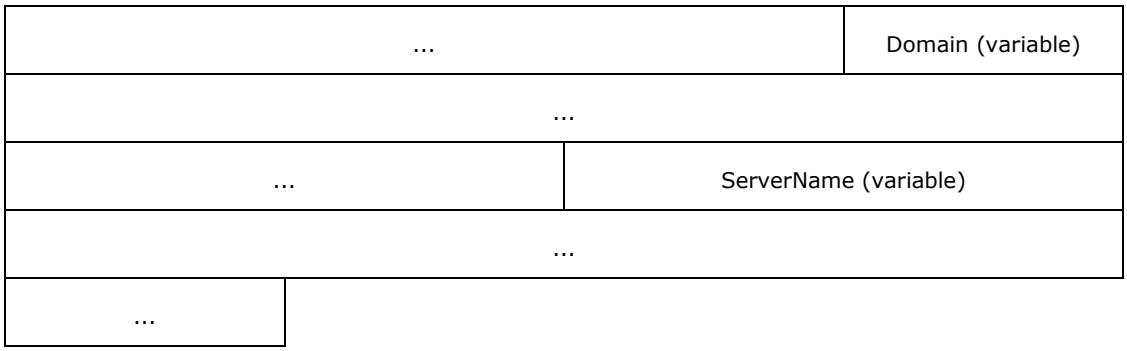
Reserved3 (2 bytes): A 16-bit unsigned integer field reserved for future use. MUST be set to zero when sent and MUST be ignored on receipt.

Reserved4 (2 bytes): A 16-bit unsigned integer field reserved for future use. MUST be set to zero when sent and MUST be ignored on receipt.

Pad1 (8 bytes): An unused, 64-bit unsigned integer. MUST be set to zero when sent and MUST be ignored on receipt.

Payload (variable): A byte array that MUST contain the following strings in the following order. All strings are the unquoted directive value. All strings MUST be null-terminated; strings MUST be encoded by using [ISO/IEC-8859-1], unless specified as **Unicode**. Each of the strings MUST be included. If the string value is empty, then a terminating null character MUST be used for the value. Remember that the last three strings are Unicode strings, so they have a Unicode terminating null character.





Username (variable): The user name value from the digest-response message that MUST be as specified in [RFC2617] section 3.2.2.

Realm (variable): The **realm** value that MUST be as specified in [RFC2617] section 3.2.1.

Nonce (variable): The nonce value from the digest-challenge message that MUST be as specified in [RFC2617] section 3.2.1.

CNonce (variable): The cnonce value from the digest-response message that MUST be as specified in [RFC2617] section 3.2.2.

NonceCount (variable): The nc-value from the digest-response message, that MUST be as specified in [RFC2617], section 3.2.2.

Algorithm (variable): The algorithm value from the digest-response message that MUST be as specified in [RFC2617] section 3.2.1.

QOP (variable): The QOP value from the digest-response message that MUST be as specified in [RFC2617] section 3.2.2.

Method (variable): Method by which Digest authentication information MUST be transmitted as part of the HTTP1.1 protocol. The string value is GET or PUT if Digest authentication is used for the HTTP1.1 protocol [RFC2617]. The string value is AUTHENTICATE if Digest authentication is used as an SASL mechanism [RFC2617].

URI (variable): The digest-URI value from the digest-response message that MUST be as specified in [RFC2617] section 3.2.2.

Response (variable): The response value from the digest-response message that MUST be as specified in [RFC2617] section 3.2.2.

Hentity (variable): The H (entity-body) value that MUST be as specified in [RFC2617] section 3.2.2.3.

Authzid (variable): The Authzid value from the digest-response message that MUST be as specified in [RFC2831] section 2.1.2.

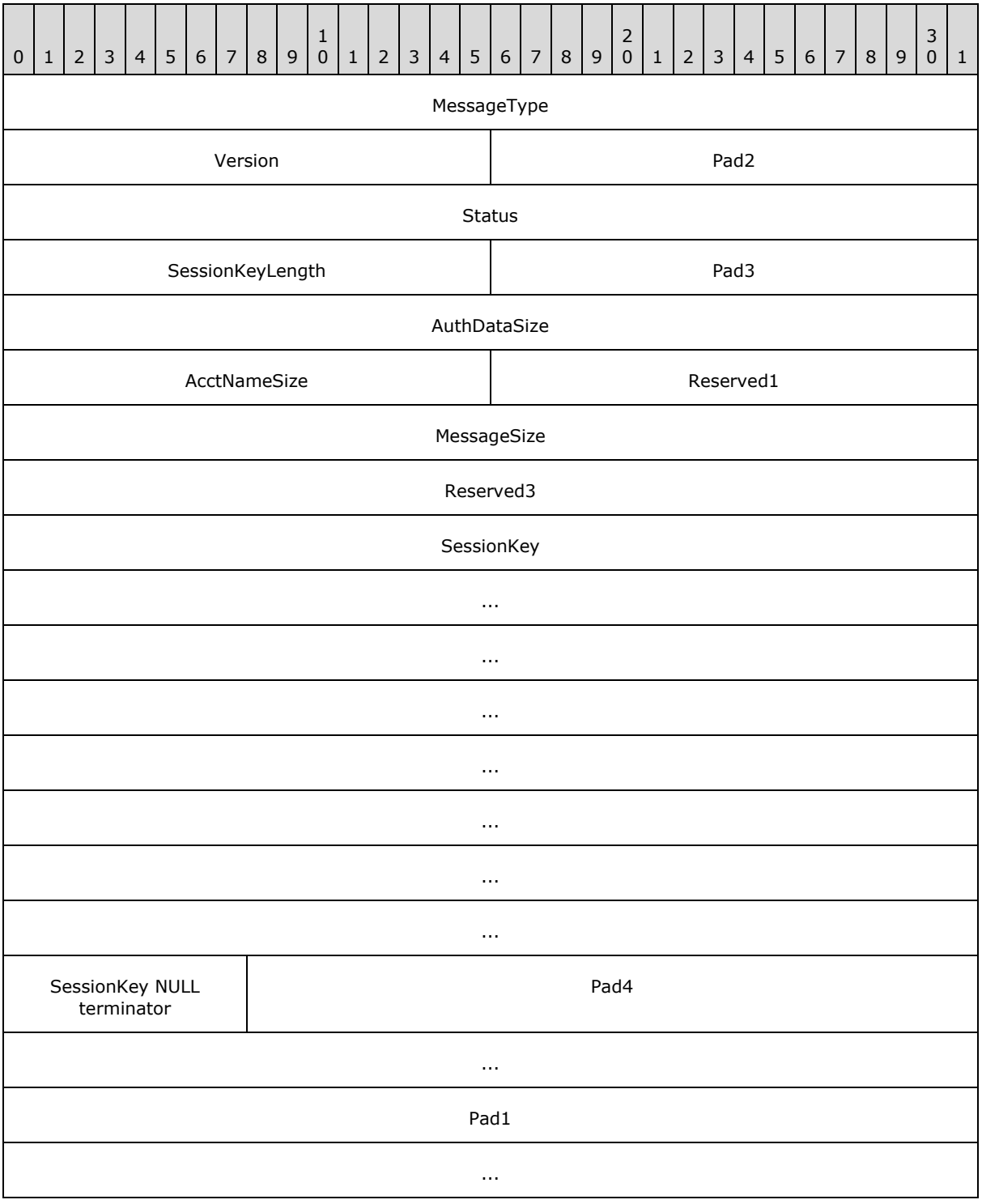
AccountName (variable): A **Unicode** string that MUST specify the user account name.

Domain (variable): A **Unicode** string that MUST specify the domain to which the user account belongs.

ServerName (variable): A **Unicode** string that MUST specify the NetBIOS name of the server that sent the DIGEST_VALIDATION_REQ message (section 2.2.3.1).

2.2.3.2 DIGEST_VALIDATION_RESP Message

The DIGEST_VALIDATION_RESP message is a response to a DIGEST_VALIDATION_REQ message.



AuthData (variable)
...
AccountName (variable)
...

MessageType (4 bytes): A 32-bit unsigned integer that MUST specify the Digest validation message type. This member MUST be 0x0000000A.

Version (2 bytes): A 16-bit unsigned integer that MUST specify the version of the Digest validation protocol. The protocol version defined in this document is 1. The value of this member MUST be 0x0001.

Pad2 (2 bytes): An unused 16-bit unsigned integer. MUST be set to zero when sent and MUST be ignored on receipt.

Status (4 bytes): A 32-bit unsigned integer specifying if the Digest authentication data sent in the DIGEST_VALIDATION_REQ (section 2.2.3.1) was successfully verified by the domain controller. On successful validation, the **Status** field MUST be set to STATUS_SUCCESS. On failure, it MUST be set to STATUS_LOGON_FAILURE. Both values are as specified in [MS-ERREF] section 2.3.

SessionKeyLength (2 bytes): A 16-bit unsigned integer that MUST specify the number of bytes of the **SessionKey** field in the DIGEST_VALIDATION_RESP message (section 2.2.3.2) plus a terminating null character. It MUST be equal to 33.

Pad3 (2 bytes): An unused 16-bit unsigned integer. MUST be set to zero when sent and MUST be ignored on receipt.

AuthDataSize (4 bytes): A 32-bit unsigned integer that MUST specify the number of bytes of the **AuthData** field in the DIGEST_VALIDATION_RESP message (section 2.2.3.2).

AcctNameSize (2 bytes): A 16-bit unsigned integer that MUST specify the number of bytes of the **AccountName** field in the DIGEST_VALIDATION_RESP message (section 2.2.3.2).

Reserved1 (2 bytes): A 16-bit unsigned integer field reserved for future use. MUST be set to zero when sent and MUST be ignored on receipt.

MessageSize (4 bytes): A 32-bit unsigned integer that MUST specify the number of bytes in the entire DIGEST_VALIDATION_RESP message (section 2.2.3.2).

Reserved3 (4 bytes): A 32-bit unsigned integer field reserved for future use. MUST be set to zero when sent and MUST be ignored on receipt.

SessionKey (32 bytes): A 32-byte buffer that MUST contain the Digest SessionKey ([RFC2617] section 3.2.2.2).

SessionKey NULL terminator (1 byte): A single byte to terminate the SessionKey. MUST be set to zero.

Pad4 (7 bytes): An unused 7-byte padding. The value of each byte MUST be set to zero when sent and MUST be ignored on receipt.

Pad1 (8 bytes): An unused 64-bit unsigned integer. MUST be set to zero when sent and MUST be ignored on receipt.

AuthData (variable): The **AuthData** field MUST contain a PACTYPE structure ([MS-PAC] section 2.3). The length of the PACTYPE structure MUST be specified by the **AuthDataSize** field. The length of this field MUST be 0 if the value of the **Status** field is STATUS_LOGON_FAILURE.

AccountName (variable): The **AccountName** field MUST contain the NetBIOS name of the user's account. The length of **AccountName** MUST be specified by the **AcctNameSize** field.

3 Protocol Details

Authentication Protocol Domain Support (specified for each of the protocols in the following sections) uses NRPC [MS-NRPC] for transport. Each of the following protocols is a simple request-response exchange over this transport. The security assurances provided by the underlying Netlogon and RPC protocols are common to all of these protocols. All of these exchanges require that a remote procedure call (RPC) connection through the Netlogon secure channel MUST be established with a domain controller (DC) for the domain to which the server belongs (section 1.5).

3.1 NTLM Logon Details

NT LAN Manager (NTLM) interactive logon and network logon MUST complete the authentication sequence by contacting the DC using an NRPC pass-through authentication ([MS-NRPC] section 3.2) method, with parameters as specified in section 3.1.5.

The **NETLOGON_NETWORK_INFO** and **NETLOGON_VALIDATION_SAM_INFO4** data structures SHOULD be exchanged ([MS-NRPC] sections 2.2.1.4.5 and 2.2.1.4.13). The DC MUST populate the **NETLOGON_VALIDATION_SAM_INFO4** with the information for the user logging on and return the SessionBaseKey ([MS-NLMP] section 3.3.1 and 3.3.2) in the **UserSessionKey** field in NETLOGON_VALIDATION_SAM_INFO4, and MUST send it back to the NTLM server. If no matching account is found, an error STATUS_NO_SUCH_USER (section 2.2) MUST be returned to the NTLM server, resulting in a logon failure.

3.1.1 Abstract Data Model

The protocol requires that the DC MUST have a database or **directory** of accounts with authorization information available to it.

The NTLM abstract data model is specified in [MS-NLMP] section 3.1.1. The Netlogon abstract data model is specified in [MS-NRPC] section 3.1.1.

The NTLM server uses the following configuration values:<3>

LogonAttempts: A 32-bit unsigned integer that contains the total number of logon attempts since the last restart.

NTLMServerDomainBlocked: A Boolean setting that controls the NTLM server responding to NTLM authentication requests. When set to TRUE, this setting disables the NTLM server from sending NTLM pass-through authentication messages (section 3.1.5) to any DC.<4>

For NTLM server implementations that use an authorization model that is based on a security identifier (SID), the server maintains the following parameter for each security context:

ImpersonationAccessToken (Public): A Token/Authorization Context (see [MS-DTYP] section 2.5.2).

The DC uses the following configuration values:

AccountDCBlocked: A Boolean setting that controls the DC responding to NTLM authentication requests. When set to TRUE, this setting disables the account domain DC from responding to NTLM pass-through authentication messages (section 3.1.5).<5>

ResourceDCBlocked: A Boolean setting controls the DC responding to NTLM authentication requests. When set to TRUE, this setting disables the resource domain DC from sending NTLM pass-through authentication messages (section 3.1.5).<6>

DCBlockExceptions: A list of server names that can use NTLM authentication.<7>

3.1.2 Timers

None.

3.1.3 Initialization

The **LogonAttempts** field SHOULD be initialized to zero on startup.

3.1.4 Higher-Layer Triggered Events

The NTLM logon message exchange MUST be triggered by a server requesting user authentication via the Netlogon remote procedure call (RPC) mechanism to the domain controller (DC).

3.1.5 Message Processing Events and Sequencing Rules

NTLM logon is a stateless protocol with request-response semantics.

The NTLM server SHOULD call the NetrLogonSamLogonEx method<8> ([MS-NRPC] section 3.5.4.5.1) with the parameters defined in the following sections. Based on the account name supplied, a domain controller (DC) for the domain MUST be located ([MS-ADTS] section 6.3.6). The NTLM server MUST establish a connection with the DC ([MS-NRPC] section 3.1.4.6). The NTLM server SHOULD invoke the **NetrLogonSamLogonEx** method ([MS-NRPC] section 3.5.4.5.1).<9>

If **NTLMServerDomainBlocked** == TRUE, then the NTLM server MUST return STATUS_NTLM_BLOCKED to the **NTLM client**.<10>

If the DC is of the resource domain,

- If **ResourceDCBlocked** == TRUE, and the NTLM server's name is not equal to any of the **DCBlockExceptions** server names, then the DC MUST return STATUS_NTLM_BLOCKED.<11>

If the DC is of the account domain,

- If **AccountDCBlocked** == TRUE, then the **APDS server** MUST return STATUS_NTLM_BLOCKED.<12>
- If the domainControllerFunctionality attribute ([MS-ADTS] section 3.1.1.3.2.25) returns a value that is >= 6, the account is not also the NTLM server's account, and the APDS server determines that an authentication policy setting ([MS-KILE] section 3.3.5.5) applies, then:
  - If the account is:
    - A user account object, and the corresponding msDS-UserAllowedToAuthenticateFrom ([MS-ADA2] section 2.457) is populated, then the APDS MUST return STATUS_ACCOUNT_RESTRICTION.<13>
    - A managed Service account object, and the corresponding msDS-ServiceAllowedToAuthenticateFrom ([MS-ADA2] section 2.432) is populated, then the APDS MUST return STATUS_ACCOUNT_RESTRICTION.<14>
  - If AllowedToAuthenticateTo is not NULL, an access check is performed to determine whether the user has the ACTRL_DS_CONTROL_ACCESS right against the AllowedToAuthenticateTo. If the access check fails the APDS MUST return STATUS_AUTHENTICATION_FIREWALL_FAILED.<15>

The DC SHOULD attempt to validate the request, increment **LogonAttempts**, and if successful, SHOULD proceed to authenticate the user. If validation is unsuccessful, the DC MUST return an error. The role of the DC in the NTLM authentication sequence is specified in [MS-NLMP] section 3.3.

Upon successful validation,

- If the domainControllerFunctionality attribute ([MS-ADTS] section 3.1.1.3.2.25) returns a value that is >= 6 and the user is a member of PROTECTED_USERS ([MS-DTYP] section 2.4.2.4), then the APDS MUST return STATUS_ACCOUNT_RESTRICTION.<16>
- Otherwise, the user account's DC MUST send the domain global groups and universal groups (that the user is a member of) to the server's DC, and MUST follow the trust path that was used to contact the user's account DC ([MS-NRPC] section 3.5.4.5.1).

When the trust crossed in the trust path has the TRUST_ATTRIBUTE_CROSS_ORGANIZATION ([MS-LSAD] section 2.2.7.9) set, the DC MUST add the **OTHER_ORGANIZATION** SID ([MS-DTYP] Section 2.4.2.4) to the user's groups.

When a user has the OTHER_ORGANIZATION SID, the server domain DC MUST perform an access check where:

- The security descriptor MUST contain the ACL granting the client user ACTRL_DS_CONTROL_ACCESS ([MS-SAMR] section 2.2.1.17) to the **server computer's** AD account object.

If the access check fails, the DC MUST reject the authentication request and return STATUS_AUTHENTICATION_FIREWALL_FAILED. The server domain DC also MUST add the domain local groups, and then send the entire list of groups to the NTLM server to be used for authorization decisions.

For NTLM server implementations that use an authorization model that is based on a security identifier (SID), the server SHOULD populate the User SID and Security Group SIDs in the **ImpersonationAccessToken** (section 3.1.1) as follows:

- Concatenate **LogonDomainId** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13) and **UserId** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13), add the result to the **ImpersonationAccessToken.Sids** array, and set the **ImpersonationAccessToken.UserIndex** field to this index.
- Concatenate **LogonDomainId** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13) and **PrimaryGroupId** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13), add the result to the **ImpersonationAccessToken.Sids** array, and set the **ImpersonationAccessToken.PrimaryGroup** field to this index.
- For each **GroupIds** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13), concatenate **LogonDomainId** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13) and **GroupIds.RelativeID** ([MS-NRPC] sections 2.2.1.4.11, 2.2.1.4.12, and 2.2.1.4.13), and add the result to the **ImpersonationAccessToken.Sids** array.
- For each **ExtraSids** ([MS-NRPC] sections 2.2.1.4.12 and 2.2.1.4.13), add the **ExtraSids.Sid** ([MS-NRPC] sections 2.2.1.4.12 and 2.2.1.4.13) to the **ImpersonationAccessToken.Sids** array.

The server SHOULD call GatherGroupMembershipForSystem ([MS-DTYP] section 2.5.2.1.1), where **InitialMembership** contains the **ImpersonationAccessToken.Sids** array, and set the **ImpersonationAccessToken.Sids** array to **FinalMembership**.

The server SHOULD call AddPrivilegesToToken ([MS-DTYP] section 2.5.2.1.2), where **Token** contains **ImpersonationAccessToken**.

Other SID structures may be added to **ImpersonationAccessToken** following authentication (see [MS-DTYP] section 2.7.1).

3.1.5.1 NTLM Interactive Logon

For NTLM interactive logons, the NTLM server SHOULD call **NetrLogonSamLogonEx** ([MS-NRPC] section 3.5.4.5.1)<17> with the following parameters (set as specified):

- LogonLevel MUST be NetlogonInteractiveInformation.
- IF the G flag in NegotiateFlags ([MS-NRPC] section 3.1.4.2) is set to FALSE, the ValidationLevel MUST be **NetlogonValidationSamInfo** ([MS-NRPC] section 2.2.1.4.17).

  ELSE IF the Y or T flags are set to FALSE in NegotiateFlags ([MS-NRPC] Section 3.1.4.2), the ValidationLevel MUST be **NetlogonValidationSamInfo2** ([MS-NRPC] section 2.2.1.4.17).

  ENDIF.
- IF SealSecureChannel ([MS-NRPC] Section 3.1.1) is set to FALSE, then the ValidationLevel MUST be **NetlogonValidationSamInfo2** ([MS-NRPC] section 2.2.1.4.17).

  ELSE the ValidationLevel SHOULD be **NetlogonValidationSamInfo4** ([MS-NRPC] section 2.2.1.4.17).<18>

  ENDIF.
- LogonInformation MUST contain a reference to NETLOGON_INTERACTIVE_INFO ([MS-NRPC] section 2.2.1.4.3).

The logon request MUST be sent to the domain controller of the user account domain that has been located.

If the domain controller for the user account is not reachable, but the user domain is one of the trusted domains, the logon MUST fail. If the user domain is not one of the trusted domains, the NTLM server's local account database MUST be used to authenticate the user.

The request that is sent to the user account domain controller MUST contain the **NTOWF** of the user's password.

The domain controller MUST verify the response to the challenge ([MS-NLMP] section 3.3). If there is a successful match, the domain controller MUST return data with ValidationInformation containing a reference to:

- NETLOGON_VALIDATION_SAM_INFO4 ([MS-NRPC] section 2.2.1.4.13), if the ValidationLevel in the request is NetlogonValidationSamInfo4.
- NETLOGON_VALIDATION_SAM_INFO2 ([MS-NRPC] section 2.2.1.4.12), if the ValidationLevel in the request is NetlogonValidationSamInfo2.
- NETLOGON_VALIDATION_SAM_INFO ([MS-NRPC] section 2.2.1.4.11), if the ValidationLevel in the request is NetlogonValidationSamInfo.

If there is not a match, the DC MUST return the failure error code STATUS_WRONG_PASSWORD (section 2.2) with no response data. <19>

3.1.5.2 NTLM Network Logon

For NTLM network logons, the NTLM server SHOULD call NetrLogonSamLogonEx ([MS-NRPC] section 3.5.4.5.1)<20> with the following parameters (set as specified):

- LogonLevel MUST be NetlogonNetworkInformation.
- IF the G flag in NegotiateFlags ([MS-NRPC] section 3.1.4.2) is set to FALSE, the ValidationLevel MUST be **NetlogonValidationSamInfo** ([MS-NRPC] section 2.2.1.4.17).

  ELSE IF the Y or T flags in NegotiateFlags ([MS-NRPC] section 3.1.4.2) are set to FALSE, the ValidationLevel MUST be **NetlogonValidationSamInfo2** ([MS-NRPC] section 2.2.1.4.17).

  ENDIF.
- IF SealSecureChannel ([MS-NRPC] section 3.1.1) is set to FALSE, then the ValidationLevel MUST be **NetlogonValidationSamInfo2** ([MS-NRPC] section 2.2.1.4.17).

  ELSE the ValidationLevel SHOULD be **NetlogonValidationSamInfo4** ([MS-NRPC] section 2.2.1.4.17).<21>

  ENDIF.
- LogonInformation MUST contain a reference to NETLOGON_NETWORK_INFO ([MS-NRPC] section 2.2.1.4.5).
- Set the **E** and **K** bits of **LogonInformation.Identity.ParameterControl**.<22>
- The following algorithm is used for authentication from the server to the DC:

  IF (NTLMSSP_NEGOTIATE_ENHANCED_SESSION_SECURITY and NtResponseLength == 24 and LmResponseLength >= 8)

  NetlogonNetworkInformation.LmChallenge = MD5(Concatenate(ChallengeToClient, LmResponse[0..7]))[0..7]

  ELSE

  NetlogonNetworkInformation.LmChallenge = ChallengeToClient

  END

The DC of the user account domain MUST be located ([MS-NRPC] section 3.5.4.3) and sent the request. This request MUST contain the NTLM challenge-response pair that was exchanged between the NTLM server and the client ([MS-NLMP] sections 2.2.1.2 and 2.2.1.3).

The DC MUST verify the response to the challenge ([MS-NLMP] section 3.3) or by means of a sub-authentication package (section 3.1.5.2.1).

If the account is a computer account, the sub-authentication package is not verified, and the **K** bit of **LogonInformation.Identity.ParameterControl** is not set, then return STATUS_NOLOGON_WORKSTATION_TRUST_ACCOUNT.<23>

If the account is a domain controller computer account, the sub-authentication package is not verified, and the E bit of **LogonInformation.Identity.ParameterControl** is not set, then return STATUS_NOLOGON_SERVER_TRUST_ACCOUNT.<24>

If there is a match, the DC MUST return data with ValidationInformation containing a reference to NETLOGON_VALIDATION_SAM_INFO4 ([MS-NRPC] section 2.2.1.4.13, if the ValidationLevel in the request is NetlogonValidationSamInfo4) or a reference to NETLOGON_VALIDATION_SAM_INFO2 ([MS-NRPC] section 2.2.1.4.12, if the ValidationLevel in the request is NetlogonValidationSamInfo2) or a reference to NETLOGON_VALIDATION_SAM_INFO ([MS-NRPC] section 2.2.1.4.11, if the ValidationLevel in the request is NetlogonValidationSamInfo). If there is not a match, the DC MUST return a failure error code STATUS_LOGON_FAILURE (section 2.2) with no response data. There can be additional causes for failure even if the match is successful, such as the account being disabled or other policy decisions. The NTLM server MUST treat all errors as resulting in a logon failure, although a DC implementation MAY choose to send more descriptive error codes.<25>

3.1.5.2.1 Verifying Responses with Sub-Authentication Packages

The request to verify by a sub-authentication package is indicated by the **ParameterControl** field of the *LogonInformation* parameter.<26>

An example of sub-authentication package usage occurs with remote access authentications using the CHAP ([RFC1994]) method. In such cases, response computation of a MD5 hash value ([RFC1994]) is used instead of NTOWF.

Using the NRPC generic pass-through ([MS-NRPC] section 3.2.4.1) MAY result in invoking a custom sub-authentication package at the **DC**, per the indication of the **ParameterControl** field of the *LogonInformation* parameter. In this case, such a sub-authentication package MUST serve as a custom response verification instead of using the method specified by section 3.3 of [MS-NLMP]. For more information about this sub-authentication package, see [MSDN-0SUBAUTHROUTINE9].

3.1.6 Timer Events

There are no timer events for NTLM logon. All associated timer events are specified in the Netlogon Remote Protocol ([MS-NRPC]) that serves as the transport.

3.1.7 Other Local Events

None.

3.2 Kerberos PAC Validation Details

Kerberos PAC validation SHOULD use the generic pass-through mechanism ([MS-NRPC] section 3.2.4.1). The KERB_VERIFY_PAC_REQUEST message (section 2.2.2.1) MUST be sent to the domain controller (DC) for privilege attribute certificate (PAC) verification. The signature verification algorithm MUST occur (section 3.2.5).

3.2.1 Abstract Data Model

The protocol requires that the DC MUST have a database or directory of accounts with Kerberos keys ([MS-KILE] section 3.1.1.2) available to it.

The server operating system MUST have the PAC.

The Netlogon abstract data model is specified in [MS-NRPC] section 3.2.1.

3.2.2 Timers

None.

3.2.3 Initialization

None.

3.2.4 Higher-Layer Triggered Events

For information on higher-layer triggered events, see section 1.6.2.

3.2.5 Message Processing Events and Sequencing Rules

Kerberos PAC validation is a stateless protocol with request-response semantics.

3.2.5.1 Generating a KERB_VERIFY_PAC_REQUEST Message

The server operating system MUST first assemble the KERB_VERIFY_PAC_REQUEST (section 2.2.2.1) structure by copying the signature values out of the privilege attribute certificate (PAC) ([MS-PAC] section 2.8) that the server operating system is verifying. The message type field MUST be set to 0x00000003 to make the server operating system ready to contact the DC.

This exchange MUST be layered on top of the Netlogon generic pass-through ([MS-NRPC] section 3.2.4.1). The server operating system MUST supply a KERB_VERIFY_PAC_REQUEST structure, packed as a single buffer, as the **LogonData** field. The **PackageName** field MUST be set to a UNICODE_STRING with a buffer of Kerberos.

If the DC cannot be reached, Netlogon ([MS-NRPC] section 3) MUST return the error STATUS_NO_LOGON_SERVERS (section 2.2). The server operating system SHOULD fail the authentication attempt.

3.2.5.2 Processing a KERB_VERIFY_PAC_REQUEST Message

On receipt of the message, the DC MUST decode the KERB_VERIFY_PAC_REQUEST (section 2.2.2.1) message to locate the server checksum and the Key Distribution Center (KDC) checksum values. The DC MUST verify the KDC checksum, which is a keyed hash [RFC4757] over the server checksum passed in the request. If the checksum verification fails, the DC MUST return an error code, STATUS_LOGON_FAILURE (section 2.2) as the return value to the Netlogon Generic Pass-through method. If the checksum is verified, the DC MUST return STATUS_SUCCESS. There is no return message.

When the method completes, the server operating system MUST examine the return code to determine if the PAC contents has been altered. Any nonzero return code MUST be treated by the server operating system as a failure.

3.2.6 Timer Events

There are no timer events for Kerberos PAC validation. All associated timer events are specified in the Netlogon Remote Protocol [MS-NRPC] that serves as the transport for Kerberos PAC validation messages.

3.2.7 Other Local Events

There are no other local events that impact the operation of this protocol.

3.3 Digest Validation Details

The Digest validation protocol SHOULD use the generic pass-through mechanism ([MS-NRPC] section 3.2.4.1). The exchanged messages are DIGEST_VALIDATION_REQ (section 2.2.3.1) and DIGEST_VALIDATION_RESP (section 2.2.3.2). The DIGEST_VALIDATION_RESP message MUST contain the status of authentication validation and, on success, MUST also contain the user's authorization information.<27>

3.3.1 Abstract Data Model

The protocol requires that the DC MUST have a database or directory of accounts with authentication and authorization information available to it. All state information, specifically the nonce challenge that foils replay attacks ([MS-DPSP] section 3.2.1) MUST be handled by the participants of the Digest authentication protocol [RFC2617] [RFC2831], and MUST be sent as part of the DIGEST_VALIDATION_REQ message.

3.3.2 Timers

None.

3.3.3 Initialization

None.

3.3.4 Higher-Layer Triggered Events

The Digest validation message exchange SHOULD be triggered by a server that is configured to authenticate users by using the Digest authentication mechanism [RFC2617] [RFC2831].<28>

3.3.5 Message Processing Events and Sequencing Rules

Digest validation is a stateless protocol with request-response semantics. The general model is as follows:

1. After the Digest server sends the DIGEST_VALIDATION_REQ (section 2.2.3.1) message, it MUST receive either a DIGEST_VALIDATION_RESP (section 2.2.3.2) message from the DC or an error status in the Netlogon generic pass-through function ([MS-NRPC] section 3.2.4.1).

2. Upon receiving the DIGEST_VALIDATION_REQ message, the DC MUST verify the keyed hash contained in the Payload buffer's **Response** field, and then send the DIGEST_VALIDATION_RESP message to the Digest server.

3.3.5.1 Generating the DIGEST_VALIDATION_REQ Message

The Digest server MUST construct the DIGEST_VALIDATION_REQ (section 2.2.3.1) message by using fields extracted from the digest-challenge and digest-response messages ([RFC2617] section 3.2 and [RFC2831] section 2.1). This message MUST be sent to the DC to verify the validity of the user's signature (keyed hash performed with the user's password) and to retrieve the privilege attribute certificate (PAC) for the user's account. If the DC cannot be contacted for any reason, the Digest server SHOULD fail the authentication attempt.

The DIGEST_VALIDATION_REQ message MUST be packed as a contiguous buffer, and the encoded data SHOULD be sent by using the generic pass-through mechanism ([MS-NRPC] section 3.2.4.1). The encoding of the DIGEST_VALIDATION_REQ is as specified in section 2.2.3.1. The PackageName ([MS-NRPC] section 3.2.4.1) in the NETLOGON_GENERIC_INFO structure ([MS-NRPC] section

2.2.1.4.2) MUST be WDigest. The **AlgType** field of the DIGEST_VALIDATION_REQ (section 2.2.3.1) message MUST be set to 0x03.<29>

3.3.5.2 Request Processing and Generating DIGEST_VALIDATION_RESP Message

If the **AlgType** field of the DIGEST_VALIDATION_REQ (section 2.2.3.1) is not set to 0x03, then the DC SHOULD return SEC_E_QOP_NOT_SUPPORTED.<30>

Using the **Username** field in the **Payload** field of the DIGEST_VALIDATION_REQ (section 2.2.3.1) message, the DC MUST look up the user's password. If the account is not found and Bit A of the **Flags** field of the DIGEST_VALIDATION_REQ message is set to:

0: The DC SHOULD return STATUS_NO_SUCH_USER.

1: If the **domain name** in the **Realm** field matches the DC's domain name, then fail with STATUS_LOGON_FAILURE. Otherwise, using the **Realm** field in the **Payload** field of the DIGEST_VALIDATION_REQ message to determine the domain, the DC SHOULD send the DIGEST_VALIDATION_REQ message to a DC in that domain.

The DC MUST verify the keyed hash contained in the Payload buffer's **Response** field of the DIGEST_VALIDATION_REQ (section 2.2.3.1) message. The algorithm to perform this validation MUST be as specified in [RFC2617] section 3.2.2.1 and [RFC2831] section 2.1.2.1.

If validation is successful, a DIGEST_VALIDATION_RESP (section 2.2.3.2) message with Status [MS-ERREF] indicating successful authentication (that is, STATUS_SUCCESS) and authorization information for the user's account (the PAC) MUST be sent back to the Digest server. If unsuccessful, the DC MUST return an error code as an error status in NRPC API. It MUST NOT send back the DIGEST_VALIDATION_RESP message.

The Digest validation response message DIGEST_VALIDATION_RESP MUST be packed as a contiguous buffer, and the encoded data SHOULD be sent by using the generic pass-through mechanism ([MS-NRPC] section 3.2.4.1). The encoding of DIGEST_VALIDATION_RESP is as specified in section 2.2.3.2. The Digest validation response message is sent by using the generic pass-through mechanism, as specified in [MS-NRPC] section 3.2.4.1.

3.3.6 Timer Events

There are no timer events for the Digest validation protocol. All associated timer events are specified in the Netlogon Remote Protocol ([MS-NRPC]) that serves as the transport for Digest validation messages.

3.3.7 Other Local Events

There are no other local events that impact the operation of this protocol.

4 Protocol Examples

4.1 NTLM Pass-Through Authentication

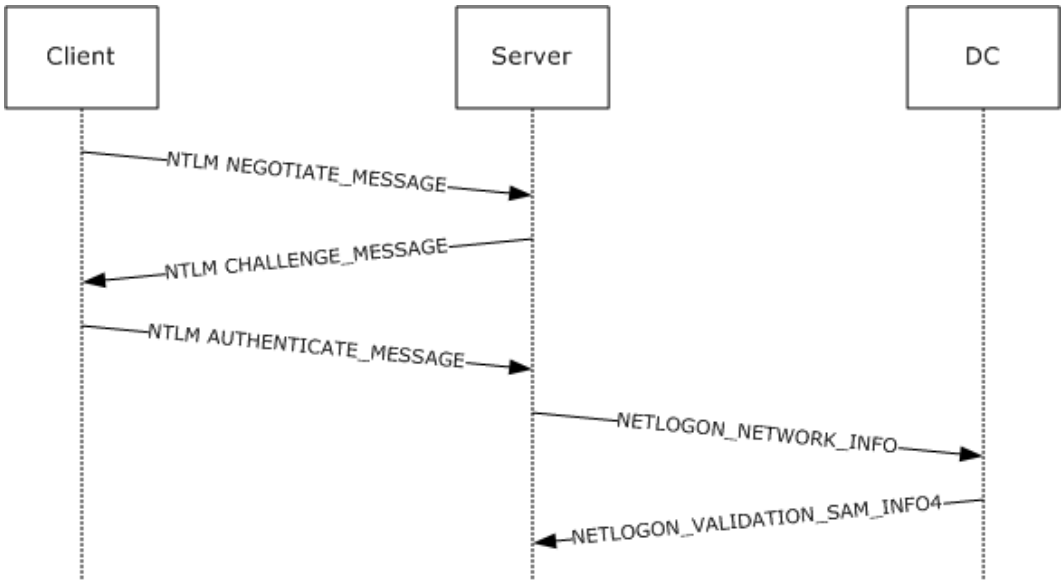


Figure 2: NTLM pass-through authentication

1. The user logs on to the computer desktop (labeled Client) by typing in the user name and password. Client sends an NTLM NEGOTIATE_MESSAGE ([MS-NLMP] section 2.2.1.1) to request authentication to the server.

2. The server sends an NTLM CHALLENGE_MESSAGE ([MS-NLMP] section 2.2.1.2) to the client.

3. The client responds to the challenge by signing it with its key and sending the response in an NTLM AUTHENTICATE_MESSAGE ([MS-NLMP] section 2.2.1.3) to the server.

4. The server forwards the client's response to the domain controller in a NETLOGON_NETWORK_INFO message.

5. The domain controller verifies the signature on the response, and returns the result to the server in a NETLOGON_VALIDATION_SAM_INFO4 message. If the verification is successful, the message contains the user's PAC with the authorization data. If the verification is unsuccessful, logon is denied.

4.2 Kerberos PAC Validation

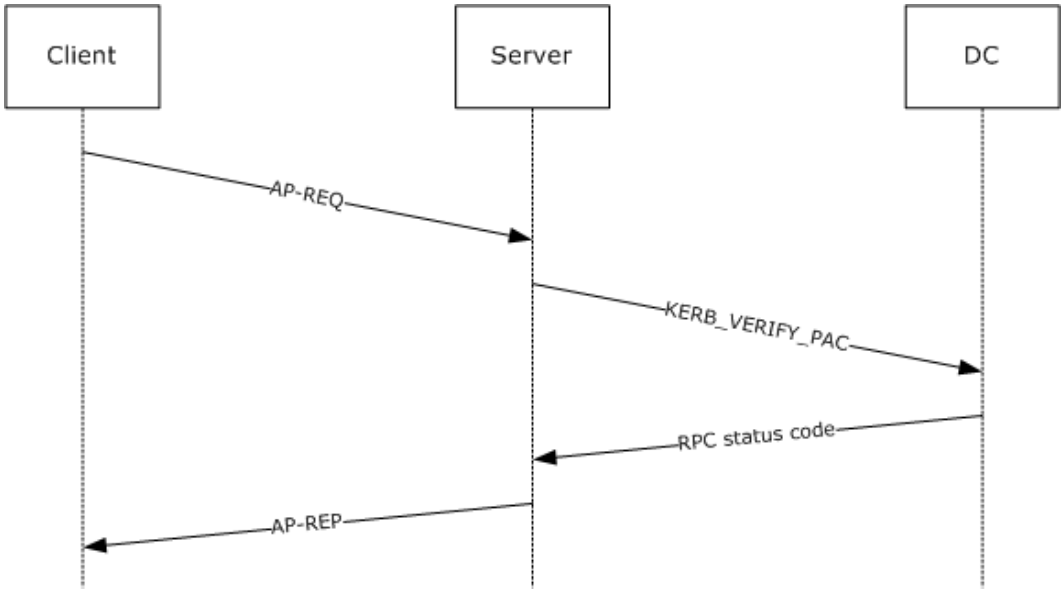


Figure 3: PAC validation

1. The client tries to access a resource requiring Kerberos authentication. The client sends an AP-REQ message to request authentication from the server.
2. The server passes the PAC to the operating system to receive an access token. The server operating system forwards the PAC signature in the AP-REQ to the domain controller for verification in a KERB_VERIFY_PAC message.
3. The domain controller verifies the signature on the response and returns the result to the server. The error is returned as the appropriate RPC status code.
4. The server verifies the AP-REQ, and sends an AP-REP if the verification is successful.

4.3 Digest Validation Protocol

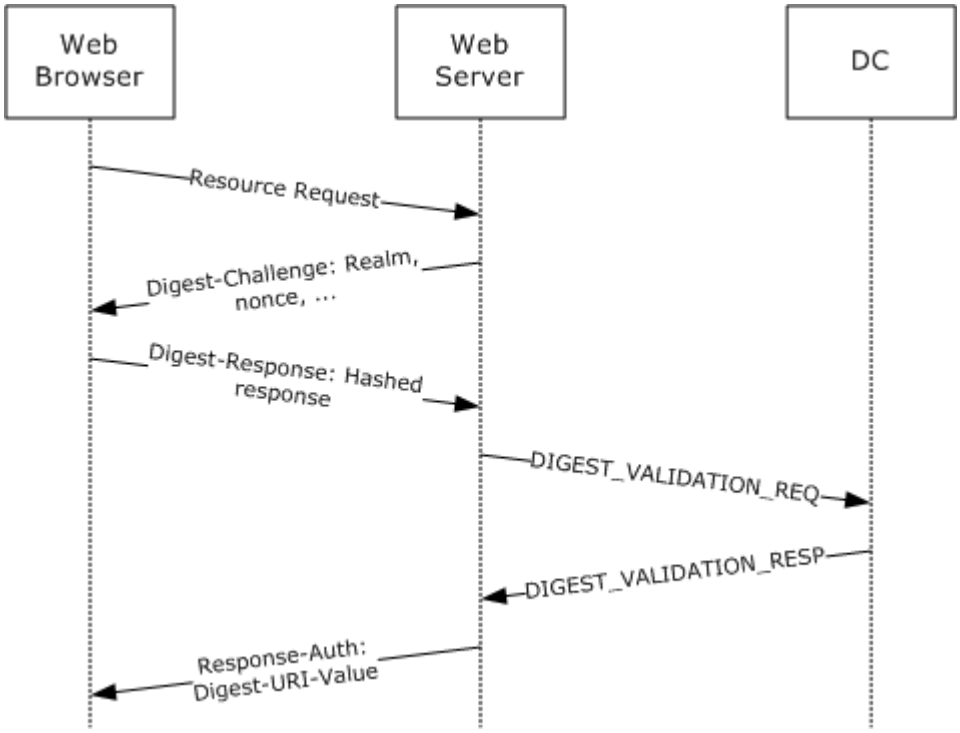


Figure 4: Digest validation protocol

1. The web server is configured to require Digest authentication to gain access to certain documents. A user attempts to gain access to the protected document by using a web browser. The web server returns the Digest-Challenge message, as specified in [RFC2617] section 3.3. This challenge message includes a randomly generated nonce intended to foil replay attacks.

2. The web browser obtains the user name and password for the user and constructs a response to the server's challenge. In the Digest-Response, the client proves knowledge of the user's password by performing a keyed hash over the user name, nonce, and other fields (the password is fed into the hash).

3. To validate the Digest-Response message, the web server constructs the DIGEST_VALIDATION_REQ (section 2.2.3.1) message and sends it to the DC. The DIGEST_VALIDATION_REQ includes the nonce and the keyed hash value from the Digest-Response message. On receiving the DIGEST_VALIDATION_REQ message, the DC validates the message by performing the following steps:

    1. Looks up the user's password by using the user name.

    2. Recomputes the keyed hash over the clear-text fields from the Digest-Response message.

    3. Compares the resulting value to the value sent by the client.

4. If the DC's computed hash and the hash sent by the client match, the DC creates and sends back the DIGEST_VALIDATION_RESP (section 2.2.3.2) message with Status indicating successful authentication (that is, STATUS_SEVERITY_SUCCESS), as specified in [MS-ERREF] section 2.3, and authorization information for the user's account (the PAC). Otherwise, the DC returns an

error code as an error status in NRPC API. It does not send back the DIGEST_VALIDATION_RESP message.

5. For mutual authentication, the server has the option to send a keyed hash over the URI that the client requested, and return it to the client in the Response-Auth message. Note that sending the Response-Auth message applies only to Digest authentication when used as a Simple Authentication and Security Layer (SASL) mechanism, as specified in [RFC2831] section 2.1.3.

5 Security

5.1 Security Considerations for Implementers

Authentication Protocol Domain Support does not have any built-in security mechanisms to provide authentication or to ensure confidentiality and integrity. Instead, it relies on security mechanisms that are specified in [MS-RPCE] section 5 to protect Netlogon RPC [MS-NRPC], which serves as the transport for the protocols defined in this document.

The Digest authentication protocol itself offers some level of protection (that is, it does not send the user's password in the clear) but is considered weaker than Kerberos [MS-KILE] and public key–based authentication (for example, client-side authentication). Consequently, the Digest Protocol Extensions should be used only in environments in which these stronger mechanisms are unavailable.

5.2 Index of Security Parameters

There are no security parameters for Authentication Protocol Domain Support. All associated security parameters are specified in the Netlogon Remote Protocol [MS-NRPC], which provides all security for Authentication Protocol Domain Support messages.

6 Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include released service packs:

- Windows NT operating system
- Windows 2000 operating system
- Windows XP operating system
- Windows Server 2003 operating system
- Windows Vista operating system
- Windows Server 2008 operating system
- Windows 7 operating system
- Windows Server 2008 R2 operating system
- Windows 8 operating system
- Windows Server 2012 operating system
- Windows 8.1 operating system
- Windows Server 2012 R2 operating system

Exceptions, if any, are noted below. If a service pack or Quick Fix Engineering (QFE) number appears with the product version, behavior changed in that service pack or QFE. The new behavior also applies to subsequent service packs of the product unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms SHOULD or SHOULD NOT implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term MAY implies that the product does not follow the prescription.

<1> Section 1.6.1: The Kerberos protocol is preferred for interactive logon. The NTLM protocol is always used for interactive logon when the domain controller is running Windows NT Server 4.0.

Network logon using NTLM is applicable under any one of the following situations:

- Client or application is explicitly configured to use NTLM.
- Client or application uses an invalid target name (the server's **principal** name) and cannot log on by using Kerberos.
- Client or application specifies a target name that cannot be resolved and, therefore, cannot log on by using Kerberos.

<2> Section 1.6.2: The following list details the behavior of each version of Windows.

- Windows 2000 Server and Windows XP do not validate the PAC when the application server is running under the local system context or has SeTcbPrivilege, as specified in [MS-LSAD] section 3.1.1.2.1. Otherwise, Windows 2000 Server and Windows XP use Kerberos PAC validation.

- Windows Server 2003 does not validate the PAC when the application server is running under the local system context, the network service context, or has SeTcbPrivilege. Otherwise, Windows Server 2003 uses Kerberos PAC validation.
- Windows Server 2003 with SP1 does not validate the PAC when the application server is under the local system context, the network service context, the local service context, or has SeTcbPrivilege privilege. Otherwise, Windows Server 2003 with SP1 and future service packs use Kerberos PAC validation.
- Windows Vista, Windows Server 2008, Windows 7, Windows Server 2008 R2, Windows 8, Windows Server 2012, Windows 8.1, and Windows Server 2012 R2 do not validate the PAC by default for services. Windows still validates the PAC for processes that are not running as services. PAC validation can be enabled when the application server is not running in the context of local system, network service, or local service; or it does not have SeTcbPrivilege, as specified in [MS-LSAD] section 3.1.1.2.1.

<3> Section 3.1.1: In Windows 2000, the following parameter is provided by the application to the NTLM server. These logical parameters can influence various protocol-defined flags.

AllowComputerLogon: A Boolean setting which indicates that the caller wants to authenticate a computer. Setting this flag results in the **K** bit being set in **LogonInformation.Identity.ParameterControl**.

<4> Section 3.1.1: Default is FALSE. Supported on Windows 7, Windows Server 2008 R2, Windows 8, Windows Server 2012, Windows 8.1, and Windows Server 2012 R2.

<5> Section 3.1.1: Default is FALSE. Supported on Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2.

<6> Section 3.1.1: Default is FALSE. Supported on Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2.

<7> Section 3.1.1: Default is NULL. Supported on Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2.

<8> Section 3.1.5: None of the Windows versions of APDS have been updated to use the **NetrLogonSamLogonEx** method. Windows uses NetrLogonSamLogonWithFlags (Opnum 45).

<9> Section 3.1.5: None of the Windows versions of APDS have been updated to use the **NetrLogonSamLogonEx** method. Windows uses NetrLogonSamLogonWithFlags (Opnum 45).

<10> Section 3.1.5: Supported on Windows 7, Windows Server 2008 R2, Windows 8, Windows Server 2012, Windows 8.1, and Windows Server 2012 R2.

<11> Section 3.1.5: Supported on Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2.

<12> Section 3.1.5: Supported on Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2.

<13> Section 3.1.5: msDS-UserAllowedToAuthenticateFrom is not supported by Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, or Windows Server 2012.

<14> Section 3.1.5: msDS-ServiceAllowedToAuthenticateFrom is not supported by Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, or Windows Server 2012.

<15> Section 3.1.5: AllowedToAuthenticateTo is not supported by Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, or Windows Server 2012 DCs.

<16> Section 3.1.5: PROTECTED_USERS is not supported by Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, or Windows Server 2012.

<17> Section 3.1.5.1: None of the Windows versions of APDS have been updated to use the **NetrLogonSamLogonEx** method. Windows uses NetrLogonSamLogonWithFlags (Opnum 45).

<18> Section 3.1.5.1: In Windows NT 4.0 and Windows 2000 Server, the ValidationLevel is **NETLOGON_VALIDATION_SAM_INFO2**.

<19> Section 3.1.5.1: If the DC returns a failure code, Windows fails the logon attempt. Other failure codes are also returned based on the policy (for a list of error codes, see [MS-ERREF]), and all of them result in logon failure.

When a Windows XP NETLOGON client talks with a Windows 2000 DC, Netlogon is responsible for negotiating the minimal ValidationLevel that is supported. This negotiated ValidationLevel is used, and the corresponding validation information is returned, as specified in [MS-NRPC] section 3.5.4.5.1. Note that the NETLOGON_VALIDATION_SAM_INFO4 structure is a superset of the NETLOGON_VALIDATION_SAM_INFO2 structure.

<20> Section 3.1.5.2: None of the Windows versions of APDS have been updated to use the **NetrLogonSamLogonEx** method. Windows uses NetrLogonSamLogonWithFlags (Opnum 45).

<21> Section 3.1.5.2: In Windows NT and Windows 2000 Server, the default ValidationLevel is **NETLOGON_VALIDATION_SAM_INFO2**.

<22> Section 3.1.5.2: In Windows 2000, if **AllowComputerLogon** is not set, then the **K** bit of **LogonInformation.Identity.ParameterControl** is not set. In Windows NT, NTLM servers never set the **K** bit.

<23> Section 3.1.5.2: In Windows NT, the DC cannot authenticate computer accounts.

<24> Section 3.1.5.2: In Windows NT, the DC cannot authenticate domain controller computer accounts.

<25> Section 3.1.5.2: When a Windows XP NETLOGON client talks with a Windows 2000 DC, Netlogon is responsible for negotiating the minimal ValidationLevel that is supported. This negotiated ValidationLevel is used, and the corresponding validation information is returned, as specified in [MS-NRPC] section 2.2.1.4.17. Note that the NETLOGON_VALIDATION_SAM_INFO4 structure is a superset of the NETLOGON_VALIDATION_SAM_INFO2 structure.

On Windows 2000 Server, Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 DCs, the user information contained in the NETLOGON_VALIDATION_SAM_INFO4 structure is obtained by querying Active Directory.

<26> Section 3.1.5.2.1: The **ParameterControl** field provides an extensibility point for software providers. Windows XP, Windows Server 2003, Windows Vista, Windows Server 2008, Windows 7, Windows Server 2008 R2, Windows 8, Windows Server 2012, Windows 8.1, and Windows Server 2012 R2 do not have sub-authentication packages installed by default.

<27> Section 3.3: The validation protocol uses the generic pass-through mechanism, as specified in [MS-NRPC] section 3.2.4.1. The Digest validation server is always a domain controller, and the Digest authentication client can be a member server of a domain or another DC in the same forest. The DC can also contact another DC in the same forest by using the DIGEST_VALIDATION_REQ and DIGEST_VALIDATION_RESP exchange, if the user's account is located in a different domain than

that of the DC that receives the request. Windows client products (such as Windows XP, Windows Vista, Windows 7, Windows 8, and Windows 8.1) do not support digest in this manner.

<28> Section 3.3.4: During the Digest authentication exchange (as specified in [RFC2617] and [RFC2831]), the Digest server initiates the Digest validation exchange with the DC. This transaction that is initiated by the Digest server does not have direct access to the user's password and relies on the DC to validate the digest input data sent by the client.

<29> Section 3.3.5.1: Windows 2000 can send other **AlgType** values.

<30> Section 3.3.5.2: Windows 2000 Server will not fail the DIGEST_VALIDATION_REQ request.

7 Change Tracking

This section identifies changes that were made to the [MS-APDS] protocol document between the November 2013 and February 2014 releases. Changes are classified as New, Major, Minor, Editorial, or No change.

The revision class **New** means that a new document is being released.

The revision class **Major** means that the technical content in the document was significantly revised. Major changes affect protocol interoperability or implementation. Examples of major changes are:

- A document revision that incorporates changes to interoperability requirements or functionality.
- The removal of a document from the documentation set.

The revision class **Minor** means that the meaning of the technical content was clarified. Minor changes do not affect protocol interoperability or implementation. Examples of minor changes are updates to clarify ambiguity at the sentence, paragraph, or table level.

The revision class **Editorial** means that the formatting in the technical content was changed. Editorial changes apply to grammatical, formatting, and style issues.

The revision class **No change** means that no new technical changes were introduced. Minor editorial and formatting changes may have been made, but the technical content of the document is identical to the last released version.

Major and minor changes can be described further using the following change types:

- New content added.
- Content updated.
- Content removed.
- New product behavior note added.
- Product behavior note updated.
- Product behavior note removed.
- New protocol syntax added.
- Protocol syntax updated.
- Protocol syntax removed.
- New content added due to protocol revision.
- Content updated due to protocol revision.
- Content removed due to protocol revision.
- New protocol syntax added due to protocol revision.
- Protocol syntax updated due to protocol revision.
- Protocol syntax removed due to protocol revision.

- Obsolete document removed.

Editorial changes are always classified with the change type **Editorially updated.**

Some important terms used in the change type descriptions are defined as follows:

- **Protocol syntax** refers to data elements (such as packets, structures, enumerations, and methods) as well as interfaces.
- **Protocol revision** refers to changes made to a protocol that affect the bits that are sent over the wire.

The changes made to this document are listed in the following table. For more information, please contact dochelp@microsoft.com.

Section	Tracking number (if applicable) and description	Major change (Y or N)	Change type
3.1.5 Message Processing Events and Sequencing Rules	Added processing rules for the domainControllerFunctionality attribute and the AllowedToAuthenticateTo element.	Y	Protocol syntax updated.

8 Index