

[MS-SCCSTR]:

SqlClient Connection String Structure

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1 Introduction

The SqlConnection Connection String structure specifies the format of the **connection strings** that are used by Microsoft .NET Framework applications that connect to Microsoft SQL Server by using the Microsoft .NET Framework Data Provider for SQL Server ("SqlConnection"). SqlConnection is a set of .NET Framework classes that are designed to enable developers to query, update, insert, and delete data on SQL Server.

A connection string is a series of arguments, delimited by a semicolon, that describe the location of a database and how to connect to it.

Sections 1.7 and 2 of this specification are normative. All other sections and examples in this specification are informative.

1.1 Glossary

This document uses the following terms:

Augmented Backus-Naur Form (ABNF): A modified version of Backus-Naur Form (BNF), commonly used by Internet specifications. ABNF notation balances compactness and simplicity with reasonable representational power. ABNF differs from standard BNF in its definitions and uses of naming rules, repetition, alternatives, order-independence, and value ranges. For more information, see [\[RFC5234\]](#).

authentication: The act of proving an identity to a server while providing key material that binds the identity to subsequent communications.

Azure Active Directory (Azure AD): The identity service in Microsoft Azure that provides identity management and access control capabilities through a REST-based API, an Azure portal, or a PowerShell command window.

Azure Multi-Factor Authentication: The Azure service that provides additional authentication for on-premises applications and applications running in Azure. Multi-Factor Authentication verifies user logons and transactions by using a mobile app, phone call, or text message.

Azure SQL Database: The data management service in Azure that provides a relational database management system with enterprise-class availability, scalability, and security and that can be accessed from anywhere in the world.

certificate chain: A sequence of certificates, where each certificate in the sequence is signed by the subsequent certificate. The last certificate in the chain is normally a self-signed certificate.

connection: Each user that has a session with a server can create multiple share connections, or resource connections, using that user ID. This resource connection is created using a tree connect Server Message Block (SMB) and is identified by an SMB TreeID or TID.

connection pool: A cache of opened connections to data sources.

connection pool blocking period: A time period during which no new connection is allowed to a specific connection pool if a timeout error or other login error occurs. During the pool blocking period, the initial error is cached and re-thrown on subsequent attempts to open a connection. The first blocking period lasts five seconds and is doubled with each subsequent failure up to one minute. For more information, see [\[MSDN-SSCP\]](#).

connection string: A series of arguments, delimited by a semicolon, that defines the location of a database and how to connect to it.

context: A collection of context properties that describe an execution environment.

credential: Previously established, **authentication** data that is used by a security principal to establish its own identity. When used in reference to the Netlogon Protocol, it is the data that is stored in the NETLOGON_CREDENTIAL structure.

data source: A database, web service, disk, file, or other collection of information from which data is queried or submitted. Supported data sources vary based on application and data provider.

database instance: A database that has a unique set of services that can have unique settings.

database mirroring: An availability solution that is based on keeping copies of the same database in different servers.

default database: The current database just after the connection is made.

enclave: A protected region of memory that is used only on the server side. This region is within the address space of SQL Server, and it acts as a trusted execution environment. Only code that runs within the enclave can access data within that enclave. Neither the data nor the code inside the enclave can be viewed from the outside, even with a debugger.

enclave computations: Locally enabled cryptographic operations and other operations in Transact-SQL queries on encrypted columns that are performed inside an enclave.

encryption: In cryptography, the process of obscuring information to make it unreadable without special knowledge.

identity provider: A web service that performs identity verification as part of its processing.

idle connection: An active connection that was opened but that does not have any pending data.

in-process connection: A connection that is opened from within the server, such as a connection that is opened by a .NET stored procedure.

Multiple Active Result Sets (MARS): A feature in SQL Server that allows applications to have more than one pending request per connection. For more information, see [\[MSDN-MARS\]](#).

named pipe: A named, one-way, or duplex pipe for communication between a pipe server and one or more pipe clients.

remote procedure call (RPC): A communication protocol used primarily between client and server. The term has three definitions that are often used interchangeably: a runtime environment providing for communication facilities between computers (the RPC runtime); a set of request-and-response message exchanges between computers (the RPC exchange); and the single message from an RPC exchange (the RPC message). For more information, see [\[C706\]](#).

replication: The process of propagating the effects of all originating writes to any replica of a naming context (NC), to all replicas of the NC. If originating writes cease and replication continues, all replicas converge to a common application-visible state.

security token: An opaque data packet that is provided to an authorized user of computer services to facilitate authentication.

security token service (STS): A web service that issues **security tokens**. That is, it makes assertions based on evidence that it trusts; these assertions are for consumption by whoever trusts it.

Unicode: A character encoding standard developed by the Unicode Consortium that represents almost all of the written languages of the world. The **Unicode** standard [\[UNICODE5.0.0/2007\]](#) provides three forms (UTF-8, UTF-16, and UTF-32) and seven schemes (UTF-8, UTF-16, UTF-16 BE, UTF-16 LE, UTF-32, UTF-32 LE, and UTF-32 BE).

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

1.2 References

Links to a document in the Microsoft Open Specifications library point to the correct section in the most recently published version of the referenced document. However, because individual documents in the library are not updated at the same time, the section numbers in the documents may not match. You can confirm the correct section numbering by checking the [Errata](#).

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.

[MS-TDS] Microsoft Corporation, "[Tabular Data Stream Protocol](#)".

[RFC1002] Network Working Group, "Protocol Standard for a NetBIOS Service on a TCP/UDP Transport: Detailed Specifications", STD 19, RFC 1002, March 1987, <http://www.rfc-editor.org/rfc/rfc1002.txt>

[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>

[RFC2460] Deering, S., and Hinden, R., "Internet Protocol, Version 6 (IPv6) Specification", RFC 2460, December 1998, <http://www.rfc-editor.org/rfc/rfc2460.txt>

[RFC4120] Neuman, C., Yu, T., Hartman, S., and Raeburn, K., "The Kerberos Network Authentication Service (V5)", RFC 4120, July 2005, <https://www.rfc-editor.org/rfc/rfc4120.txt>

[RFC5234] Crocker, D., Ed., and Overell, P., "Augmented BNF for Syntax Specifications: ABNF", STD 68, RFC 5234, January 2008, <http://www.rfc-editor.org/rfc/rfc5234.txt>

[RFC791] Postel, J., Ed., "Internet Protocol: DARPA Internet Program Protocol Specification", RFC 791, September 1981, <http://www.rfc-editor.org/rfc/rfc791.txt>

[RFC793] Postel, J., Ed., "Transmission Control Protocol: DARPA Internet Program Protocol Specification", RFC 793, September 1981, <http://www.rfc-editor.org/rfc/rfc793.txt>

[UNICODE2.0.0] UNICODE, "Unicode 2.0.0", July 1996, <http://www.unicode.org/versions/Unicode2.0.0/>

1.2.2 Informative References

[MS-NETOD] Microsoft Corporation, "[Microsoft .NET Framework Protocols Overview](#)".

[MSDN-DAD] Microsoft Corporation, "Database Detach and Attach (SQL Server)", <https://docs.microsoft.com/en-us/sql/relational-databases/databases/database-detach-and-attach-sql-server>

[MSDN-DLO] Microsoft Corporation, "default language Option", in SQL Server 2000 Retired Technical documentation, p. 710, <https://www.microsoft.com/en-us/download/confirmation.aspx?id=51958>

[MSDN-FILE] Microsoft Corporation, "Naming Files, Paths, and Namespaces", <https://docs.microsoft.com/en-us/windows/desktop/FileIO/naming-a-file>

[MSDN-NETLIB] Microsoft Corporation, "Network Libraries", in SQL Server 2000 Retired Technical documentation, pp. 88-90, <https://www.microsoft.com/en-us/download/confirmation.aspx?id=51958>

[MSDN-NP] Microsoft Corporation, "Named Pipes", <https://docs.microsoft.com/en-us/windows/desktop/ipc/named-pipes>

[MSDN-NTLM] Microsoft Corporation, "Microsoft NTLM", <https://docs.microsoft.com/en-us/windows/desktop/SecAuthN/microsoft-ntlm>

[MSDN-SD] Microsoft Corporation, "Selecting a Database", [https://docs.microsoft.com/en-us/previous-versions/sql/sql-server-2008-r2/ms180770\(v=sql.105\)](https://docs.microsoft.com/en-us/previous-versions/sql/sql-server-2008-r2/ms180770(v=sql.105))

[MSDN-UNI] Microsoft Corporation, "Using Named Instances", [https://docs.microsoft.com/en-us/previous-versions/sql/sql-server-2005/ms165614\(v=sql.90\)](https://docs.microsoft.com/en-us/previous-versions/sql/sql-server-2005/ms165614(v=sql.90))

[MSKB-313295] Microsoft Corporation, "How to use the server name parameter in a connection string to specify the client network library", <https://support.microsoft.com/en-us/help/313295/how-to-use-the-server-name-parameter-in-a-connection-string-to-specify>

[MSKB-328383] Microsoft Corporation, "SQL Server clients may change protocols when the client computers try to connect to an instance of SQL Server", <https://support.microsoft.com/en-us/help/328383/sql-server-clients-may-change-protocols-when-the-client-computers-try>

1.3 Overview

The SqlConnection Connection String Structure specifies a method for a .NET Framework application to specify the parameters that are used to connect to a **data source**. A **connection string** specifies a set of properties as keys and their associated values. The connection string can include one or more key/value pairs to specify information such as the user identification, the password, the server name, and the database name. The values that are specified in the connection string affect the way an application connects to the data source.

1.4 Relationship to Protocols and Other Structures

Some of the properties of the SqlConnection **connection string** set specific tabular data stream (TDS) fields.

For more details, see section [2.2](#).

1.5 Applicability Statement

This document describes the format of SqlConnection **connection strings** that are used to establish a **connection** between a .NET Framework application and a SQL Server **data source** in scenarios where network or local connectivity is available. If network or local connectivity is not available, attempts to establish a connection will fail.

1.6 Versioning and Localization

The SqlConnection **connection string Type System Version** key (see section [2.2](#)) is used to indicate the type of system that is expected by the .NET Framework application.

The SqlConnection connection string **Packet Size** key (see section [2.2](#)) is used to specify the packet size, in bytes, to use for the data exchange between a **data source** object and a database.

1.7 Vendor-Extensible Fields

None.

2 Structures

2.1 SqlClient Connection String

A SqlClient **connection string** MUST conform to the **Augmented Backus-Naur Form (ABNF)** [RFC5234] grammar. In accordance with section 2.4 of the RFC, this description assumes external encoding of **Unicode**.

```
SqlClientConnectionString = *(KeyValuePair SC) [KeyValuePair] *(WhiteSpace / NullTerm)

KeyValuePair=*WhiteSpace /
(*WhiteSpace Key *WhiteSpace EQ (*WhiteSpace / Value) *WhiteSpace)

Key="Addr" / "Address" / "App" / "ApplicationIntent" / "Application Name" / "Async" /
"Asynchronous Processing" / "AttachDBFilename" / "Authentication" / "Column Encryption
Setting" / "Connection Lifetime" / "Connection Reset" / "ConnectionRetryCount" /
"ConnectionRetryInterval" / "Connect Timeout" / "Connection Timeout" / "Context Connection" /
"Current Language" / "Database" / "Data Source" / "Enclave Attestation Url" / "Encrypt" /
"Enlist" / "Extended Properties" / "Failover Partner" / "Initial Catalog" / "Initial File
Name" / "Integrated Security" / "Language" / "Load Balance Timeout" / "Max Pool Size" / "Min
Pool Size" / "MultipleActiveResultSets" / "MultiSubnetFailover" / "Net" / "Network" /
"Network Address" / "Network Library" / "Packet Size" / "Password" / "Persist Security Info"
/ "PersistSecurityInfo" / "PoolBlockingPeriod" / "Pooling" / "PWD" / "Replication" / "Server"
/ "Timeout" / "Transaction Binding" / "TransparentNetworkIPResolution" / "Trusted Connection"
/ "TrustServerCertificate" / "Type System Version" / "UID" / "User" / "User ID" / "User
Instance" / "Workstation ID" / "WSID"

Value= UnquotedValue / SingleQuotedValue / DoubleQuotedValue

SingleQuotedValue = SQUOTE *(NonNullSQuote / EscSQuote)SQUOTE
NonNullSQuote=%x0001 - %x0026 / %x0028-%xFFFF; not null, not single quote
EscSQuote=SQUOTE SQUOTE; Escaped single quote

DoubleQuotedValue = DQUOTE *( NonNullDQuote / EscDQuote) DQUOTE
NonNullDQuote= %x0001 - %x0021 / %x0023-%xFFFF; not null, not double quote
EscDQuote=DQUOTE DQUOTE; Escaped double quote

UnquotedValue = (UnquotedStart / (1*WhiteSpace EQ)) *NonCtrlSC UnquotedEnd

; not control chars, not white space, not single quote, not double quote, not semicolon
UnquotedEnd= UnquotedStart / EQ

; not control chars, not white space, not single quote, not double quote
; not semicolon, not equal sign
UnquotedStart=%x0021-%x0021 / %x0023-%x0026 / %x0028-%x003A /
%x003C / %x003E-%x007E / %x00A0-%x167F / %x1681-%x180D /
%x180F-%x1FFF / %x200B-%x2027 / %x202A-%x202E /
%x2030-%x205E / %x2060-%x2FFF / %x3001-%xFFFF

; not control chars, not semicolon,
NonCtrlSC=%x0020-%x003A / %x003C-%x007E / %x00A0-%xFFFF

WhiteSpace=SP / OSM / MVS / ENQD / EMQD / ENSP / EMSP / TPEMSP / FPEMSP / SPEMSP /
FSP / PSP / TSP / HSP / NNOBRKSP / MMSP / ISP / LS / PS / CHTAB / LF /
LNTAB / FF / CR / NL / NBRKSP

NullTerm= %x0000; NULL terminator (U+0000)
SP= %x0020; SPACE (U+0020)
OSM= %x1680; OGHAM SPACE MARK (U+1680)
MVS= %x180E; MONGOLIAN VOWEL SEPARATOR (U+180E)
ENQD= %x2000; EN QUAD (U+2000)
EMQD= %x2001; EM QUAD (U+2001)
ENSP= %x2002; EN SPACE (U+2002)
EMSP= %x2003; EM SPACE (U+2003)
TPEMSP= %x2004; THREE-PER-EM SPACE (U+2004)
```

FPEMSP= %x2005; FOUR-PER-EM SPACE (U+2005)
 SPEMSP= %x2006; SIX-PER-EM SPACE (U+2006)
 FSP= %x2007; FIGURE SPACE (U+2007)
 PSP= %x2008; PUNCTUATION SPACE (U+2008)
 TSP= %x2009; THIN SPACE (U+2009)
 HSP= %x200A; HAIR SPACE (U+200A)
 NNOBRKSP= %x202F ; NARROW NO-BREAK SPACE (U+202F)
 MMSP= %x205F ; MEDIUM MATHEMATICAL SPACE (U+205F)
 ISP= %x3000; IDEOGRAPHIC SPACE (U+3000);

 LS= %x2028; LINE SEPARATOR character (U+2028)

 PS= %x2029; PARAGRAPH SEPARATOR character (U+2029)

 CHTAB= %x0009; CHARACTER TABULATION (U+0009)
 LF= %x000A; LINE FEED (U+000A)
 LNTAB= %x000B; LINE TABULATION (U+000B)
 FF= %x000C; FORM FEED (U+000C)
 CR= %x000D; CARRIAGE RETURN (U+000D)
 NL= %x0085; NEXT LINE (U+0085)
 NBRKSP= %x00A0; NO-BREAK SPACE (U+00A0)

 SC= %x003B; SEMICOLON (U+003B)
 EQ= %x003D; EQUAL SIGN (U+003D)
 SQUOTE= %x0027; SINGLE QUOTE (U+0027)
 DQUOTE= %x0022; DOUBLE QUOTE (U+0022)

2.1.1 Guidelines

The following list contains guidelines for the components of the SqlConnection String.

- **KeyValuePair**
 - A **KeyValuePair** structure is a collection of keys and values in which each key is associated with one or more values. In a SqlConnection connection string, **KeyValuePair** structures follow the following format: key1=value1, key2=value2, and so on.
 - If only white spaces are inside a **KeyValuePair** structure, the **KeyValuePair** structure MUST be ignored.
- **Key**
 - Any white spaces that precede the **Key** value MUST be ignored.
 - Any white spaces that precede the **EQ** value MUST be ignored.
 - The **Key** value MUST be case insensitive.
- **Value**
 - The value in a **KeyValuePair** MUST be **UnquotedValue**, **SingleQuotedValue**, **DoubleQuotedValue**, or empty.
 - **UnquotedValue**, which starts with **EQ**, MUST be preceded by at least one space. **UnquotedValue** MUST NOT end with **SQUOTE** or **DQUOTE**.
 - A single quote symbol MUST be escaped to be used within **SingleQuotedValue** (use **EscSQuote**). A double quote symbol MUST be escaped to be used within **DoubleQuotedValue** (use **EscDQuote**).
 - Any white spaces that precede or trail **Value** MUST be ignored. **Value** MUST be case insensitive, with the exception of the value of **Password Key**. The value of **Password Key** MUST be case sensitive.

2.1.2 Restrictions

Only the keys specified in **Key** are valid in the SqlConnection Connection String structure, and their meanings are described in section 2.2. Any other **KeyValuePair** properties MUST be treated as errors.

If there are duplicate keys, the last instance wins.

If **Context Connection** is set to "true", the only other key allowed is **Type System Version**.

If the **MultiSubnetFailover** key is set to "true", the **Failover Partner** key MUST NOT be allowed.

If the **ApplicationIntent** key is set to "ReadOnly", the **Failover Partner** key MUST NOT be allowed.

There MUST be no default values for keys if the **KeyValuePair** (whole pair) is missing, unless otherwise specified in section 2.2.

2.2 Keys and Values

The following table provides a list of all keys accepted as a SqlConnection Connection String.

Keyword	Description
Addr	Synonym of the Data Source key.
Address	Synonym of the Data Source key.
App	Synonym of the Application Name key.
ApplicationIntent	When the value of this key is set to "ReadOnly", the client MUST request a read workload when connecting to an AlwaysOn-enabled database. The value of this key MUST be "ReadOnly" or "ReadWrite". The default value of this key is "ReadWrite".
Application Name	Sets the name of the application in the application identifier as specified by the ibAppName and cchAppName fields in [MS-TDS] section 2.2.6.4. The value of this key MUST be a string that has a maximum length of 128 characters. The default value of this key is ".NET SqlConnection Data Provider".
Async	Synonym of the Asynchronous Processing key.
Asynchronous Processing<1>	When the value of this key is set to "true", asynchronous support MUST be enabled. The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
AttachDBFilename	Sets the name of the primary file of an attachable database<2> as specified by the ibAttachDBFile and cchAttachDBFile fields in [MS-TDS] section 2.2.6.4. The default value of this key is "". If the value of the AttachDBFilename key is specified in the connection string, the database is attached and becomes the default database for the connection . If this key is not specified and if the database was previously attached, the database will not be reattached. The previously attached database will be used as the default database for the connection. If this key is specified together with the AttachDBFilename key, the value of this key SHOULD be used as the alias. However, if the name is already used in

Keyword	Description
	<p>another attached database, the connection MUST fail.</p> <p>For more information about attachable databases, see [MSDN-DAD].</p> <p>For more information about default databases, see [MSDN-SD].</p>
Authentication	<p>Specifies the authentication method that is used to authenticate a user. The value of this key MUST be one of the following:</p> <ul style="list-style-type: none"> ▪ Sql Password: Indicates that a user connects by using SQL Server authentication. If this value is specified, the User ID and Password keys MUST also be specified, unless the user name and the password are passed as a secure string by using SqlClient programming interfaces. ▪ Active Directory Password: Indicates that a user MAY<3> connect by using a user name and password. If this value is specified, the User ID and Password keys MUST also be specified, unless the user name and the password are passed as a secure string by using SqlClient programming interfaces. In this case, SqlClient contacts a security token service (STS) to obtain a security token for the database. The STS validates the user name and password in Azure Active Directory (Azure AD), which acts as an identity provider. Subsequently, SqlClient uses the security token to connect to the database. ▪ Active Directory Integrated: Indicates that a user SHOULD<4> connect with a domain account and its domain credentials by using either Kerberos [RFC4120] or another platform-specific authentication process, such as NTLM [MSDN-NTLM].<5> If this value is set, the User ID and Password keys MUST NOT be set. ▪ Active Directory Interactive: Indicates that a user MAY<6> connect by using Microsoft Azure Multi-Factor Authentication for Azure SQL Database and by using Azure AD. This method supports native and federated Azure AD users and all guest users from other accounts. When this value is specified, the User ID key MUST also be specified and the Password key MUST NOT be specified. For a given user ID, an additional sign-in pop-up authentication window that is supported by Azure AD requires users to enter a password manually. Due to its interactive nature, this method is not recommended for use with an automated workflow. <p>If the Authentication key is specified, the Integrated Security key is ignored if it is set to "true", "yes", or "sspi".</p>
Column Encryption Setting	<p>When this key is set to "enabled" and column encryption is supported, SqlClient SHOULD<7> transparently encrypt the values of input query parameters that correspond to transparently encrypted columns in the database, before sending the values to the server. Similarly, SqlClient transparently decrypts any values from encrypted columns that are received from the server in query results.</p> <p>If this key is set to "disabled" and the query contains any parameters that correspond to transparently encrypted columns and/or the query requires enclave computations, the query will fail.</p> <p>If this key is set to "disabled" and the query retrieves any values from transparently encrypted columns, the user will receive the values in cypher text. In other words, SqlClient will not decrypt these values.</p> <p>The value of this key MUST be "enabled" or "disabled".</p> <p>The default value of this key is "disabled".</p>
Connection Lifetime	<p>The minimum time, in seconds, for the connection to live in the connection pool before it is destroyed.</p> <p>Valid values MUST be unsigned integers that range from greater than or equal to 0 to less than or equal to 2147483647.</p>

Keyword	Description
	The default value of this key is 0, which means no pool usage at all.
Connection Reset	The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "true", and "false" is ignored.
ConnectionRetryCount	Specifies the number of reconnection attempts if an idle connection failure is detected. Valid values MUST be unsigned integers that range from greater than or equal to 0 to less than or equal to 255. The default value of this key is 1.
ConnectionRetryInterval	Specifies the amount of time, in seconds, between each reconnection attempt. Valid values MUST be unsigned integers that range from greater than or equal to 1 to less than or equal to 60. The default value of this key is 10.
Connection Timeout	Specifies the amount of time, in seconds, to wait for a connection to complete. Valid values MUST be unsigned integers that range from greater than or equal to 0 to less than or equal to 2147483647. The default value of this key is 15.
Connect Timeout	Synonym of the Connection Timeout key.
Context Connection	The value of this key MUST be "true" to open an in-process connection to the server. The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
Current Language	Sets the language used for database server warning or error messages as specified by the ibLanguage and cchLanguage fields in [MS-TDS] section 2.2.6.4. For more information about default language, see [MSDN-DLO] . The value of this key MUST be a string that has a maximum length of 128 characters. The default value of this key is "".
Database	Synonym of the Initial Catalog key.
Data Source	Specifies the network address of an instance of the database server.<8> The value of this key MUST be a string that has a maximum length of 128 characters. The default value of this key is "". Data Source MUST be the TCP format, the Named Pipes format, or the LocalDB format. TCP format is as follows: <ul style="list-style-type: none"> ▪ tcp:<host name>\<instance name> ▪ tcp:<host name>,<TCP/IP port number> The TCP format MUST start with the prefix "tcp:" and is followed by the database instance, as specified by a host name and an instance name.

Keyword	Description
	<p>The host name MUST be specified in one of the following ways:</p> <ul style="list-style-type: none"> ▪ NetBIOSName [RFC1002] ▪ IPv4Address [RFC791] ▪ IPv6Address [RFC2460] <p>The instance name is used to resolve to a particular TCP/IP port number [RFC793] on which a database instance is hosted. Alternatively, specifying a TCP/IP port number directly is also allowed. If both instance name and port number are not present, the default database instance is used.</p> <p>For more information about instance name, see [MSDN-UNI].</p> <p>The Named Pipes format is as follows:</p> <ul style="list-style-type: none"> ▪ np:\\<host name>\pipe\<pipe name> <p>The Named Pipes format MUST start with the prefix "np:" and is followed by a named pipe name.</p> <p>The host name MUST be specified in one of the following ways:</p> <ul style="list-style-type: none"> ▪ NetBIOSName [RFC1002] ▪ IPv4Address [RFC791] ▪ IPv6Address [RFC2460] <p>The pipe name is used to identify the database instance to which the .NET Framework application will be connected.</p> <p>If the value of the Network key is specified, the prefixes "tcp:" and "np:" SHOULD NOT <9> be specified.</p> <p>The LocalDB format MUST start with "(localdb)" followed by a "\" and either the instance name or the LocalDB version number in the format "vXX.X". The format is as follows:</p> <ul style="list-style-type: none"> ▪ (localdb)\<instance name>, where <instance name> MUST be case insensitive and MUST NOT contain the terms Default, MSSQLServer, or other reserved keywords. If a reserved keyword is used in an instance name, an error will occur. Also, <instance name> MUST be limited to 16 characters, where the first character MUST be a letter or an underscore (_). Acceptable letters are those that are defined by the Unicode Standard 2.0 [UNICODE2.0.0], including Latin characters a-z and A-Z, and letter characters from other languages. Subsequent characters MUST be letters defined by the Unicode Standard 2.0, decimal numbers from Basic Latin or other national scripts, the dollar sign (\$), or an underscore (_). Embedded spaces or other special characters MUST NOT be allowed in instance names. The backslash (\), comma (,), colon (:), semicolon (;), single quotation mark ('), ampersand (&), number sign (#), or at sign (@) also MUST NOT be allowed in instance names. ▪ (localdb)\vXX.X, for the default instance, where X MUST be any valid decimal number from Basic Latin or other national scripts. <p>For more information about the format of the Data Source key, see [MSKB-313295].</p> <p>For more information about named pipes, see [MSDN-NP].</p>
Enclave Attestation Url	<p>Specifies an endpoint of an enclave attestation service. This key MAY <10> identify the service that is used to verify whether the enclave, which is configured in the SQL Server instance for computations on encrypted database columns, is valid and secure.</p> <p>If the value of this key is "" and SqlClient sends a query that requires enclave</p>

Keyword	Description
	computations, the query will fail. The default value of this key is "".
Encrypt	Specifies whether encryption is used as specified by [MS-TDS] section 2.2.6.5 . The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated as a value of "false". If the Authentication key is specified, the default value of this key is "true". Otherwise, the default value of this key SHOULD <11> be "false".
Enlist	When the value of this key is set to "true", the connection MUST be automatically enlisted in current transaction context . The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key MAY <12> be "false".
Extended Properties	Synonym of the AttachDBFilename key.
Failover Partner <13>	The name of the failover partner server where database mirroring is configured. This parameter is optional. If the value of this key is "", then Initial Catalog MUST be present, and its value MUST NOT be "". The value of this key MUST be a string that has a maximum length of 128 characters. The default value of this key is "".
Initial Catalog	Sets the name of the initial or default database of a data source as specified by the ibDatabase and cchDatabase fields in [MS-TDS] section 2.2.6.4. The value of this key MUST be a string that has a maximum length of 128 characters. The default value of this key is "". For more information about default databases, see [MSDN-SD].
Initial File Name	Synonym of the AttachDBFilename key.
Integrated Security	The value of this key MUST be "sspi", "true", "false", "yes", or "no". The value of "sspi", "true", or "yes" indicates that a user connects by using either Kerberos [RFC4120] or another platform-specific authentication process, such as NTLM [MSDN-NTLM]. <14> If the value of this key is "yes", "sspi", or "true", the User ID and Password keys MUST be ignored. A value of "yes" or "sspi" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
Language	Synonym of the Current Language key.
Load Balance Timeout	Synonym of the Connection Lifetime key.
Max Pool Size	The maximum number of connections that are allowed in the pool. Max Pool Size does not impose any restrictions other than those implied or explicitly stated in this section. Examples of such restrictions can be derived from limitations on available resources or of a targeted system. Valid values MUST be unsigned integers that are greater than or equal to 1.

Keyword	Description
	Values that are less than Min Pool Size MUST raise an error. The default value of this key is 100.
Min Pool Size	The minimum number of connections that are allowed in the pool. Valid values MUST be unsigned integers that are greater than or equal to 0. Zero (0) in this field means that no minimum connections are initially opened. Values that are greater than Max Pool Size MUST raise an error. The default value of this key is 0.
MultipleActiveResultSets<15>	When the value of this key is set to "true", the application MUST maintain Multiple Active Result Sets (MARS) . When the value of this key is set to "false", the application MUST process or cancel all result sets from one batch before it can execute any other batch on that connection. The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
MultiSubnetFailover	The value of this key MUST be "true", "false", "yes", or "no".<16> A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
Net	Synonym of the Network Library key.
Network	Synonym of the Network Library key.
Network Address	Synonym of the Data Source key.
Network Library	Specifies the network component used in communication between the client and the data source. The behavior is platform-dependent. The supported values for this key include the following. There are several of these named components (values), each of which implements a specific protocol behavior.<17> <ul style="list-style-type: none"> ▪ dbnmpntw (Named Pipes [MSDN-NETLIB]) ▪ dbmsrpcn (Multiprotocol [MSDN-NETLIB], Windows RPC [MSDN-NETLIB]) ▪ dbmsadsn (Apple Talk [MSDN-NETLIB]) ▪ dbmsgnet (VIA [MSDN-NETLIB]) ▪ dbmslpcn (Shared Memory [MSDN-NETLIB]) ▪ dbmsspxn (IPX/SPX [MSDN-NETLIB]) ▪ dbmssocn (TCP/IP [RFC793]) ▪ Dbmsvinn (Banyan Vines [MSDN-NETLIB]) <p>The corresponding network library MUST be installed in the client system. If a network is not specified to connect to a local server, the shared memory library MUST be used. The default value of this key is "".</p>
Packet Size	Sets the network packet size in bytes (as specified by the PacketSize field in [MS-TDS] section 2.2.6.4) to be used for data exchange between the data source object and the database.

Keyword	Description
	Valid values MUST be unsigned integers that range from greater than or equal to 512 to less than or equal to 32767. The default packet size is 8000 bytes.
Password	Specifies the password associated with User ID . The value of this key MUST be a string that has a maximum length of 128 characters. The default value of this key is "".
Persist Security Info	When the value of this key is set to "false", security-sensitive information, such as the password, MUST NOT be returned as part of the connection if the connection is open or has ever been in an open state. The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
PersistSecurityInfo	Synonym of the Persist Security Info key.
PoolBlockingPeriod<18>	Specifies the blocking period behavior for a connection pool. The possible values of this key are the following: <ul style="list-style-type: none"> ▪ Auto: The connection pool blocking period is determined automatically based on the type of server instance. The connection pool blocking period of an on-premises SQL Server instance is enabled. ▪ AlwaysBlock: The connection pool blocking period is always enabled. ▪ NeverBlock: The connection pool blocking period is always disabled. The default value of this key is "Auto".
Pooling	When the value of this key is set to "true", any newly created connection MUST be added to the pool when closed by the application. In a next attempt to open the same connection, that connection MUST be drawn from the pool. Connections are considered the same if they have the same connection string. Different connections MUST have different connection strings. Connection strings MUST be compared as is. The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "true".
PWD	Synonym of the Password key.
Replication	When the value of this key is set to "true", replication MUST be supported using the connection. The value of this key MUST be "true", "false", "yes", or "no". A value of "yes" MUST be treated the same as a value of "true". A value of "no" MUST be treated the same as a value of "false". The default value of this key is "false".
Server	Synonym of the Data Source key.
Timeout	Synonym of the Connection Timeout key.
Transaction Binding	Controls a connection association with an enlisted transaction.

Keyword	Description
	<p>The value of this key MUST be one of the following:</p> <ul style="list-style-type: none"> ▪ Transaction Binding=Implicit Unbind ▪ Transaction Binding=Explicit Unbind <p>The Implicit Unbind value MUST cause the connection to detach from the transaction when it ends. After the connection detaches and/or after the transaction ends, additional requests on the connection MUST be committed automatically.</p> <p>The Explicit Unbind value MUST cause the connection to remain attached to the transaction until the connection is closed or if an explicit call to the SqlConnection.TransactionEnlist(null) method is made.</p> <p>The default value of this key is none.</p>
TransparentNetworkIPResolution	<p>When the value of this key is set to "true", the application is required to retrieve all IP addresses for a particular DNS entry and attempt to connect with the first one in the list. If the connection is not established within 0.5 seconds, the application will try to connect to all others in parallel. When the first answers, the application will establish the connection with the respondent IP address.</p> <p>If the MultiSubnetFailover key is set to "true", TransparentNetworkIPResolution MUST be ignored.</p> <p>If the Failover Partner key is set, TransparentNetworkIPResolution MUST be ignored.</p> <p>The value of this key MUST be "true", "false", "yes", or "no".</p> <p>A value of "yes" MUST be treated the same as a value of "true".</p> <p>A value of "no" MUST be treated the same as a value of "false".</p> <p>The default value of this key is "true".</p>
Trusted Connection	Synonym of the Integrated Security key.
TrustServerCertificate	<p>When the value of this key is set to "true", or when the value of this key set to "false" and the Encrypt key is set to "false" and the Authentication key is not set, SqlConnection bypasses the step of walking the certificate chain to validate trust. The channel MUST NOT be encrypted if TrustServerCertificate is set to "true" and Encrypt is set to "false".</p> <p>The value of this key MUST be "true", "false", "yes", or "no".</p> <p>A value of "yes" MUST be treated the same as a value of "true".</p> <p>A value of "no" MUST be treated the same as a value of "false".</p> <p>The default value of this key is "false".</p>
Type System Version	<p>A string value that indicates the type system that the .NET Framework application expects. <19></p> <p>When the value of this key is set to "Latest", the latest version that can be handled by the client-server pair MUST be used. The value of this key MUST automatically move forward as the client and server components are upgraded.</p> <p>The default value of this key is none.</p>
UID	Synonym of the User ID key.
User	Synonym of the User ID key.
User ID	<p>Specifies the user identification to be used when connecting to the data source.</p> <p>The value of this key MUST be a string that has a maximum length of 128 characters.</p>

Keyword	Description
	The default value of this key is "".
User Instance	<p>The value of this key MUST be "true", "false", "yes", or "no".<20></p> <p>A value of "yes" MUST be treated the same as a value of "true".</p> <p>A value of "no" MUST be treated the same as a value of "false".</p> <p>The default value of this key is "false".</p>
Workstation ID	<p>Sets the workstation identifier as specified by the ibHostName and cchHostName fields in [MS-TDS] section 2.2.6.4. The default value is the name of the workstation that is running the ODBC application.</p> <p>The value of this key MUST be a string that has a maximum length of 128 characters.</p> <p>The default value of this key is none.</p>
WSID	Synonym of the Workstation ID key.

3 Structure Examples

The following section contains connection string examples that are based on the **SqlConnectionString** structure.

3.1 Trusted Connection

The **Trusted Connection** connection string is expressed as follows.

```
Authentication=Active Directory Integrated; Data Source=ServerName; Initial Catalog=DatabaseName;
```

"Authentication=Active Directory Integrated" specifies that a user domain account is used to establish this **connection**.

"Data Source=ServerName" specifies that ServerName is the name of the server to which the connection is established.

"Initial Catalog=DatabaseName" specifies that DatabaseName is the name of the data source.

3.2 Standard Security Connection

The **Standard Security Connection** connection string is expressed as follows.

```
Data Source =ServerName;Initial Catalog=DatabaseName; Authentication=Sql Password; User ID=UserName; Password=UserPassword;
```

"User ID=UserName" specifies that UserName is the name of the user who establishes the connection.

"Password=UserPassword" specifies that UserPassword is the password of the user who establishes the connection.

"Authentication=Sql Password" specifies SQL Server authentication.

3.3 Named Instance

The named instance connection string is expressed as follows.

```
Data Source= ServerName\InstanceName;Initial Catalog=DatabaseName; Authentication=Active Directory Integrated
```

"Data Source=ServerName\InstanceName" specifies that the connection is being established to the named instance InstanceName on the server whose name is ServerName.

The LocalDB named instance connection string is expressed as follows.

```
Data Source= (localdb)\InstanceName;Initial Catalog=DatabaseName; Authentication=Active Directory Integrated
```

"Data Source=(localdb)\InstanceName" specifies that the connection is being established to the named instance InstanceName on the LocalDB server.

3.4 SQL Server Express LocalDB Default Instance

The SQL Server Express LocalDB default instance connection string is expressed as follows.

```
Data Source= (localdb)\v11.0;Initial Catalog=DatabaseName; Authentication=Active Directory  
Integrated
```

"Data Source=(localdb)\v11.0" specifies that the connection is being established to the default instance on the SQL Server Express LocalDB server.

3.5 Escaped Single Quote

The **Escaped Single Quote** connection string is expressed as follows.

```
Data Source=ServerName;DATABASE=DatabaseName; Application Name='John''s Application'
```

"Application Name='John''s Application'" specifies that "John's Application" is the name of the application.

4 Security

4.1 Security Considerations for Implementers

A connection string can contain **credential** information in clear text. It is recommended that .NET Framework applications take special care when accessing credential information; it is advised that, whenever possible, .NET Framework applications avoid passing the credential information in the connection string. [<21>](#) Instead, it is recommended that applications use **Authentication=Active Directory Integrated** or **Integrated Security=sspi** in the SqlConnection Connection String structure, or use SqlConnection APIs to specify credential information.

4.2 Index of Security Fields

The following security parameters for SqlConnection Connection String are described in section [2.2](#).

- Authentication
- Encrypt
- Integrated Security
- Password
- TrustServerCertificate
- User ID

5 Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include updates to those products.

This document specifies version-specific details in the Microsoft .NET Framework. For information about which versions of .NET Framework are available in each released Windows product or as supplemental software, see [\[MS-NETOD\]](#) section 4.

- Microsoft .NET Framework 1.0
- Microsoft .NET Framework 1.1
- Microsoft .NET Framework 2.0
- Microsoft .NET Framework 3.5
- Microsoft .NET Framework 4.0
- Microsoft .NET Framework 4.5
- Microsoft .NET Framework 4.6
- Microsoft .NET Framework 4.7
- Microsoft .NET Framework 4.8
- 2007 Microsoft Office system
- Microsoft Office 2010 system
- Microsoft Office 2013 system
- Microsoft Office 2016
- Microsoft SQL Server 2000
- Microsoft SQL Server 2005
- Microsoft SQL Server 2008
- Microsoft SQL Server 2008 Express
- Microsoft SQL Server 2008 R2
- Microsoft SQL Server 2012
- Microsoft SQL Server 2014
- Microsoft SQL Server 2016
- Microsoft SQL Server 2017
- 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
- Windows 10 operating system
- Windows Server 2016 operating system
- Windows Server operating system
- Windows Server 2019 operating system

Exceptions, if any, are noted in this section. If an update version, service pack or Knowledge Base (KB) number appears with a product name, the behavior changed in that update. The new behavior also applies to subsequent updates 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 2.2](#): The **Asynchronous Processing** key is ignored in the .NET Framework 4.5, .NET Framework 4.6, .NET Framework 4.7, and .NET Framework 4.8.

[<2> Section 2.2](#): A file path that conforms to the format specified in [\[MSDN-FILE\]](#).

[<3> Section 2.2](#): The "Active Directory Password" value is not supported by Microsoft SQL Server. This value was introduced in the .NET Framework 4.6.1 and is not supported by the .NET Framework 1.0, .NET Framework 1.1, .NET Framework 2.0, .NET Framework 3.5, .NET Framework 4.0, .NET Framework 4.5, and .NET Framework 4.6.

[<4> Section 2.2](#): The "Active Directory Integrated" value was introduced in SQL Server 2016 and is not supported by SQL Server 2000, SQL Server 2005, SQL Server 2008, SQL Server 2008 Express, SQL Server 2008 R2, SQL Server 2012, and SQL Server 2014. This value was also introduced in the .NET Framework 4.6.1 and is not supported by the .NET Framework 1.0, .NET Framework 1.1, .NET Framework 2.0, .NET Framework 3.5, .NET Framework 4.0, .NET Framework 4.5, and .NET Framework 4.6.

[<5> Section 2.2](#): In Microsoft implementations, the user domain account is a Microsoft Windows user domain account. The SQL Server configuration determines whether SqlClient authenticates to the database directly by using either Kerberos or NTLM, or whether SqlClient initially contacts an STS to obtain an access token that subsequently is used to connect to the database.

[<6> Section 2.2](#): The "Active Directory Interactive" value is not supported by SQL Server. This value was introduced in the .NET Framework 4.7.2 and is not supported by the .NET Framework 1.0, .NET Framework 1.1, .NET Framework 2.0, .NET Framework 3.5, .NET Framework 4.0, .NET Framework 4.5, .NET Framework 4.6, .NET Framework 4.7, and .NET Framework 4.7.1.

[<7> Section 2.2](#): The **Column Encryption Setting** key is not supported by SQL Server 2000, SQL Server 2005, SQL Server 2008, SQL Server 2008 Express, SQL Server 2008 R2, SQL Server 2012, and SQL Server 2014. This key is also not supported by the .NET Framework 1.0, .NET Framework 1.1, .NET Framework 2.0, .NET Framework 3.5, .NET Framework 4.0, and .NET Framework 4.5.

[<8> Section 2.2](#): The value of the **Data Source** key can be either the name of a server on the network or the name of a SQL Server Configuration Manager advanced server entry. To specify a named instance of SQL Server, the server name `ServerName\InstanceName` can be used. Otherwise, if InstanceName is omitted, SqlClient connects to the default server. "(Local)" is also a valid name

representing a copy of SQL Server that is running on the same computer. SQL Server 2000 does not support multiple instances of SQL Server running on the same computer.

<9> [Section 2.2](#): In Microsoft implementations, if the value of the **Network** key is specified as "DBNETLIB," the protocol prefixes "tcp:" and "np:" can still be used.

<10> [Section 2.2](#): The **Enclave Attestation Url** key is not supported by SQL Server. This key was introduced in the .NET Framework 4.7.2 and is not supported by the .NET Framework 1.0, .NET Framework 1.1, .NET Framework 2.0, .NET Framework 3.5, .NET Framework 4.0, .NET Framework 4.5, .NET Framework 4.6, .NET Framework 4.7, and .NET Framework 4.7.1.

<11> [Section 2.2](#): Even if the **Encrypt** key is set to "false", SqlConnection looks at [Software\Microsoft\MSSQLServer\Client\SuperSocketNetLib], and if the value of **Encrypt** is set to "true", the encryption is considered enabled.

<12> [Section 2.2](#): The default value is "true" if the platform is WIN32NT. Otherwise, the default value is "false".

<13> [Section 2.2](#): The **Failover Partner** key is not supported by the .NET Framework 1.0 or .NET Framework 1.1.

<14> [Section 2.2](#): In Microsoft implementations, NTLM authentication [\[MSDN-NTLM\]](#) is used when the value of the **Integrated Security** key is "yes". In addition, depending on the server configuration, NTLM authentication might be used if the value of the **Authentication** key is "Active Directory Integrated".

<15> [Section 2.2](#): The **MultipleActiveResultSets** key is not supported by the .NET Framework 1.0 or .NET Framework 1.1.

<16> [Section 2.2](#): When the value of the **MultiSubnetFailover** key is set to "true", SQL Server 2012, SQL Server 2014, SQL Server 2016, and SQL Server 2017 enable fast failover for all AlwaysOn availability groups and failover cluster instances.

<17> [Section 2.2](#): In Microsoft implementations, the behaviors of the values for the various components are described in the following table.

Value	Meaning
DBNMPNTW	The component DBNMPNTW implements the named pipes protocol [MSDN-NP] .
DBMSSOCN	The component DBMSSOCN implements the TCP/IP protocol.
DBMSSPXN	The component DBMSSPXN implements the NWLink IPX/SPX protocol.
DBMSRPCN	The component DBMSRPCN implements the Multi-Protocol protocol.
DBMSVINN	The component DBMSVINN implements the Banyan Vines protocol.
DBMSADSN	The component DBMSADSN implements the ADSP protocol.
DBMSSHRN	The component DBMSSHRN implements the Shared Memory protocol.
DBMSLPCN	The component DBMSLPCN implements the Shared Memory protocol.
DBNETLIB	The default search order of network component can be used.

If the value specified is not listed above, or if the **Network** key is not specified, the default search order of network component can be used. For more information about the default search order of network component, see [\[MSKB-328383\]](#).

[<18> Section 2.2](#): The **PoolBlockingPeriod** key was introduced in the .NET Framework 4.6.2 and is not supported by the .NET Framework 1.0, .NET Framework 1.1, .NET Framework 2.0, .NET Framework 3.5, .NET Framework 4.0, .NET Framework 4.5, .NET Framework 4.6, and .NET Framework 4.6.1.

[<19> Section 2.2](#): In a Microsoft implementation, the value is one of the following:

- Type System Version=SQL Server 2000

The following conversions are performed when connecting to an instance of SQL Server 2000:

- XML to NTEXT
- UDT to VARBINARY
- VARCHAR(MAX) to TEXT
- NVARCHAR(MAX) to NEXT

- Type System Version=SQL Server 2005

- Type System Version=SQL Server 2008 (Applicable to only the Microsoft .NET Framework 2.0 Service Pack 1 (SP1), .NET Framework 3.5, .NET Framework 4.0, .NET Framework 4.5, .NET Framework 4.6, .NET Framework 4.7, and .NET Framework 4.8.)

- Type System Version=SQL Server 2012 (Applicable to only the .NET Framework 4.5, .NET Framework 4.6, .NET Framework 4.7, and .NET Framework 4.8.)

- Type System Version=Latest (The value "Latest" is equivalent to "Type System Version=SQL Server 2008". "Latest" should not be used.)

Because "Latest" defaults to SQL Server 2008, the applications that target SQL Server 2012, SQL Server 2014, SQL Server 2016, and SQL Server 2017 require that users provide the correct version number for the type compatibility that the .NET Framework application expects. For example, an application that runs against SQL Server 2008 and that targets SQL Server 2016 uses "Type System Version=SQL Server 2008".

[<20> Section 2.2](#): The value for the **User Instance** key indicates whether to redirect the connection from the default instance of SQL Server 2008 Express to another connection that is running in the same context of the user.

[<21> Section 4.1](#): Connection strings are stored "as is" in memory or in any other persistent media. It is advised that the application safeguard any credential information.

6 Change Tracking

This section identifies changes that were made to this document since the last release. Changes are classified as Major, Minor, or None.

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.
- A document revision that captures changes to protocol functionality.

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 **None** means that no new technical changes were introduced. Minor editorial and formatting changes may have been made, but the relevant technical content is identical to the last released version.

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

Section	Description	Revision class
2.2 Keys and Values	Added .NET Framework 4.8 to the product behavior notes.	Major
5 Appendix A: Product Behavior	Added .NET Framework 4.8 to the list of applicable products.	Major

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