

# [MS-RDPADRV]: Remote Desktop Protocol: Audio Level and Drive Letter Persistence Virtual Channel Extension

---

## Intellectual Property Rights Notice for Open Specifications Documentation

- **Technical Documentation.** Microsoft publishes Open Specifications documentation for protocols, file formats, languages, standards as well as overviews of the interaction among each of these technologies.
- **Copyrights.** This documentation is covered by Microsoft copyrights. Regardless of any other terms that are contained in the terms of use for the Microsoft website that hosts this documentation, you may make copies of it in order to develop implementations of the technologies described in the Open Specifications and may distribute portions of it in your implementations using these technologies or your documentation as necessary to properly document the implementation. You may also distribute in your implementation, with or without modification, any schema, IDL's, or code samples that are included in the documentation. This permission also applies to any documents that are referenced in the Open Specifications.
- **No Trade Secrets.** Microsoft does not claim any trade secret rights in this documentation.
- **Patents.** Microsoft has patents that may cover your implementations of the technologies described in the Open Specifications. Neither this notice nor Microsoft's delivery of the documentation grants any licenses under those or any other Microsoft patents. However, a given Open Specification may be covered by Microsoft [Open Specification Promise](#) or the [Community Promise](#). If you would prefer a written license, or if the technologies described in the Open Specifications are not covered by the Open Specifications Promise or Community Promise, as applicable, patent licenses are available by contacting [iplg@microsoft.com](mailto:iplg@microsoft.com).
- **Trademarks.** The names of companies and products contained in this documentation may be covered by trademarks or similar intellectual property rights. This notice does not grant any licenses under those rights. For a list of Microsoft trademarks, visit [www.microsoft.com/trademarks](http://www.microsoft.com/trademarks).
- **Fictitious Names.** The example companies, organizations, products, domain names, email addresses, logos, people, places, and events depicted in this documentation are fictitious. No association with any real company, organization, product, domain name, email address, logo, person, place, or event is intended or should be inferred.

**Reservation of Rights.** All other rights are reserved, and this notice does not grant any rights other than specifically described above, whether by implication, estoppel, or otherwise.

**Tools.** The Open Specifications do not require the use of Microsoft programming tools or programming environments in order for you to develop an implementation. If you have access to Microsoft programming tools and environments you are free to take advantage of them. Certain Open Specifications are intended for use in conjunction with publicly available standard

specifications and network programming art, and assumes that the reader either is familiar with the aforementioned material or has immediate access to it.

## Revision Summary

Date	Revision History	Revision Class	Comments
07/12/2012	1.0	New	Released new document.
10/25/2012	1.1	Minor	Clarified the meaning of the technical content.
01/31/2013	1.1	No change	No changes to the meaning, language, or formatting of the technical content.
08/08/2013	1.1	No change	No changes to the meaning, language, or formatting of the technical content.
11/14/2013	1.1	No change	No changes to the meaning, language, or formatting of the technical content.
02/13/2014	1.1	No change	No changes to the meaning, language, or formatting of the technical content.
05/15/2014	1.1	No change	No changes to the meaning, language, or formatting of the technical content.

# Contents

<b>1 Introduction</b>	<b>4</b>
1.1 Glossary	4
1.2 References	4
1.2.1 Normative References	4
1.2.2 Informative References	5
1.3 Overview	5
1.4 Relationship to Other Protocols	5
1.5 Prerequisites/Preconditions	5
1.6 Applicability Statement	6
1.7 Versioning and Capability Negotiation	6
1.8 Vendor-Extensible Fields	6
1.9 Standards Assignments	6
<b>2 Messages</b>	<b>7</b>
2.1 Transport	7
2.2 Message Syntax	7
2.2.1 SAE_Started	7
2.2.2 SAE_VolumeChange	7
2.2.3 SAE_RemoteConnect	8
2.2.4 SADLE_Started	8
2.2.5 SADLE_SerializedCache	9
<b>3 Protocol Details</b>	<b>11</b>
3.1 Common Details	11
3.1.1 Abstract Data Model	11
3.1.2 Timers	11
3.1.3 Initialization	11
3.1.3.1 Audio Level Protocol Initialization	11
3.1.3.2 Drive Letter Protocol Initialization	11
3.1.4 Higher-Layer Triggered Events	11
3.1.4.1 Audio Level Protocol Events	11
3.1.4.2 Drive Letter Protocol Events	12
3.1.5 Message Processing Events and Sequencing Rules	12
3.1.6 Timer Events	12
3.1.7 Other Local Events	12
<b>4 Protocol Examples</b>	<b>13</b>
4.1 Audio Level Protocol initialization and change	13
4.2 Drive Letter Protocol initialization and change	13
<b>5 Security</b>	<b>14</b>
5.1 Security Considerations for Implementers	14
5.2 Index of Security Parameters	14
<b>6 Appendix A: Product Behavior</b>	<b>15</b>
<b>7 Change Tracking</b>	<b>16</b>
<b>8 Index</b>	<b>17</b>

# 1 Introduction

This document describes an extension to the RDP dynamic virtual channel protocol. The RDP dynamic virtual channel protocol allows information to be passed between a remote desktop connection client device and a session on a remote host computer. This extension provides a mechanism for clients to be notified when the **audio level** is changed and/or when a drive letter(2) is assigned to a USB storage device that is redirected from the client to the session. The extension provides a mechanism for the client to read the audio level and/or drive letter(2) from the session. It is assumed that this information will be stored in non-volatile storage so that if the client is disconnected and rebooted it will retain the values. When the client is later connected to a session on a remote session host the extension provides a mechanism for the client to send the audio level and/or drive letter(2) information to the session and initialize those settings to the stored values. The goal of this functionality is to make a remote desktop client behavior similar to the behavior of a standalone Windows client PC.

## 1.1 Glossary

The following terms are defined in [\[MS-GLOS\]](#):

### **drive letter (2)**

The following terms are specific to this document:

**audio level:** The relative volume level, expressed as a percentage (0-100) of a speaker and/or microphone level. The device must be physically connected to a client device and then logically connected to a session that the client connects to using the RDP protocol.

**dynamic virtual channel:** A transport used for communication between an RDP client and server over a main data connection as specified in [\[MS-RDPEDYC\]](#).

**virtual channel:** A transport used for communication between a client and a server component over a main data connection, in 1600-byte chunks, as specified in Static Virtual Channels in [\[MS-RDPBCGR\]](#).

**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.

### 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](mailto:dochelp@microsoft.com). We will assist you in finding the relevant information.

[MSDN-EDataFlow] Microsoft Corporation, "EDataFlow enumeration", [http://msdn.microsoft.com/en-us/library/windows/desktop/dd370828\(v=vs.85\).aspx](http://msdn.microsoft.com/en-us/library/windows/desktop/dd370828(v=vs.85).aspx)

[MS-RDPEDYC] Microsoft Corporation, "[Remote Desktop Protocol: Dynamic Channel Virtual Channel Extension](#)".

[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>

## 1.2.2 Informative References

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

## 1.3 Overview

This extension to the RDP **virtual channels** protocol allows an RDP (remote desktop connection) client device's behavior, with respect to audio levels and drive letters(2), to mimic a Windows client PC session. The following sections provide an audio level and drive letter(2) scenarios.

### Audio level scenario

For example, a user logs onto a PC running a Windows client operating system, plugs in a headset, and finds the level is too loud. The user can lower the audio level by using the Windows user interface. If the audio level was initially set to 100%, the user might change it to 50% to get to a comfortable volume. If the user logs out, reboots the computer, and logs back on, the volume will still be set to 50%.

Contrast that to the experience of a user logging onto a remote session using a thin client. The user adjusts the audio level to 50%, but if the user logs out and back on, by default the audio level is always set back to 100%. This requires the user to re-adjust the audio level every time she logs off on. (This is also true for disconnecting and reconnecting to a session.) With the extension to the virtual channel protocol defined in this document, the audio level settings are saved on the client and each time the device connects to a remote session, the audio level will keep its preset value.

### Drive letter scenario

For another example, a user logs onto a PC running a Windows client operating system, plugs a USB storage device into the PC, assigns it the drive letter(2) *N:*, and then configures the system to automatically and periodically back up the user's folder onto the USB storage device which has the letter *N:* assigned to it. If the user then reboots the computer and logs back on, the USB storage device will still be assigned *N:* and the backups will continue to occur without problems.

Contrast that to the experience of a user logging on to a remote session using a thin client. The user sets the drive letter(2) to *N:* and the backups can begin, but when the user logs off and back on, the drive letter(2) has now been assigned the next available letter by the session (for example, the next available drive letter(2) *G:* if the host server already has letters A through F assigned to drives). This will cause the backup to fail and require the user to reset the drive letter(2) to *N:* every time he logs off and back on. With this extension to the virtual channel protocol, the drive letter(2) settings for a specific storage device will be remembered on the client, and each time the device connects to a remote session, the drive letter(2) will keep its preset value.

## 1.4 Relationship to Other Protocols

The Audio Level and Drive Letter Persistence Virtual Channel Extension is implemented over RDP Dynamic Virtual Channels, as defined in [\[MS-RDPEDYC\]](#).

## 1.5 Prerequisites/Preconditions

None.

## **1.6 Applicability Statement**

This protocol is applicable to scenarios where the implementation is required to persist audio volume settings and drive letter(2) mappings for RDP sessions on a per client basis, as opposed to a per user basis.

## **1.7 Versioning and Capability Negotiation**

## **1.8 Vendor-Extensible Fields**

None.

## **1.9 Standards Assignments**

None.

## 2 Messages

### 2.1 Transport

This protocol is designed to operate over a **dynamic virtual channel**, as specified in [\[MS-RDPEDYC\]](#). The virtual channel name for audio levels is "WMSAud" and for drive letters(2) is "WMSDL". The Remote Desktop Protocol layer manages the creation, setup, and transmission of data over the virtual channel. These virtual channels MUST be used to establish connections and exchange audio level or drive letter(2) information.

### 2.2 Message Syntax

The following sections contain Remote Desktop Protocol: Audio Level and Drive Letter Persistence Virtual Channel Extension message syntax.

#### 2.2.1 SAE\_Started

- The SAE\_Started message is sent from the server to the client to initiate the protocol. It signals that the server is initializing a new RDP session and requires the initial audio volume settings for the session. The client MUST respond with a SAE\_VolumeChange message for each dataflow (as defined in [\[MSDN-EDataFlow\]](#)) for which it has a persisted value cached.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
eEvent (0x00000001)																															

**eEvent(4 bytes):** A 32-bit unsigned integer that specifies message type. The value for SAE\_Started is 0x00000001.

#### 2.2.2 SAE\_VolumeChange

- When sent from the client to the server, the SAE\_VolumeChange message indicates a request to set the volume setting for a specific dataflow (as defined in [\[MSDN-EDataFlow\]](#)) to the specified level. When sent from the server to the client, it indicates that the volume setting for a specific dataflow has been changed to the specified level.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
eEvent (0x00000002)																															
eDataFlow																															
lVolume																															
fMuted																															

**eEvent(4 bytes):** A 32-bit unsigned integer that specifies message type. The value for SAE\_VolumeChange is 0x00000002.

**eDataFlow (4 bytes):** A 32-bit unsigned integer that specifies the specific volume setting. The **eDataFlow** field MUST be one of the following values.

Value	Meaning
eRender 0x00000000	The specified volume level affects the render or playback volume.
eCapture 0x00000001	The specified volume level affects the capture or recording volume.

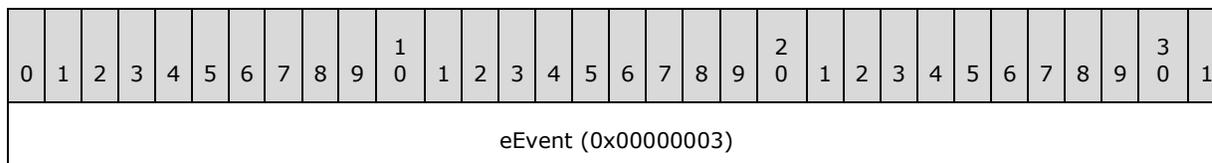
**IVolume (4 bytes):** A 32-bit float. The volume level is normalized to the range of 0.0 to 1.0, where 0.0 is the minimum level and 1.0 is the maximum level. Within this range, the relationship of the normalized volume level to the attenuation of signal amplitude is described by a nonlinear, audio-tapered curve.<1>

**fMuted (4 bytes):** A 32-bit unsigned integer that specifies if the dataflow (as defined in [\[MSDN-EDataFlow\]](#)) is turned off or disabled.

Value	Meaning
FALSE0x00000000	The specified dataflow is not disabled.
TRUE0x00000001	The specified dataflow is disabled.

### 2.2.3 SAE\_RemoteConnect

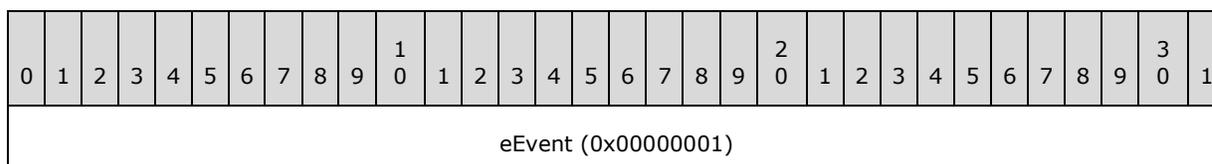
- The SAE\_RemoteConnect message is sent from the server to the client to initiate the protocol. It signals that the server has reconnected to an existing RDP session and requires the initial audio volume settings for the session. The client MUST respond with a SAE\_VolumeChange message for each dataflow (as defined in [\[MSDN-EDataFlow\]](#)) for which it has a persisted value cached.



**eEvent(4 bytes):** A 32-bit unsigned integer that specifies message type. The value for SAE\_RemoteConnect is 0x00000003.

### 2.2.4 SADLE\_Started

- The SADLE\_Started message is sent from the server to the client to initiate the protocol. It signals that the server is initializing an RDP session and requires the **drive letter** mapping settings for the session. The client MUST respond with a SADLE\_SerializedCache message if it has persisted drive letter mappings cached.



**eEvent(4 bytes):** A 32-bit unsigned integer that specifies message type. The value for SADLE\_Started is 0x00000001.

## 2.2.5 SADLE\_SerializedCache

The SADLE\_SerializedCache message is sent from the client to the server in response to a SADLE\_Started message to restore persisted drive letter mappings for use in an RDP session. This message is sent from the server to the client whenever the drive letter mappings in the RDP session are changed so that they can be persisted for future sessions.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
eEvent (0x00000002)																															
cbMessageData																															
cbNameValueData																															
cNameValuePairs																															
Value name 1 (variable)																															
Value 1 (variable)																															
...																															
Value name n (variable)																															
Value n (variable)																															
Unused (variable)																															

**eEvent (4 bytes):** An unsigned integer that specifies message type. The value for SADLE\_SerializedCache is 0x00000002.

**cbMessageData (4 bytes):** An unsigned integer that specifies the size of the message data.

**cbNameValueData (4 bytes):** An unsigned integer that specifies the size of the message data.

**cNameValuePairs (4 bytes):** An unsigned integer that specifies the count of pairs of Value names and Values in this message.

**Value name 1 (variable length):** A NAME\_DATA structure. Each instance of this structure is byte-aligned and cannot align to a WORD or DWORD boundary.

**Value 1 (variable length):** A VALUE\_DATA structure. Each instance of this structure is byte-aligned and cannot align to a WORD or DWORD boundary.

### NAME\_DATA

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Name marker (0x18181818)																															
cchName																															
szName																...															

**Value marker(4 bytes):** The constant 0x18181818.

**cchName(4 bytes):** The length of **szName**, in bytes.

**szName (variable, cchName WCHARs):** The value's name, as a Unicode string.

#### VALUE\_DATA

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Value marker (0x27272727)																															
Value type																															
cbValue																															
rgValue								...																							

**Value marker(4 bytes):** The constant 0x27272727.

**Value type (4 bytes):** The registry value type of this value, for example, REG\_BINARY.

**cbValue (4 bytes):** The length of **rgValue**, in bytes.

**rgValue (variable, cbValue bytes):** The value data.

## 3 Protocol Details

### 3.1 Common Details

The protocol is designed to allow an RDP client to be notified of changes to session configuration settings so that those settings may be persisted across sessions and allowed to restore those settings while the session is initializing.

#### 3.1.1 Abstract Data Model

None.

#### 3.1.2 Timers

None.

#### 3.1.3 Initialization

The protocol initializes after an RDP client/server session has been established and the required virtual channel transport has been created.

##### 3.1.3.1 Audio Level Protocol Initialization

The server MUST send an SAE\_Started message to the client if the RDP session is being initially created, or it MUST send an SAE\_RemoteConnect message if connecting to an existing RDP session. Upon receipt of either of these messages, the RDP client SHOULD reply with an SAE\_VolumeChange message containing the same information as the last received SAE\_VolumeChange message. If the RDP client has no persisted configuration data, then no response is sent.

##### 3.1.3.2 Drive Letter Protocol Initialization

The server MUST create a volatile Windows registry key where changes will be stored (HKCU\Software\Microsoft\Terminal Server\[session id]\Drive Letter Cache, where [session id] is the decimal RDP session ID). The presence of this key signals to RDP that USB Redirection of Mass Storage devices should search a cache of device-to-drive-letter mappings when assigning drive letters(2) to newly redirected devices. The server MUST then send a SADLE\_Started message to the client. Upon receiving the SADLE\_STARTED message, the RDP client SHOULD reply with a SADLE\_SerializedCache message containing the same information as the last received SADLE\_SerializedCache message. If the RDP client has no persisted configuration data, then no response should be sent. The RDP client MUST make no attempt to redirect USB Mass Storage devices prior to the protocol being initialized.

#### 3.1.4 Higher-Layer Triggered Events

The server MUST monitor the settings for changes and notify the client by sending the appropriate configuration message.

##### 3.1.4.1 Audio Level Protocol Events

The server MUST monitor the Master Volume Level for changes which can be done via the Core Audio Interfaces including IAudioEndpointVolume. Changes to the Master Volume Level MUST be sent to the client as a SAE\_VolumeChange message.

### 3.1.4.2 Drive Letter Protocol Events

The server MUST monitor the Windows registry key HKCU\Software\Microsoft\Terminal Server\[session id]\Drive Letter Cache for changes (where [session id] is the decimal RDP session ID). When the key changes, all DWORD Registry Values contained in the key MUST be enumerated and the value name/DWORD value pairs are stored packed into a single contiguous block, which is then sent to the RDP client using a SADLE\_SerializedCache message.

### 3.1.5 Message Processing Events and Sequencing Rules

The protocol has two classes of messages, protocol initialization messages, and data transmission messages. Protocol initialization messages are always sent from the RDP server session to the RDP client when the session is first established or has reconnected. The client responds with the appropriate data transmission message if it has any cached data. The client MUST never send data transmission messages to the server except in response to a protocol initialization message.

After the protocol initialization message has been received, the server MUST send a data transmission message to the client every time the data is changed in the RDP session. When the client receives a data transmission message, it MUST discard any old cached copy of the data and cache the current data.

### 3.1.6 Timer Events

None.

### 3.1.7 Other Local Events

None.

## 4 Protocol Examples

### 4.1 Audio Level Protocol initialization and change

1. An RDP client that has persisted audio level data for both the render and capture dataflows (as defined in [\[MSDN-EDataFlow\]](#)) creates a new session on an RDP server.
2. The RDP server begins monitoring the RDP audio device for master volume level changes.
3. The RDP server sends an SAE\_Started message to the client.
4. The RDP client retrieves persisted render dataflow audio level data and sends an SAE\_VolumeChange message to the server.
5. The RDP server changes the master render audio volume to the level in the SAE\_VolumeChange message.
6. The RDP client retrieves persisted capture dataflow audio level data, and sends an SAE\_VolumeChange message to the server.
7. The RDP server changes the master capture audio volume to the level in the SAE\_VolumeChange message.
8. The user changes the render audio volume level in the RDP session.
9. The RDP server detects the change, and sends an SAE\_VolumeChange message to the RDP client.
10. The RDP client updates its persisted render volume settings to those in the SAE\_VolumeChange message.

### 4.2 Drive Letter Protocol initialization and change

1. An RDP client that has persisted drive letter(2) data creates a new session with ID 3 on an RDP server.
2. The RDP server creates a volatile Windows Registry Key: HKCU\Software\Microsoft\Terminal server\3\Drive Letter Cache.
3. The RDP server begins monitoring the registry key for changes.
4. The RDP server sends a SADLE\_Started message to the client.
5. The RDP client retrieves persisted drive-letter data and sends a SADLE\_SerializedCache message to the server.
6. The RDP server unpacks the registry value name/value pairs and recreates the registry values under the key HKCU\Software\Microsoft\Terminal server\3\Drive Letter Cache.
7. The RDP server adds new value under HKCU\Software\Microsoft\Terminal server\3\Drive Letter Cache.
8. The RDP server detects the change and sends a SADLE\_SerializedCache message to the RDP client.
9. The RDP client updates its persisted-drive-letter data to match that in the SAE\_ SerializedCache message.

## **5 Security**

### **5.1 Security Considerations for Implementers**

None.

### **5.2 Index of Security Parameters**

None.

## 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 8 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 2.2.2:](#) Note that the shape of the curve might change in future versions of Windows.

## 7 Change Tracking

No table of changes is available. The document is either new or has had no changes since its last release.

## 8 Index

### A

[Applicability](#) 6

### C

[Change tracking](#) 16

Client

[overview](#) 11

### F

[Fields - vendor-extensible](#) 6

### G

[Glossary](#) 4

### I

[Implementer - security considerations](#) 14

[Index of security parameters](#) 14

[Informative references](#) 5

[Introduction](#) 4

### M

Messages

[SADLE SerializedCache message](#) 9

[SADLE Started message](#) 8

[SAE RemoteConnect message](#) 8

[SAE Started message](#) 7

[SAE VolumeChange message](#) 7

[transport](#) 7

### N

[Normative references](#) 4

### O

[Overview \(synopsis\)](#) 5

### P

[Parameters - security index](#) 14

[Preconditions](#) 5

[Prerequisites](#) 5

[Product behavior](#) 15

Proxy

[overview](#) 11

### R

References

[informative](#) 5

[normative](#) 4

[Relationship to other protocols](#) 5

### S

[SADLE SerializedCache message](#) 9

[SADLE Started message](#) 8

[SAE RemoteConnect message](#) 8

[SAE Started message](#) 7

[SAE VolumeChange message](#) 7

Security

[implementer considerations](#) 14

[parameter index](#) 14

Server

[overview](#) 11

[Standards assignments](#) 6

### T

[Tracking changes](#) 16

[Transport](#) 7

### V

[Vendor-extensible fields](#) 6