[MS-NCT-Diff]:

Network Cost Transfer Protocol

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Revision Summary

Date	Revision History	Revision Class	Comments
7/14/2016	1.0	New	Released new document.
6/1/2017	2.0	Major	Significantly changed the technical content.
9/15/2017	3.0	Major	Significantly changed the technical content.
12/1/2017	3.0	None	No changes to the meaning, language, or formatting of the technical content.

Table of Contents

1 Introduction

The Network Cost Transfer Protocol enables an IEEE 802.11 access point (AP) to communicate the network cost and tethering identification information about the AP ~~to clients~~type to wireless clients. It defines two vendor-specific Information Elements within the 802.11 beacon and probe response to relay this information to the client.

Sections 1.5, 1.8, 1.9, 2, and 3 of this specification are normative. All other sections and examples in this specification are informative.

1.1 Glossary

This document uses the following terms:

802.11 Access Point (AP): Any entity that has IEEE 802.11 functionality and provides access to the distribution services, via the wireless medium for associated stations (STAs).

Beacon: A management frame that contains all of the information required to connect to a network. In a WLAN, Beacon frames are periodically transmitted to announce the presence of the network.

~~**client**: Synonym for client computer.~~

~~**information element (IE)**: (1) In a Wi-Fi Protected Setup (WPS) scenario, descriptive information consisting of informative type-length-values that specify the possible and currently deployed configuration methods for a device. The IE is transferred and added to the Beacon and Probe Response frames, and optionally to the Probe Request frame and associated request and response messages.~~

~~(2)~~**information element (IE)**: A unit of information transmitted as part of the management frames in the IEEE 802.11 [IEEE802.11-2012] protocol. Wireless devices, such as access points, communicate descriptive information about themselves in the form of one or more IEs in their management frames.

~~**Media**~~**Medium Access Control (MAC~~) address~~:)**: A ~~hardware address provided by the network interface vendor that uniquely identifies each interface on a physical network for~~ data communication ~~with other interfaces, as specified in [IEEE802.3]. It is used by the media access control~~ protocol sublayer that is part of the seven-layer OSI model data-link layer ~~of a network connection.~~

~~**Message Authentication Code (MAC)**: A message authenticator computed through the use of a symmetric key. A MAC algorithm accepts a secret key~~(layer 2). It provides addressing and ~~a data buffer, and outputs a MAC. The data and MAC can then be sent~~channel access control mechanisms that make it possible for several terminals or network nodes to ~~another party, which can verify the integrity and authenticity of the data by using the same secret key and the same MAC algorithm.~~communicate within a multipoint network, typically a local area network (LAN).

~~**metered network**: A network on which data usage is measured and limited.~~

network cost: Information about how the Internet service provider bills customers for data usage on the network.

organizationally unique identifier (OUI): A unique 24-bit string that uniquely identifies a vendor, manufacturer, or organization on a worldwide l basis, as specified in [IEEE-OUI]. The OUI is used to help distinguish both physical devices and software, such as a network protocol, that belong to one entity from those that belong to another.

Probe Response: A frame that contains the advertisement IE for a device. The Probe Response is sent in response to a Probe Request. The Probe Response frame is defined in the Wi-Fi Peer-to-Peer (P2P) Specification v1.2 [WF-P2P1.2] section 4.2.3.

tether: Enables a device to gain access to the Internet by establishing a connection with another device that is connected to the Internet.

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.

[IEEE-OUI] IEEE Standards Association, "IEEE OUI Registration Authority", February 2007, http://standards.ieee.org/regauth/oui/oui.txt

[IEEE802.11-2007] Institute of Electrical and Electronics Engineers, "Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications", ANSI/IEEE Std 802.11-2007, http://standards.ieee.org/getieee802/download/802.11-2007.pdf

Note There is a charge to download this document.

[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

None.

1.3 Overview

The Network Cost Transfer Protocol enables an IEEE 802.11 access point (AP) to communicate the network cost and information about the AP type to clients. It defines two vendor-specific information elements (IEs~~) (2~~), Network Cost and Tethering Identifier, within the 802.11 Beacon and Probe Response to relay this information to the client. Tethering allows a Windows device to share Internet connectivity from one interface over a Wi-Fi adapter, acting as a network to which other devices can connect.

Network Cost IE is used by clients to determine whether data transferred on that ~~particular~~specific connection is metered (section 2.2.1). The Tethering Identifier IE is used to differentiate tethering (device-based) networks from stand-alone APs (section 2.2.2). The difference can then be used to vary the experience in implementation-defined ways.

1.4 Relationship to Other Protocols

The Network Cost Transfer Protocol extends the IEEE802.11 standard, whose conventions are applied as specified in [IEEE802.11-2007]. The Network Cost Transfer Protocol introduces a specific use for one of that protocol's reserved information element types, and it defines additional ~~MAC~~Medium Access Control (MAC) layer abstract service primitives for managing the configuration, transmission, and receipt of these new information elements.

1.5 Prerequisites/Preconditions

The Network Cost Transfer Protocol requires APs to adhere to 802.11 standard specifications. The AP SHOULD have knowledge about the metered state of its network connection. This state may be explicitly configured, inferred from media type, or obtained using any other relevant means.

1.6 Applicability Statement

This protocol is only applicable to APs that support tethering. The client is required to support connecting to Wi-Fi networks. Lastly, the Tethering Identifier information element (IE) ~~(2)~~ only applies to multi-purpose devices capable of acting as access points, not to dedicated network hardware.

1.7 Versioning and Capability Negotiation

None.

1.8 Vendor-Extensible Fields

None.

1.9 Standards Assignments

Parameter	Value	Reference
OUI	00-50-F2	As specified in [IEEE-OUI]

2 Messages

2.1 Transport

The two vendor-specific information elements ~~(2)~~ in the Network Cost Transfer Protocol are transmitted as part of IEEE802.11 Beacons or Probe Responses. There are no requirements for the order of the information elements and it is not necessary that both be used at the same time.

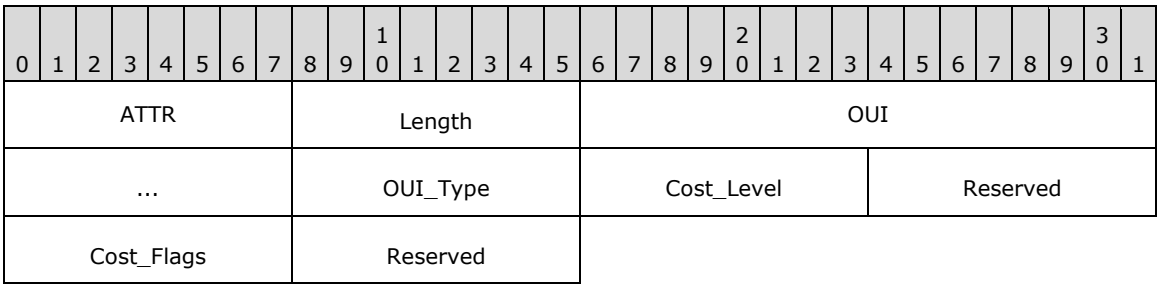
The format of information elements is specified in [IEEE802.11-2007] section 7.3.2. The format and processing of Beacon or Probe Response frames are also specified in [IEEE802.11-2007].

2.2 Message Syntax

The following sections specify Network Cost Transfer Protocol Message syntax.

2.2.1 Network Cost IE

The Network Cost information element (IE) ~~(2)~~ structure SHOULD<1> be used by clients to determine whether data transferred on that ~~particular~~specific connection is metered. The structure of the Network Cost IE is shown in the following packet.



ATTR - Attribute_ID (1 byte): Contains the ID of the element as specified [IEEE802.11-2007] section 7.3.2. It MUST contain a value of 221 (OxDD), identifying a vendor-specific element (as specified in [IEEE802.11-2007] table 26) in which the vendor is identified by an IEEE-issued OUI.

Length (1 byte): The total length of the subsequent fields. This value MUST be 0x08.

OUI - Organizationally Unique Identifier (OUI) **(3 bytes):** The IEEE-assigned OUI for Microsoft. The **OUI** field MUST contain a value of (00:50:F2) as specified in [IEEE-OUI].

OUI_Type (1 byte): A packet subtype within the universe specific to a ~~particular~~specific OUI value. For the Network Cost IE, the OUI Type MUST contain a value of 0x11.

Cost_Level (1 byte): A value indicating the metering type of the network connection, as specified in section 2.2.1.2.

Reserved (1 byte): SHOULD be 0.

Cost_Flags (1 byte): Flags that indicate possible states of the network connection, as specified in section 2.2.1.1.

Reserved (1 byte): SHOULD be 0.

2.2.1.1 Cost Flags

The following table shows the possible **cost flags** that can be represented in the IE:

Value	Name	Description
0x00	Unknown	The usage is unknown or unrestricted.
0x01	Over Data Limit	Usage has exceeded the data limit of the metered network; different network costs or conditions might apply.
0x02	Congested	The network operator is experiencing or expecting heavy load.
0x04	Roaming	The tethering connection is roaming outside the provider's home network or affiliates.
0x08	Approaching Data Limit	Usage is near the data limit of the metered network; different network costs or conditions might apply once the limit is reached.

If the AP is aware that any of these states applies to its network connection, it SHOULD indicate the corresponding flag in all Beacons and Probe Responses.

2.2.1.2 Cost Level

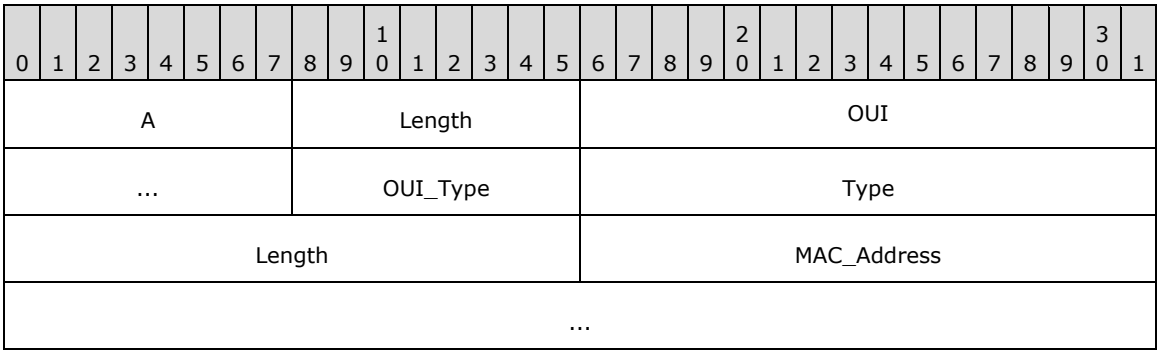
The following table shows the possible **cost levels** that can be represented in the IE:

Value	Name	Description
0x00	Unknown	The connection cost is unknown.
0x01	Unrestricted	The connection is unlimited and has unrestricted usage constraints.
0x02	Fixed	Usage counts toward a fixed allotment of data which the user has already paid for (or agreed to pay for).
0x04	Variable	The connection cost is on a per-byte basis.

The AP MUST indicate the cost level that most accurately describes the network's cost and metering type, based on configuration or other information sources.<2>

2.2.2 Tethering Identifier IE

The Tethering Identifier information element (IE~~) (2~~) SHOULD<3> be used to differentiate tethering (device-based) networks from stand-alone APs. The structure of the Tethering Identifier IE is shown in the following packet.



A - Attribute_ID (1 byte): Contains the ID of the element as specified [IEEE802.11-2007] section 7.3.2. It MUST contain a value of 221 (0xDD), identifying a vendor-specific element (as specified in [IEEE802.11-2007] table 26) in which the vendor is identified by an IEEE-issued OUI.

Length (1 byte): The length of the subsequent fields. This value MUST be 14 (0x0E).

OUI - Organizationally Unique Identifier (OUI) **(3 bytes):** The IEEE-assigned OUI for Microsoft. The **OUI** field MUST contain a value of (00:50:F2) as specified in [IEEE-OUI].

OUI_Type (1 byte): A packet subtype within the universe specific to a ~~particular~~specific OUI value. For the Tethering Identifier IE, the OUI Type MUST contain a value of 18 (0x12).

Type (2 bytes): Used to specify that the network is broadcasted as tethered. The **Type** field MUST contain a value of 43 (0x2B).

Length (2 bytes): Contains the length of the **MAC_Address** field in octets. This value MUST be 6 (0x06).

MAC_Address (6 bytes): Contains the Medium Access Control (MAC) address of the AP.

3 Protocol Details

3.1 AP Role Details

To compensate for an unreliable transmission over the wireless medium, the information elements ~~(2)~~ SHOULD be contained in each Beacon frame and Probe Response.

3.1.1 Abstract Data Model

None.

3.1.2 Timers

None.

3.1.3 Initialization

The 802.11 Access Point (AP) MUST have initial information about the cost state of the upstream flow of data and convey the appropriate flag in the IE. This information may be administratively configured, inferred from media type, or acquired by other means.

3.1.4 Higher-Layer Triggered Events

If the metering state of the network changes, the AP SHOULD immediately reflect the new value in all future ~~beacons~~Beacons and ~~probe responses~~Probe Responses.

3.1.5 Message Processing Events and Sequencing Rules

None.

3.1.6 Timer Events

None.

3.1.7 Other Local Events

None.

3.2 Client Role Details

The client acquires information about the network during network discovery and connection. The client role is triggered when in range of an 802.11 Access Point (AP) and finding the relevant information element ~~(2)~~ in the Beacon or Probe Response frame.

3.2.1 Abstract Data Model

For each AP to which the client is currently connected, the client SHOULD maintain the current estimated cost state and network type.

3.2.2 Timers

None.

3.2.3 Initialization

None.

3.2.4 Higher-Layer Triggered Events

When in range of an 802.11 Access Point (AP), the client SHOULD inspect the Beacon and Probe Response frames for the information elements ~~(2)~~ defined by this protocol. If they are present, they SHOULD inform the client's data about the network. If not, the client may infer value using implementation-specific defaults.

3.2.5 Message Processing Events and Sequencing Rules

If these information elements ~~(2)~~ are found, the local knowledge of the current network SHOULD be updated with the information they contain. Use of this information is implementation-dependent and handled by higher-layer protocols.

3.2.6 Timer Events

None.

3.2.7 Other Local Events

None.

4 Protocol Examples

The following table shows some sample cost attribute values:

Name	Cost Flag	Cost Level	Description
Default WLAN	0x00	0x01	Unrestricted connection; standard WLAN backed by fixed broadband.
Portable Hotspot Default	0x00	0x02	Metered network; limit unknown or not yet reached; reasonable default for mobile broadband connections without other information.
Over Limit / Throttled	0x01	0x01	User has exceeded data limit; speed is reduced, but no further usage limitation applies.
Over Limit / Charges	0x01	0x04	User has exceeded data limit; additional usage incurs incremental charges.
Portable Hotspot / Roaming	0x04	0x04	Connection is roaming; incremental charges apply due to network state.

The following is an example of the Network Cost IE conveyed in a Beacon or Probe Response frame for the over data limit cost flag.

Offset (hex)	Value (hex)	Field
0000	DD	Element ID
0001	08	Length
0002	00	OUI (Microsoft)
0003	50	
0004	F2	
0005	11	OUI Type
0006	02	Cost Level (Fixed)
0007	00	Reserved
0008	01	Cost Flag (Over Data Limit)
0009	00	Reserved

Figure 1: Example of the Network Cost IE

The following is an example of the Tethering Identifier IE conveyed in a Beacon or Probe Response frame.

Offset (hex)	Value (hex)	Field
0000	DD	Element ID
0001	0E	Length
0002	00	OUI (Microsoft)
0003	50	
0004	F2	
0005	12	OUI Type
0006	00	Type
0007	2B	
0008	00	Length
0009	06	
0010	68	MAC Address
0011	5D	
0012	43	
0013	0B	
0014	66	
0015	12	

Figure 2: Example of the Tethering Identifier IE

5 Security

5.1 Security Considerations for Implementers

The information transferred by this protocol is transmitted unencrypted, even for a secured AP. Do not include sensitive information.

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 updates to those products.

- 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

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 2.2.1: Windows 8 and Windows Server 2012 could consume but not generate the IE. They implemented only the client role.

<2> Section 2.2.1.2: Windows acting as APs always set the cost to Fixed with no flags set, regardless of the actual state.

<3> Section 2.2.2: Windows 8 and Windows Server 2012 did not implement this IE.

7 Change Tracking

~~This section identifies~~ No table of changes ~~that were made to this~~ is available. The document is either new or has had no changes since ~~the~~its 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**~~
~~6 Appendix A: Product Behavior~~	~~Added Windows Server to the applicable products list.~~	~~Major~~

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