



**IEEE 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**

**Amendment 7: Extensions to
Direct-Link Setup (DLS)**

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997, USA

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IEEE Std 802.11r™-2008, IEEE Std 802.11y™-2008,
IEEE Std 802.11w™-2009, IEEE Std 802.11n™-2009,
and IEEE Std 802.11ac™-2010)



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Approved 30 September 2010
IEEE-SA Standards Board

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Abstract: This amendment provides direct-link setup enhancements to the IEEE 802.11 MAC and PHY, extending direct-link setup to be independent of the access point (AP), and adding power save capabilities. The direct-link setup is made independent of the AP by tunneling the protocol messages inside data frames.

Keywords: channel switching, direct link, off-channel direct link, power saving, tunneled direct-link setup

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This introduction is not part of IEEE Std 802.11z-2010, IEEE Standard for Information Technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless Medium Access Control (MAC) and Physical Layer (PHY) specifications—Amendment 7: Extensions to Direct-Link Setup.

This document provides amendments to the IEEE 802.11 PHY/MAC layers related to direct-link setup.

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2. Normative references

Insert the following new reference in alphabetical order:

IETF RFC 1042, A Standard for the Transmission of IP Datagrams over IEEE 802[®] Networks, J. Postel, J. Reynolds, February 1988.

3. Definitions

Change definition 3.45 as follows:

3.45 dynamic frequency selection (DFS) owner: A station (STA) in an independent basic service set (IBSS) or off-channel TDLS direct link that takes responsibility for selecting the next channel after radar is detected operating in a channel. In an IBSS, it cannot be guaranteed that there will be a single DFS owner at any particular time and the protocol is robust to this situation.

Insert the following new definitions 3.z1 through 3.z15 in alphabetical order:

3.z1 access point (AP) path: Path between two tunneled direct-link setup (TDLS) peer stations (STAs) via the AP.

3.z2 base channel: Channel on which the tunneled direct-link setup (TDLS) peer station (STA) is associated with an access point (AP).

3.z3 off-channel: Channel that is not the base channel.

3.z4 peer unscheduled automatic power save delivery (peer U-APSD): A power save mode based on unscheduled service periods that may be used between two stations (STAs) that have set up a tunneled direct-link setup (TDLS) direct link.

3.z5 peer unscheduled automatic power save delivery [peer U-APSD (PU)] buffer station (STA): A tunneled direct-link setup (TDLS) peer STA that buffers traffic for a PU sleep STA.

3.z6 peer unscheduled automatic power save delivery [peer U-APSD (PU)] sleep station (STA): A tunneled direct-link setup (TDLS) STA that entered power save mode on a TDLS direct link and that is using peer U-APSD for the delivery of buffered traffic.

3.z7 tunneled direct-link setup (TDLS): A protocol that uses a specific Ethertype encapsulation to TDLS frames through an access point (AP) to establish a TDLS direct link. TDLS is separate from direct-link setup (DLS).

3.z8 tunneled direct-link setup (TDLS) direct link: Direct link between two non-AP stations (STAs) that has been established using the TDLS protocol.

3.z9 tunneled direct-link setup (TDLS) initiator station (STA): A STA that transmits a TDLS Setup Request frame or a TDLS Discovery Request frame.

3.z10 tunneled direct-link setup (TDLS) peer power save mode (PSM): A power save mode that is based on periodically scheduled service periods, which may be used between two stations (STAs) that have set up a TDLS direct link.

3.z11 tunneled direct-link setup (TDLS) peer power save mode (PSM) initiator: A station (STA) that transmits a tunneled direct-link setup (TDLS) Peer PSM request frame.

3.z12 tunneled direct-link setup (TDLS) peer power save mode (PSM) responder: A station (STA) that transmits a TDLS Peer PSM response frame.

3.z13 tunneled direct-link setup (TDLS) peer station (STA): A STA with a tunneled direct-link setup (TDLS) direct link.

3.z14 tunneled direct-link setup (TDLS) power save mode (PSM): TDLS peer PSM or peer unscheduled automatic power save delivery (U-APSD).

3.z15 tunneled direct-link setup (TDLS) responder station (STA): A STA that receives or is the intended recipient of a TDLS Setup Request frame or TDLS Discovery Request frame.

3A. Definitions specific to IEEE 802.11

Change definition 3A.26 as follows:

3A.26 IDO STA: A STA that is the DFS Owner of an IBSS or off-channel TDLS direct link that is operating on a channel within a regulatory class that has a value of 20 or 40 for the entry in the column labeled “Channel Spacing (MHz)” and that has a value of 5 for the entry in the column labeled “Channel Starting Frequency (GHz)” of any of the tables found in Annex J.

4. Abbreviations and acronyms

Insert the following new abbreviations and acronyms into Clause 4 in alphabetical order:

IE	information element
peer U-APSD	peer unscheduled automatic power save delivery
PTI	peer traffic indication
PU	peer U-APSD
TDLS	tunneled direct-link setup
TDLS peer PSM	tunneled direct-link setup peer power save mode
TPK	TDLS Peer Key
TPKSA	TDLS Peer Key Security Association

5. General description

5.2 Components of the IEEE 802.11 architecture

Insert the following new subclause after 5.2.9:

5.2.10 Tunneled direct-link setup

Tunneled direct-link setup (TDLS) is characterized by the use of signaling frames that are encapsulated in data frames so that the signaling frames can be transmitted through an AP transparently. Therefore, unlike

with DLS, the AP does not need to be direct-link aware, nor does it have to support the same set of capabilities that will be used on the direct link, in order for TDLS to be used. To allow a STA to enter a TDLS power save mode, TDLS provides two power save mechanisms: peer U-APSD and TDLS peer PSM. TDLS allows STAs to use the TDLS Peer Key Handshake to provide data confidentiality and message authentication. STAs that set up a TDLS direct link remain associated with the AP, but have the option of transmitting frames directly to the other TDLS peer STA. TDLS is separate from DLS.

7. Frame formats

7.1 MAC frame formats

7.1.3 Frame fields

7.1.3.1 Frame Control field

7.1.3.1.7 More Data field

Insert the following paragraph at the end of 7.1.3.1.7:

If a STA with TDLS peer PSM enabled sets the More Data Ack subfield to one in its QoS Capability information element of its transmitted TDLS Setup Request frame or TDLS Setup Response frame, then a TDLS peer STA may indicate that it has a pending transmission for the STA by setting the More Data field to one in ACK frames transmitted to the STA.

7.1.3.5 QoS Control field

Change Table 7-4 as follows:

Table 7-4—QoS Control field

Applicable frame (sub) types	Bits 0–3	Bit 4	Bits 5–6	Bit 7	Bits 8–15
QoS CF-Poll and QoS CF-Ack+CF-Poll frames sent by HC	TID	EOSP	Ack Policy	Reserved	TXOP limit
QoS Data+CF-Poll and QoS Data+CF-Ack+CF-Poll frames sent by HC	TID	EOSP	Ack Policy	A-MSDU Present	TXOP limit
QoS Data and QoS Data+CF-Ack frames sent by HC	TID	EOSP	Ack Policy	A-MSDU Present	AP PS Buffer State
QoS Null frames sent by HC	TID	EOSP	Ack Policy	Reserved	AP PS Buffer State
QoS Data and QoS Data+CF-Ack frames sent by non-AP STAs <u>that are not a PU buffer STA or a PU sleep STA</u>	TID	0	Ack Policy	A-MSDU Present	TXOP duration requested
	TID	1	Ack Policy	A-MSDU Present	Queue size
QoS Null frames sent by non-AP STAs <u>that are not a PU buffer STA or a PU sleep STA</u>	TID	0	Ack Policy	Reserved	TXOP duration requested
	TID	1	Ack Policy	Reserved	Queue size
<u>QoS Data and QoS Data+CF-Ack frames sent by PU buffer STAs</u>	<u>TID</u>	<u>EOSP</u>	<u>Ack Policy</u>	<u>A-MSDU Present</u>	<u>Reserved</u>
<u>QoS Null frames sent by PU buffer STAs</u>	<u>TID</u>	<u>EOSP</u>	<u>Ack Policy</u>	<u>Reserved</u>	<u>Reserved</u>
<u>QoS Data and QoS Data+CF-Ack frames sent by PU sleep STAs</u>	<u>TID</u>	<u>Reserved</u>	<u>Ack Policy</u>	<u>A-MSDU Present</u>	<u>Reserved</u>
<u>QoS Null frames sent by PU sleep STAs</u>	<u>TID</u>	<u>Reserved</u>	<u>Ack Policy</u>	<u>Reserved</u>	<u>Reserved</u>

7.3 Management frame body components

7.3.1 Fields that are not information elements

7.3.1.7 Reason Code field

Insert the following two new reason codes into Table 7-22, and update the reserved values accordingly:

Table 7-22—Reason codes

Reason code	Meaning
25	TDLS direct-link teardown due to TDLS peer STA unreachable via the TDLS direct link
26	TDLS direct-link teardown for unspecified reason

7.3.1.9 Status Code field

Insert six new status codes into Table 7-23 as follows, and update the reserved values accordingly:

Table 7-23—Status codes

Status code	Meaning
2	TDLS wakeup schedule rejected but alternative schedule provided
3	TDLS wakeup schedule rejected
5	Security disabled
6	Unacceptable lifetime
7	Not in same BSS
72	Invalid contents of RSNIE

7.3.1.11 Action field

Insert one new Category Value in Table 7-24 in the correct position to preserve ordering by the “Code” column, and update the reserved range of values appropriately.

Table 7-24—Category values

Code	Meaning	See subclause
12	TDLS	7.4.11

7.3.2 Information elements

In Table 7-26, insert five new information elements as follows, and renumber the reserved values accordingly:

Table 7-26—Element IDs

Information element	Element ID	Length (in octets)	Extensible
Link Identifier (see 7.3.2.62)	101	20	Yes
Wakeup Schedule (see 7.3.2.63)	102	20	Yes
Channel Switch Timing (see 7.3.2.64)	104	6	Yes
PTI Control (see 7.3.2.65)	105	5	Yes
PU Buffer Status (see 7.3.2.66)	106	3	Yes

7.3.2.25 RSN information element

7.3.2.25.1 Cipher suites

Insert one new entry in Table 7-32 as follows, and update the reserved values accordingly:

Table 7-32—Cipher suite selectors

OUI	Suite type	Meaning
00-0F-AC	7	Group addressed traffic not allowed

7.3.2.25.2 AKM suites

Insert one new entry in Table 7-34 as follows, and update the reserved values accordingly:

Table 7-34—AKM suite selectors

OUI	Suite type	Authentication type	Key management type
00-0F-AC	7	TDLS	TPK Handshake

7.3.2.27 Extended Capabilities information element

Insert six new rows to Table 7-35a as follows, and renumber the reserved values accordingly:

Table 7-35a—Capabilities field

Bit	Information	Notes
28	Peer U-APSD Buffer STA Support	The Peer U-APSD Buffer STA Support subfield indicates support for the Peer U-APSD Buffer STA function, as defined in 11.2.1.14. When dot11TDLSPeerUAPSDBufferSTAActivated is true, and to indicate support for Peer U-APSD on this link, the Peer U-APSD Buffer STA Support subfield is set to one. Otherwise, the Peer U-APSD Buffer STA Support subfield is set to zero to indicate that this capability is not supported on this link.
29	TDLS Peer PSM Support	The TDLS Peer PSM Support subfield indicates support for TDLS Peer PSM, as defined in 11.2.1.13. When dot11TDLSPeerPSMActivated is true, and to indicate support for TDLS Peer PSM on this link, the TDLS Peer PSM Support subfield is set to one. Otherwise, the TDLS Peer PSM Support subfield is set to zero to indicate that this capability is not supported on this link.
30	TDLS channel switching	When dot11TDLSChannelSwitchingActivated is true, and to indicate that the STA supports TDLS with TDLS Channel Switching on this link as described in 11.21, the TDLS Channel Switching capability subfield is set to one. Otherwise, the TDLS Channel Switching subfield is set to zero to indicate that this capability is not supported on this link.
37	TDLS Support	The TDLS Support subfield indicates support for TDLS, as defined in 11.21. When dot11TunneledDirectLinkSetupImplemented is true, this field is set to one to indicate support for TDLS. The field is set to zero otherwise, to indicate that TDLS is not supported.
38	TDLS Prohibited	The TDLS Prohibited subfield indicates whether the use of TDLS is prohibited. The field is set to one to indicate that TDLS is prohibited and to zero to indicate that TDLS is allowed.
39	TDLS Channel Switching Prohibited	The TDLS Channel Switching Prohibited subfield indicates whether the use of TDLS Channel Switching is prohibited. The field is set to one to indicate that TDLS Channel Switching is prohibited and to zero to indicate that TDLS Channel Switching is allowed.

Insert five new subclauses 7.3.2.62 through 7.3.2.66 after subclause 7.3.2.61 as follows:

7.3.2.62 Link Identifier element

The Link Identifier element contains information that identifies a TDLS direct link. The element information format is defined in Figure 7-95o28.

Element ID	Length	BSSID	TDLS initiator STA Address	TDLS responder STA Address
1	1	6	6	6

Octets:

Figure 7-95o28—Link Identifier element format

The Element ID field is defined in Table 7-26.

The Length field is set to 18.

The BSSID field is set to the BSSID of the BSS to which the TDLS initiator STA is associated.

The TDLS initiator STA Address field is set to the TDLS initiator STA's MAC address.

The TDLS responder STA Address field is set to the TDLS responder STA's MAC address.

7.3.2.63 Wakeup Schedule information element

The Wakeup Schedule information element contains information regarding the periodic wakeup schedule for TDLS Peer Power Save Mode. The information element format is defined in Figure 7-95o29.

Element ID	Length	Offset	Interval	Awake Window Slots	Maximum Awake Window Duration	Idle Count
1	1	4	4	4	4	2

Octets:

Figure 7-95o29—Wakeup Schedule element format

The Element ID field is defined in Table 7-26.

The Length field is set to 18.

The Offset field is the time in microseconds between TSF 0 and the start of a first Awake Window. See 11.2.1.13.

The Interval field is set to the time in microseconds between the start of two successive Awake Windows. See 11.2.1.13.

The Awake Window Slots field is set to the duration of the Awake Window in units of backoff slots (see 9.9.1.3). See 11.2.1.13.

The Maximum Awake Window Duration field is set to the maximum duration of the Awake Window, in units of microseconds. See 11.2.1.13.

The Idle Count field is set to the number of consecutive Awake Windows during which no directed frame is received from the TDLS peer STA before a TDLS peer STA deletes the wakeup schedule. See 11.2.1.13.

7.3.2.64 Channel Switch Timing element

The Channel Switch Timing element contains information regarding the channel switch timing. The element is defined in Figure 7-95o30.

	Element ID	Length	Switch Time	Switch Timeout
Octets:	1	1	2	2

Figure 7-95o30—Channel Switch Timing element format

The Element ID field is defined in Table 7-26.

The Length field is set to 4.

The Switch Time field is set to the time it takes for a STA sending the Channel Switch Timing element to switch channels, in units of microseconds.

The Switch Timeout field is set to a time in units of microseconds. The STA sending the Channel Switch Timing element will wait for the first data frame exchange on the off-channel for Switch Timeout microseconds before switching back to base channel. The time is measured from the end of the last symbol of the ACK frame that is transmitted in response to TDLS Channel Switch Response frame, as seen at the air interface.

7.3.2.65 PTI Control element

The PTI Control element contains information regarding the traffic buffered at the PU buffer STA for the PU sleep STA at the time a TDLS Peer Traffic Indication frame is transmitted by the PU buffer STA. The element is optionally included in the TDLS Peer Traffic Indication frame. The element is defined in Figure 7-95o31.

	Element ID	Length	TID	Sequence Control
Octets:	1	1	1	2

Figure 7-95o31—PTI Control element format

The Element ID field is defined in Table 7-26.

The Length field is set to 3.

The TID field contained in the PTI Control element is set to the TID of the latest MPDU that has been transmitted over the TDLS direct link to the PU sleep STA that is the destination of the TDLS Peer Traffic Indication frame that contains the PTI Control element. See 11.2.1.14.

The Sequence Control field is defined in 7.1.3.4. The Sequence Control field contained in the PTI Control element is set to the sequence number of the latest MPDU that has been transmitted over the TDLS direct link to the PU sleep STA that is the destination of the TDLS Peer Traffic Indication frame that contains the PTI Control element. See 11.2.1.14.

7.3.2.66 PU Buffer Status element

The PU Buffer Status element contains information regarding the traffic buffered at the PU buffer STA for the PU sleep STA at the time a TDLS Peer Traffic Indication frame is transmitted by the PU buffer STA. The element is included in the TDLS Peer Traffic Indication frame. The element is defined in Figure 7-95o32.

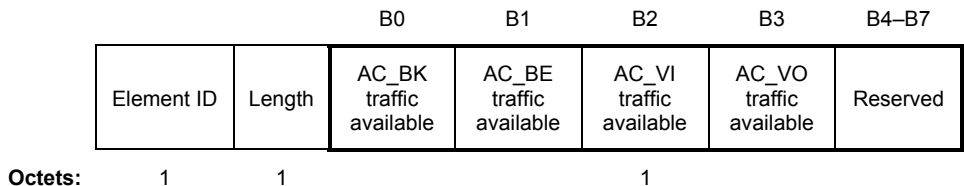


Figure 7-95o32—PU Buffer Status element format

The Element ID field is defined in Table 7-26.

The Length field is set to 1.

The AC_BK traffic available field is one bit in size and is set to 1 if AC_BK contains traffic buffered for the PU sleep STA to which the PU Buffer Status element will be transmitted, and is set to 0 otherwise.

The AC_BE traffic available field is one bit in size and is set to 1 if AC_BE contains traffic buffered for the PU sleep STA to which the PU Buffer Status element will be transmitted, and is set to 0 otherwise.

The AC_VI traffic available field is one bit in size and is set to 1 if AC_VI contains traffic buffered for the PU sleep STA to which the PU Buffer Status element will be transmitted, and is set to 0 otherwise.

The AC_VO traffic available field is one bit in size and is set to 1 if AC_VO contains traffic buffered for the PU sleep STA to which the PU Buffer Status element will be transmitted, and is set to 0 otherwise.

7.4 Action frame format details

7.4.7 Public Action details

7.4.7.1 Public Action frames

Insert one new entry in Table 7-57e, and update the reserved values accordingly:

Table 7-57e—Public Action field values

Action field value	Description
14	TDLS Discovery Response

After 7.4.7.10, insert a new subclause 7.4.7.11 as follows:

7.4.7.11 TDLS Discovery Response frame format

The TDLS Discovery Response frame contains the information shown in Table 7-57f4.

Table 7-57f4—Information for TDLS Discovery Response frame

Order	Information	Notes
1	Category	The Category field is set to the value for TDLS, as defined in Table 7-24.
2	Action	The Action field is set to 14, representing TDLS Discovery Response.
3	Dialog Token	The Dialog Token is copied from the corresponding TDLS Discovery Request frame. The Dialog Token is specified in 7.3.1.12.
4	Capability	The Capability field indicates the capabilities of the STA. The Capability field is defined in 7.3.1.4.
5	Supported rates	The Supported Rates element indicates the rates which are supported by the STA. The Supported Rates element is defined in 7.3.2.2.
6	Extended supported rates	The Extended Supported Rates element is present whenever there are more than eight supported rates, and it is optional otherwise. The Extended Supported Rates element is defined in 7.3.2.14.
7	Supported Channels	The Supported Channels element is defined in 7.3.2.19 (optional). Included if the TDLS channel switching capability field is set to one.
8	RSNIE	The RSNIE may be included if security is required on the direct link. The RSNIE is defined in 7.3.2.25.
9	Extended Capabilities	The Extended Capabilities element may be present if any of the fields in this element are nonzero. The Extended Capabilities element is defined in 7.3.2.27.
10	FTIE	The FTIE may be included if security is required on the direct link. The FTIE is defined in 7.3.2.48.
11	Timeout Interval	The Timeout Interval element contains the TPK Key Lifetime (optional). Included if security is required on the direct link. The Timeout Interval element is defined in 7.3.2.49.
12	Supported Regulatory Classes	The Supported Regulatory Classes element is defined in 7.3.2.51 (optional). Included if the TDLS channel switching capability field is set to one.
13	HT Capabilities	The HT Capabilities element is present when the dot11HighThroughputOptionImplemented attribute is true. The HT Capabilities element is defined in 7.3.2.56.
14	20/40 BSS Coexistence	The 20/40 BSS Coexistence element is present when the dot112040BSSCoexistenceManagementSupport is true. The 20/40 BSS Coexistence element is defined in 7.3.2.60.
15	Link Identifier	The Link Identifier element is specified in 7.3.2.62.

The TDLS Discovery Response frame is transmitted directly (i.e., not via the AP) to the TDLS peer STA that sent the corresponding TDLS Discovery Request frame. See 11.21.

Insert the following new subclause 7.4.11 after 7.4.10:

7.4.11 TDLS Action frame details

Several Action frame formats are defined to support TDLS. The Action field values associated with each frame format within the TDLS category are defined in Table 7-57v1.

Table 7-57v1—TDLS Action field values

Action field value	Meaning
0	TDLS Setup Request
1	TDLS Setup Response
2	TDLS Setup Confirm
3	TDLS Teardown
4	TDLS Peer Traffic Indication
5	TDLS Channel Switch Request
6	TDLS Channel Switch Response
7	TDLS Peer PSM Request
8	TDLS Peer PSM Response
9	TDLS Peer Traffic Response
10	TDLS Discovery Request
11–255	Reserved

7.4.11.1 TDLS Setup Request frame format

The frame body of a TDLS Setup Request frame contains the information shown in Table 7-57v2.

Table 7-57v2—Information for TDLS Setup Request frame

Order	Information	Notes
1	Category	The Category field is set to the value for TDLS, as defined in Table 7-24.
2	Action	The Action field is set to 0, representing TDLS Setup Request.
3	Dialog Token	The Dialog Token field contains a unique non-zero value for the conversation between the STAs involved in this request. The Dialog Token is specified in 7.3.1.12.
4	Capability	The Capability field indicates the capabilities of the STA. The Capability field is defined in 7.3.1.4.
5	Supported rates	The Supported Rates element indicates the rates which are supported by the STA. The Supported Rates element is defined in 7.3.2.2.
6	Country	The Country information element shall be present when dot11MultiDomainCapabilityEnabled is true or dot11SpectrumManagementRequired is true. The Country information element is defined in 7.3.2.9.
7	Extended supported rates	The Extended Supported Rates element is present whenever there are more than eight supported rates, and it is optional otherwise. The Extended Supported Rates element is defined in 7.3.2.14.
8	Supported Channels	The Supported Channels element is defined in 7.3.2.19 (optional). Included if the TDLS channel switching capability field is set to one.
9	RSNIE	RSNIE of the TDLS initiator STA (optional). The RSNIE is included if security is required on the direct link. The RSNIE is defined in 7.3.2.25.
10	Extended Capabilities	The Extended Capabilities element may be present if any of the fields in this element are non-zero. The Extended Capabilities element is defined in 7.3.2.27.
11	QoS Capability	The QoS Capability element is present when dot11QosOptionImplemented is true. The QoS Capability element is defined in 7.3.2.35.
12	FTIE	FTIE of the TDLS Initiator (optional). The FTIE is included if security is required on the direct link. The FTIE is defined in 7.3.2.48.
13	Timeout Interval	The Timeout Interval element contains the TPK Key Lifetime (optional). Included if security is required on the direct link. The Timeout Interval element is defined in 7.3.2.49.
14	Supported Regulatory Classes	The Supported Regulatory Classes element is defined in 7.3.2.51 (optional). Included if the TDLS channel switching capability field is set to one.
15	HT Capabilities	The HT Capabilities element is present when the dot11HighThroughputOptionImplemented attribute is true. The HT Capabilities element is defined in 7.3.2.56.