IEEE P802.11
Wireless LANs

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| Proxy Neighbor Discovery  |
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Abstract

802.11-2029 11.21.14 describes a WNM STA ARP Proxy, and also adds an IPv6 ARP Proxy.

However, there is no such thing as ARP in IPv6. The equivalent function to IPv4 ARP Proxy is IPv6 ND Service.

This function operates differently from what 11.21.14 describes, as assuming equivalence with IPv4 ARP Proxy is an oversimplification. Using the same term for both is confusing.

This submission proposes a correction to the text, aiming at accurately stating the function description.

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| CID | Comment | Proposed change | Resolution |
| 1208 | There is no such thing as ARP in IPv6.The equivalent function to IPv4 ARP Proxy is IPv6 ND Service. | Clarify that in the case of IPv6, the ARP proxy function is inscribed into a functional service called IPv6 ND Proxy.  | Revise  |
| 1209 | The IPv6 address lifecycle and neighbor discovery operations are different from that of IPv4. Clubbing the IPv6 operations within the same description as IPv4 causes confusion and is technically incorrect.  | RFCs exist (e.g., 8505, 8928 and 8929) to define the ND proxy function for IPv6, and address the case of an AP. Clarify the functional differences between IPv4 and IPv6 for address lifecycle, the functional differences for IPv6 ND services and proxy functions, and point to the relevant RFCs.  | Revise |

Discussion: this change proposal was adopted in 802.11md, but the RFC numbers were not available yet at that time. A race condition prevented the change to make it to the final 802.11-2020.

Summary of the motivation: there is no such thing as an IPv6 proxy. Yet 11.21.14 gives this impression, both because of the naming convention chosen for both IPv6 and IPv4, that only applies to IPv4, and the description that was tailored for IPv4 (and IPv6 was added in a way that looks like patching on existing text). Additionally, that clause provides guidance on IPv6 behavior, but the recommendation is incomplete and misguided in some cases. One option is to remove all guidance; a better option is to add a clarifying note.

To editors: change the following two clauses as follows:

4.3.21.13 Proxy ARP

The IETF has defined a Proxy ARP function for IPv4 (IETF RFC 1027) and an IPv6 Neighbor Discovery (ND) Proxy function for IPv6 (IETF RFC 4389) where the proxy impersonates the target by replying to IPv4 ARP and IPv6 ND query respectively with its own MAC address for devices that are effectively reachable but not bridgeable beyond self. But those functions differ from the ones provided by the Proxy ARP service where the proxy would reply on behalf of the target. Therefore, the term Proxy ARP service in this standard does not refer to the functions defined in those RFCs. However, the Proxy ARP service in this standard for both IPv4 and IPv6 is similar to the function described in IETF RFC 7342.

The Proxy ARP service enables an AP to avoid forwarding to the BSS broadcast ARP frames for IPv4 (IETF RFC 826) and IP layer multicast packets IPv6 ND messages for IPv6 (IETF RFC 4861 and IETF RFC 4862) which target not match the address of an associated STA. If the target matches the address of an associated non-AP STAs, the Proxy ARP service can either respond on behalf of the non-AP STA, or preferably send the frames as unicast transmissions to the target STA(s) only. As a result, an associated STA that is not a target is not exposed to extraneous IPv4 ARP frames or IPv6 Neighbor Discovery packets. This way, the Proxy ARP service reduces the amount of broadcast transmissions and enables associated STAs to remain in power save for longer periods of time.

For IPv6, the Proxy ARP service follows the recommendations in section 7 of IETF RFC 4389. In contrast to IPv4 ARP, IPv6 ND is still in evolution, and it might be hazardous for a proxy function to answer on behalf of the STA, when the STA might desire to use specific options in its own responses that the proxy ARP service is not aware of. For that reason, the Proxy ARP service for IPv6 effectively follows IETF RFC 8929 which recommended that the AP just turn the broadcast into a frame individually addressed to the targeted STA as suggested by RFC 6085, rather than respond on its behalf.

11.21.14 Proxy ARP service

Implementation of the proxy ARP service is optional for a WNM STA. A STA that implements the proxy ARP service has dot11ProxyARPImplemented equal to true. When dot11ProxyARPImplemented is true, dot11WirelessManagementImplemented shall be true. When dot11ProxyARPActivated is true, the Proxy ARP Service bit in the Extended Capabilities field shall be set to 1 to indicate that the AP supports the proxy ARP service. When dot11ProxyARPActivated is false, the Proxy ARP Service bit shall be set to 0 to indicate that the AP does not support the proxy ARP service.

When the AP sets the Proxy ARP field to 1 in the Extended Capabilities element, the AP shall maintain a Hardware Address to Internet Address mapping for each associated STA and for each IPv4 and IPv6 address of the STA, and shall update the mapping when one of the addresses of the associated STA changes. A Proxy ARP service receives and processes three types of messages: IPv4 ARP requests, IPv6 ND address lookups, and IPv6 ND duplicate address detection (DAD) messages. These messages are all received as group addressed. If the target address is not known, the Proxy ARP service does not forward the request to the BSS. If the target address is known, the Proxy ARP service can either respond directly on behalf of a STA or forward the request as a unicast frame to the intended STA. For fixed devices in doze state, a direct response is preferable. Otherwise, forwarding as unicast is recommended, to avoid responding with misleading information.

For IPv4, when the address being resolved in the ARP request (IETF RFC 826) is used by a non-AP STA currently associated to the BSS, the proxy ARP service shall either respond on behalf of the STA to an ARP request or an ARP probe (IETF RFC 5227) or preferably turn the ARP request into a unicast frame sent to that STA.

When an AP receives an IPv4 ARP request from one associated STA or from the DS with a target IPv4 address that corresponds to a second associated STA, the AP that decides to form a proxy ARP response frame shall insert the second STA MAC address as the (#479)sender’s MAC address in the ARP response.

In contrast to IPv4, Stateless Address Autoconfiguration (SLAAC), which is part of IPv6 Neighbor Discovery (ND), enables a node to form multiple addresses, some of them temporary and with a particular attention paid to privacy. SLAAC addresses may be formed and deprecated asynchronously to the association. Even if the knowledge of IPv6 addresses used by a STA can be obtained by snooping protocols such as IPv6 ND and DHCPv6, or by observing data traffic sourced at the STA, such methods provide only an imperfect knowledge of the state of the STA at the AP, in particular when SLAAC is enabled. Running a Proxy ARP service on an incomplete set of addresses may result in a loss of connectivity, in particular for addresses rarely used and in situations of mobility.

This non-deterministic representation of IPv6 address location and binding may also result in undesirable state persistence in the AP when a STA ceases to use an IPv6 address. It follows that protocol snooping is not a recommended technique and that snooping should only be used as last resort. IETF RFC 8505 defines an address registration mechanism that enables the AP to maintain a deterministic knowledge of all the IPv6 addresses of all the associated STAs. IETF RFC 8929 defines a proxy ND service that leverages the address registration to maintain an accurate proxy state that follows the movements of the STAs, while IETF RFC 8928 protects the address ownership against impersonation attacks and address spoofing.

The proxy ARP function for IPv4 and IPv6 shall support snooping of DHCPv4, DHCPv6 and IPv6 ND to discover the IPv4 and IPv6 addresses owned by the STA.

For IPv6, since the state obtained by snooping SLAAC is unreliable, the proxy ARP function shall support the backbone router function defined in IETF RFC 8929, which creates a binding state based on an RFC 8505 registration by the STA. The proxy ARP function should support IETF RFC 8928 to protect the ownership of the addresses. The non-AP STA shall support the address registration mechanism defined in IETF RFC 8505 and should support the address protection mechanism defined in IETF RFC 8928.

IPv6 ND uses IP layer multicast Internet Control Message Protocol version 6 (ICMPv6) Neighbor Solicitation (NS) messages (section 4.3 of IETF RFC 4861) for address resolution (section 7.2 of IETF RFC 4861), which is the equivalent of ARP request, and for duplicate address detection (DAD). The proxy ARP function shall drop those messages if the target IP address does not correspond to an associated STA. NS messages are sent as IP layer unicast for neighbor unreachability detection (NUD) (section 7 of IETF RFC 4861). The proxy ARP function shall not operate on IP layer unicast NS messages.

With the IPv6 ND proxy operation defined in IETF RFC 8929, the backbone router function at the AP typically operates as a bridging proxy though operation as a routing proxy is also possible. As a bridging proxy, the NS lookups are replied with the MAC address of the STA, and the packets to the STA are bridged normally; as a routing proxy, the backbone router function replies to lookups from the wired backbone with its own MAC address and then routes to the STA at the IP layer. The routing proxy isolates the layer-2 domains and hides the MAC address of the STA in the wired backbone, for a better stability and scalability of the bridged domain. The Proxy ARP function shall support the bridging proxy and may support the routing proxy operation.

When the target IPv6 address of a IP layer multicast NS message corresponds to an associated STA, the Proxy ARP service may respond on behalf of an associated low-power STA with a neighbor advertisement (NA) message (section 4.4 of IETF RFC 4861) with the override flag set to zero, to conserve energy. Preferably, though, the Proxy ARP service should transmit the IP layer multicast NS message as a unicast frame to the STA and let the STA respond, as recommended in IETF RFC 8929. When MAC address mappings change, the AP may send unsolicited Neighbor Advertisement messages on behalf of a STA if the IPv6 Neighbor Discovery function at the STA failed to do so.

The IPv6 ND function at the STA shall register all of the IPv6 addresses on the interface (see section 10 of IETF RFC 8929) to the proxy ARP service at the AP to ensure that the proxy ARP service is aware of all those addresses and will proxy for them. The proxy ND operation may support address mobility (section 6 of IETF RFC 8929) to transfer a role of ND proxy for this STA to the AP with which the STA is associated following a mobility event.

Insert the following references to annex A:

**References:**

[BX1] IETF RFC 6775, Neighbor Discovery Optimization for IPv6 over Low-Power Wireless Personal Area Networks, Z. Shelby, S. Chakrabarti, E. Nordmark, C. Bormann, November 2012.

[BX2] IETF RFC 8505, An Update to 6LowPAN ND, P. Thubert, E. Nordmark, S. Chakrabarti, C. Perkins, June 2018.

[BX3] IETF RFC 8929, 6lo backbone router, [P.](https://tools.ietf.org/html/draft-ietf-6lo-backbone-router-06) Thubert, C.E. Perkins, E. Levy-Abegnoly, November 2020.

[BX4]IETF RFC 8928, Address Protected Neighbor Discovery for Low-power and Lossy Networks, [P.](https://tools.ietf.org/html/draft-ietf-6lo-ap-nd-06) Thubert, B. Sarikaya, M. Sethi, R. Struik, November 2020.

[BX5] IETF RFC 6085, Address Mapping of IPv6 Multicast Packets on Ethernet, Wojciech Dec and Ole Trøan and Sri Gundavelli and Mark Townsley, January 2011.

IETF RFC 1027, "Using ARP to implement transparent subnet gateways”, Carl-Mitchell, S. and J. Quarterman, October 1987.

IETF RFC 4389 Neighbor Discovery Proxies (ND Proxy), Thaler, D., Talwar, M., and C. Patel, April 2006.