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Link-layer Event Notifications for Detecting Network Attachments
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Abstract

Certain network access technologies are capable of providing various link-layer status information to IP. Link-layer event notifications can help IP expeditiously detect configuration changes. This draft

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provides a non-exhaustive catalogue of information available from well-known access technologies.

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1. Introduction

It is not an uncommon occurrence for a node to change its point-of attachment to the network. This can happen due to mobile usage (e.g., a mobile phone moving among base stations) or nomadic usage (e.g., road-warrior case).

A node changing its point-of attachment to the network may end up changing its IP subnet and therefore require re-configuration of IP-layer parameters, such as IP address, default gateway information, and DNS server address. Detecting the subnet change can usually use network-layer indications such as a change in the advertised prefixes (i.e., appearance and disappearance of prefixes). But generally reliance on such indications does not yield rapid detection, since these indications are not readily available upon node changing its point of attachment.

The changes on the underlying link-layer status can be relayed to IP in the form of link-layer event notifications. Establishment and tear down of a link-layer connection are two basic events types. Additional information can be conveyed in addition to the event type, such as the identifier of the network attachment point, or network-layer configuration parameters obtained via the link-layer attachment process. It is envisaged that such event notifications can in certain circumstances be used to expedite the inter-subnet movement detection and reconfiguration process. For example, the notification indicating that the node has established a new link-layer connection can be used for immediately probing the network for a possible configuration change. In the absence of such a notification from the link-layer, IP has to wait for indications that are not immediately available, such as receipt of next scheduled router advertisement, unreachability of the default gateway, etc.

It should be noted that a link-layer event notification does not always translate into a subnet change. Even if the node has torn

down a link-layer connection with one attachment point and established a new connection with another, it may still be attached to the same IP subnet. For example, several IEEE 802.11 access points can be attached to the same IP subnet. Moving among these access points does not warrant any IP-layer configuration change.

In order to enable an enhanced scheme for detecting change of subnet, we need to define link-layer event notifications that can be realistically expected from various access technologies. The objective of this draft is to provide a catalogue of link-layer events and notifications in various architectures. While this document mentions the utility of this information for detecting change of subnet (or, detecting network attachment - DNA), the

detailed usage is left to other documents, namely DNA solution specifications.

The document limits itself to the minimum set of information that is necessary for solving the DNA problem [[I-D.ietf-dna-goals](#)]. A broader set of information may be used for other problem spaces (e.g., anticipation-based Mobile IP fast handovers [[I-D.ietf-mobileip-lowlatency-handoff](#)] [[I-D.ietf-mipshop-fast-mipv6](#)]). Separate documents that are backward-compatible with this one can be generated to discuss further enhancements.

These event notifications are considered with hosts in mind, although they may also be available on the network side (e.g., on the access points and routers). An API or protocol-based standard interface may be defined between the link-layer and IP for conveying this information. That activity is beyond the scope of this document.

[1.1](#) Requirements notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](#)].

[2.](#) Link-Layer Event Notifications

Link-layer event notifications are considered to be one of the inputs to the DNA process. A DNA process is likely to take other inputs (e.g., presence of advertised prefixes, reachability of default gateways) before determining whether IP-layer configuration must be updated. It is expected that the DNA process can take advantage of link-layer notifications when they are made available to IP. While by itself a link-layer notification may not constitute all the input DNA needs, it can at least be useful for prompting the DNA process to collect further information (i.e., other inputs to the process). For example, the node may send a router solicitation as soon as it learns that a new link-layer connection is established.

Two basic link-layer events are considered potentially useful to DNA process: link up and link down. Both of these events are deterministic, and their notifications are provided to IP-layer after the events successfully conclude. These events and notifications are associated with a network interface on the node. The IP module may receive simultaneous independent notifications from each one of the network interfaces on the node.

Node's establishment of a link-layer connection with an attachment point that signifies the availability of IP service (i.e., being able to send and receive IP packets) between the two is considered a link up event. The attachment point is typically an access network element, such as an access point, a base station, or a wired switch [TO-DO: How about ad-hoc networks? Attached neighbors may be considered attachment points].

The actual event is managed by the link-layer of the node through execution of link-layer protocols and mechanisms. Once the event successfully completes within the link-layer, its notification must be delivered to the IP-layer. By the time the notification is delivered, the link-layer of the node must be ready to accept IP packets from the IP and the physical-layers.

Link down event signifies the discontinuation of the IP service between the node and the attachment point. When the link-layer connection is physically or logically torn down and it can no longer carry IP packets, this is considered to be a link down event.

Among these two events the first one to take place after an interface becomes enabled must be a link up event. During the time a network interface is enabled, it may go through a series of link up and down events. Each time the interface changes its point of attachment, a link down event with the previous attachment point must be followed by a link up event with the new one. Finally, when the network

interface is disabled, this must generate a link down event. Each one of these events must generate a notification in order they occur.

A node may have to change its IP-layer configuration even when the link-layer connection stays the same. An example scenario is the IPv6 subnet renumbering [[RFC2461](#)]. Therefore, there exists cases where IP-layer configuration may have to change even without the IP-layer receiving a link up notification. Therefore, a link-layer notification is not a mandatory indication of a subnet change.

In addition to the type of the event (link up, link down), a link-layer notification may also optionally deliver information relating to the attachment point. Such auxiliary information may include identity of the attachment point (e.g., base station

identifier), or the IP-layer configuration parameters associated with the attached subnet (e.g., subnet prefix, default gateway address, etc.). While merely knowing that a new link-layer connection is established may prompt DNA process to immediately seek other clues for detecting network configuration change, auxiliary information may constitute further clues (and even the final answers sometimes). In cases where there is a one-to-one mapping between the attachment point identifiers and the IP-layer configurations, learning the former can reveal the latter. Furthermore, IP-layer configuration parameters obtained during link-layer connection may be exactly what the DNA process is trying to discover (e.g., IP address configured during PPP link establishment).

The link-layer process leading to a link up or link down event depends on the link technology. While a link-layer notification must always indicate the event type, the availability and types of auxiliary information on the attachment point depends on the link-layer technology as well. The following subsections examine three link-layer technologies and describe when a link-layer notification must be generated and what information must be included in it. The coverage on the link types may be expanded in the future [T0-D0: Add IEEE 802.3].

[2.1](#) GPRS/3GPP

GPRS is an enhancement to the GSM data transmission architecture and capabilities, designed to allow for packet switching in user data transmission within the GPRS network as well as for higher quality of service for the IP traffic of Mobile Terminals with external Packets Data Networks such as the Internet or corporate LANs [[GPRS](#)][GPRS-LINK].

The GPRS architecture consists of a Radio Access Network and a packet domain Core Network.

- The GPRS Radio Access Network is composed of Mobile Terminals (MT), a Base Station Subsystem and Serving GPRS Support Nodes (SGSN).
- An IP Core Network that acts as the transport backbone of user datagrams between SGSNs and Gateway GPRS Support Nodes (GGSN). The GGSN ensures the GPRS IP core network connectivity with external networks, such as Internet or Local Area Networks. GGSN acts as the

default IP gateway for the MT.

A MT that wants to establish IP-level connections should first perform a GPRS attach to the SGSN. This should be followed by a request the GPRS network to settle the necessary soft state mechanism (GPRS tunneling protocol) between its serving SGSN and the GGSN. The soft state maintained between the MT, the SGSN and the GGSN is called a PDP Context. It is used for guaranteeing a negotiated quality of service for the IP flows exchanged between the GPRS MT and an external Packet Data Network such as Internet . Only after the PDP Context is established and tunneling mechanism takes place can the MT's IP packets be forwarded to and from its remote IP peers. The aim of PDP Context establishment is also to provide IP-level configuration on top of the GPRS link-layer attachment.

Successful establishment of a PDP Context on a GPRS signifies the availability of IP service to the MT. Therefore, this link-layer event must generate a link up event notification sent to IP-layer. The auxiliary information carried along with this notification must be the IP address of the MT which is obtained as part of the PDP Context. In case of IPv6, IPv6 address of the MT may be obtained by alternative methods, such as DHCPv6 [[RFC3315](#)][GPRS-GSSA] or stateless address autoconfiguration [[RFC2462](#)][GPRS-CN]. In that case, the IP address auxiliary information must be set to null.

Similarly, PDP Context deactivation must generate a link down event notification.

[2.2](#) cdma2000/3GPP2

cdma2000-based 3GPP2 packet data services provide mobile users wide area high-speed access to packet switched networks [[CDMA2K](#)]. Some of the major components of the 3GPP2 packet network architecture consist of:

- Mobile Station (MS), which allows mobile access to packet-switched networks over a wireless connection.
- Radio Access Network, which consists of the Base Station Transceivers, Base Station Controllers, and the Packet Control Function.

- Network Access Server known as the Packet Data Switching Node (PDSN). The PDSN also serves as default IP gateway for the IP MS.

3GPP2 networks use the Point-to-Point Protocol (PPP [[RFC1661](#)]) as the link-layer protocol between the MS and the PDSN. Before any IP packets may be sent or received, PPP must reach the Network-Layer Protocol phase, and the IP Control Protocol (IPCP [[RFC1332](#)], IPV6CP [[RFC2472](#)]) reach the Opened state. When these states are reached in PPP, a link up event notification must be delivered to the IP-layer.

When the PPP is used for 3GPP2 Simple (i.e., non-Mobile) IPv4 Service, IPCP enables configuration of IPv4 address on the MS. This IPv4 address must be provided as the auxiliary information along with the link up notification. IPV6CP used for Simple IPv6 service does not provide an IPv6 address, but the interface-identifiers for local and remote end-points of the PPP link. Since there is no standards-mandated correlation between the interface-identifier and other IP-layer configuration parameters, this information is deemed not useful for DNA (hence it is not provided as auxiliary information).

IPCP/IPV6CP termination, or the underlying LCP or NCP reaching Closed State signify the end of corresponding IP service on the PPP link. This event must generate a link down notification delivered to the IP-layer.

[2.3](#) IEEE 802.11/WiFi

IEEE 802.11-based WiFi networks are the wireless extension of the Local Area Networks. Currently available standards are IEEE 802.11b [[IEEE-802.11b](#)], IEEE 802.11g [[IEEE-802.11g](#)], and IEEE 802.11a [[IEEE-802.11a](#)]. The specifications define both the MAC-layer and the physical-layer. The MAC layer is the same for all these technologies.

Two operating modes are available in the IEEE 802.11 series. In ad-hoc mode, mobile station (STA) in range may directly communicate with other, i.e., without any infrastructure or intermediate hop. In infrastructure mode, all link-layer frames are transmitted to an access point (AP) which then forwards them to the final receiver. This document only considers infrastructure mode [for now... TO-DO: consider ad-hoc too].

A STA must establish a IEEE 802.11 link with an AP in order to send and receive IP packets. In a WiFi network that supports Robust Secure Network (RSN [[IEEE-802.11i](#)]), successful completion of 4-way handshake between the STA and AP commences the availability of IP service. The link up event notification must be generated upon this

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event. In non-RSN-based networks, successful association or re-association events on the link-layer must cause a link up notification sent to the IP-layer.

As part of the link establishment, Basic Service Set Identification (BSSID) and Service Set Identifier (SSID) associated with the AP is learned by the STA. BSSID is a unique identifier of the AP. Its value is set to the MAC address of the AP in infrastructure mode. SSID carries the identifier of the Extended Service Set (ESS) - the set composed of APs and associated STAs that share a common distribution system. BSSID and SSID should be provided as auxiliary information along with the link up notification. Unfortunately this information does not provide a deterministic indication of whether the IP-layer configuration must be changed upon movement. There is no standards-mandated one-to-one relation between the BSSID/SSID pairs and IP subnets. An AP with a given BSSID can connect a STA to any one of more than one IP subnets. Similarly, an ESS with the given SSID may span multiple IP subnets. And finally, the SSIDs are not globally unique. The same SSID may be used by multiple independent ESSs. See [Appendix A](#) of [DNA4] for a detailed discussion. Nevertheless, BSSID/SSID information may be used in a probabilistic way by the DNA process, hence it is provided with the link up event notification.

Disassociation event in RSN-based, and de-authentication and disassociation events in non-RSN-based WiFi networks must translate to link down events, and generate the corresponding link-layer notifications.

[3.](#) IANA Considerations

This document has no actions for IANA.

[4.](#) Security Considerations

A faked link-layer event notification can be used to launch a denial-of service attack on the node and the associated network. Secure generation and delivery of these notifications must be ensured. This is a subject for link-layer and network stack designs and therefore it is outside the scope of this document.

[5.](#) Acknowledgements

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