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MPLS Generic Associated Channel (G-ACh) Advertisement Protocol
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Abstract

The MPLS Generic Associated Channel (G-ACh) provides an auxiliary logical data channel associated with a Label Switched Path (LSP), a pseudowire, or a section (link) over which a variety of protocols may flow. These protocols are commonly used to provide Operations, Administration, and Maintenance (OAM) mechanisms associated with the primary data channel. This document specifies simple procedures by which an endpoint of an LSP, pseudowire, or section may inform the other endpoints of its capabilities and configuration parameters, or other application-specific information. This information may then be used by the receiver to validate or adjust its local configuration, and by the network operator for diagnostic purposes.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on June 2, 2012.

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1. Introduction

The MPLS Generic Associated Channel (G-ACh) is defined and described in [RFC5586]. It provides an auxiliary logical data channel associated with an MPLS Label Switched Path (LSP), a pseudowire, or a section (link) over which a variety of protocols may flow. A primary purpose of the G-ACh and the protocols it supports is to provide Operations, Administration, and Maintenance (OAM) capabilities associated with the underlying LSP, pseudowire, or section. Examples of such capabilities include Pseudowire Virtual Circuit Connectivity Verification (VCCV) [RFC5085], Bidirectional Forwarding Detection (BFD) for MPLS [RFC5884], and MPLS packet loss, delay, and throughput measurement [RFC6374], as well as OAM functions developed for the MPLS Transport Profile (MPLS-TP) [RFC5921].

This document specifies procedures for an MPLS Label Switching Router (LSR) to advertise its capabilities and configuration parameters, or other application-specific information, to its peers over LSPs, pseudowires, and sections. Receivers can then make use of this information to validate or adjust their own configurations, and network operators can make use of it to diagnose faults and configuration inconsistencies between endpoints.

The main principle guiding the design of the MPLS G-ACh advertisement protocol (GAP) is simplicity. The protocol provides a one-way method of distributing information about the sender. How this information is used by a given receiver is a local matter. The data elements distributed by the GAP are application-specific and, except for those associated with the GAP itself, are outside the scope of this document. An IANA registry is created to allow GAP data elements to be defined as needed.

1.1. Motivation

It is frequently useful in a network for a node to have general information about its adjacent nodes, i.e., those nodes to which it has links. At a minimum this allows a human operator or management application with access to the node to determine which adjacent nodes this node can see, which is helpful when troubleshooting connectivity problems. A typical example of an "adjacency awareness protocol" is the Link Layer Discovery Protocol [LLDP], which can provide various pieces of information about adjacent nodes in Ethernet networks, such as system name, basic functional capabilities, link speed/duplex settings, and maximum supported frame size. Such data is useful both for human diagnostics and for automated detection of configuration inconsistencies.

In MPLS networks, the G-ACh provides a convenient link-layer-agnostic

means for communication between LSRs that are adjacent at the link layer. The G-ACh advertisement protocol presented in this document thus allows LSRs to exchange information of a similar sort to that supported by LLDP for Ethernet links.

An important special case arises in networks based on the MPLS Transport Profile (MPLS-TP) [RFC5921] that do not also support IP: without IP, protocols for determining the Ethernet address of an adjacent MPLS node, such as the Address Resolution Protocol [RFC0826] and IP version 6 Neighbor Discovery [RFC4861], are not available. The G-ACh advertisement protocol can be used to discover the Ethernet MAC addresses of MPLS nodes lacking IP capability [I-D.fbb-mpls-tp-ethernet-addressing].

The applicability of the G-ACh advertisement protocol is not limited to link-layer adjacency, either in terms of message distribution or message content. The G-ACh exists for any MPLS LSP or pseudowire, so GAP messages can be exchanged with remote LSP or pseudowire endpoints. The content of GAP messages is extensible in a simple manner, and can include any kind of information that might be useful to MPLS LSRs connected by links, LSPs, or pseudowires. For example, in networks that rely on the G-ACh for OAM functions, GAP messages might be used to inform adjacent LSRs of a node's OAM capabilities and configuration parameters.

1.2. Terminology

Term	Definition
G-ACh	Generic Associated Channel
GAL	G-ACh Label
GAP	G-ACh Advertisement Protocol
LSP	Label Switched Path
LSR	Label Switching Router
OAM	Operations, Administration, and Maintenance

1.3. Requirements Language

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. Overview

The G-ACh Advertisement Protocol has a simple one-way mode of operation: a device configured to send information for a particular data channel (MPLS LSP, pseudowire, or section) transmits GAP

messages over the G-ACh associated with the data channel. The payload of a GAP message is a collection of Type-Length-Value (TLV) objects, organized on a per-application basis. An IANA registry is created to identify specific applications.

Although one GAP message can contain data for several applications, the receiver maintains the data associated with each application separately. This enables the sender to transmit a targeted update that refreshes the data for a subset of applications without affecting the data of other applications.

For example, a GAP message might be sent containing the following data:

Application A: A-TLV1, A-TLV2, A-TLV3

Application B: B-TLV1

Application C: C-TLV1, C-TLV2

A second message might then be sent containing:

Application B: B-TLV1, B-TLV2

Upon receiving the second message, the receiver flushes the old data for Application B and replaces it with the new data. The data associated with Applications A and C from the first message is retained. In other words, the GAP update granularity is per-application, not per-message or per-TLV-object.

The rate at which GAP messages are transmitted is at the discretion of the sender, and may fluctuate over time as well as differ per-application. Each message contains, for each application it describes, a lifetime that informs the receiver how long to wait before discarding the data for that application.

The GAP itself provides no fragmentation and reassembly mechanisms. In the event that an application wishes to send larger chunks of data via GAP messages than fall within the limits of packet size, it is the responsibility of the application to fragment its data accordingly.

3. Message Format

An Associated Channel Header (ACH) Channel Type has been allocated for the GAP as follows:

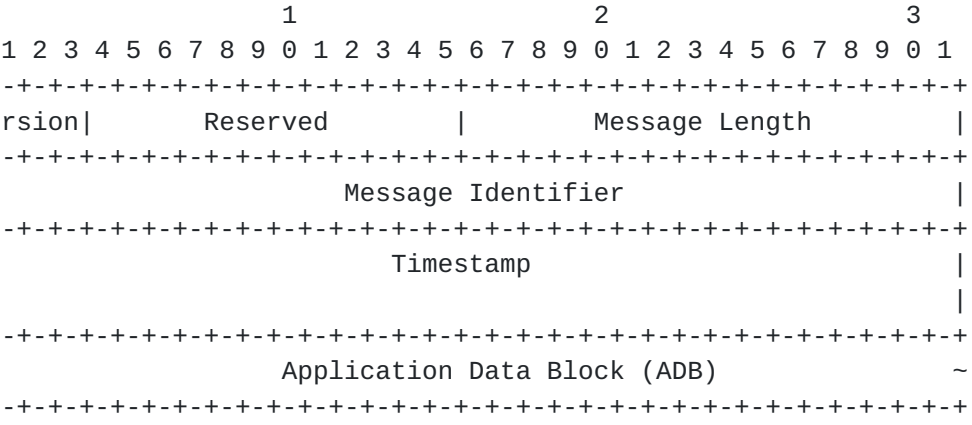
Protocol	Channel Type
G-ACh Advertisement Protocol	0xXXXX

For this Channel Type, the ACH SHALL NOT be followed by the ACH TLV Header defined in [RFC5586].

Fields in this document shown as Reserved or Resv are reserved for future specification and MUST be set to zero. All integer values for fields defined in this document SHALL be encoded in network byte order.

The payload of a GAP message is an Application Data Block (ADB) consisting of one or more block elements. Each block element contains an application identifier, a lifetime, and a series of TLV objects for the application it describes.

The following figure shows the format of a G-ACh Advertisement Protocol message, which follows the Associated Channel Header (ACH):



GAP Message Format

The meanings of the fields are:

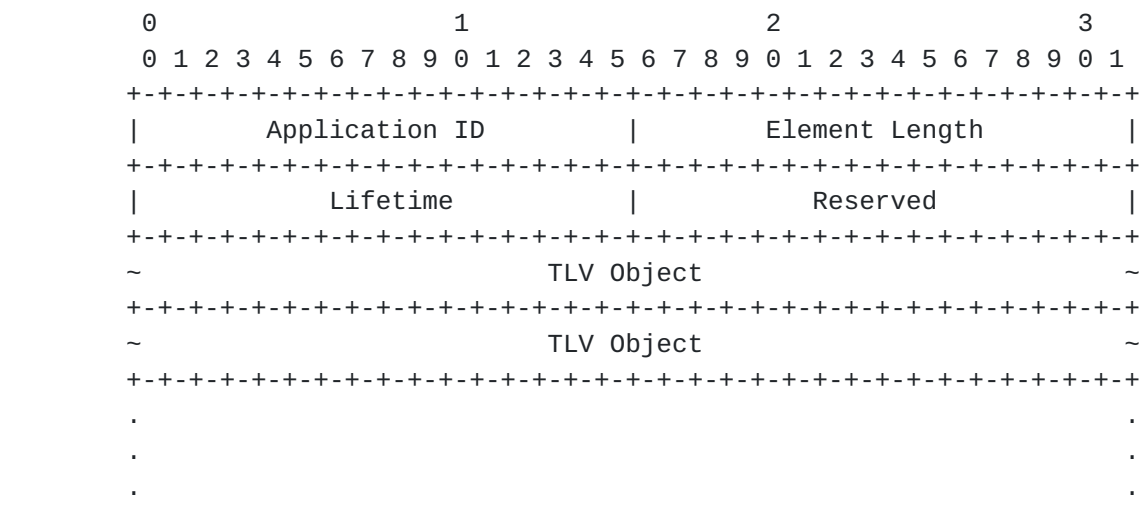
Version: Protocol version, currently set to 0

Message Length: Size in octets of this message, i.e. of the portion of the packet following the Associated Channel Header

Message Identifier: Unique identifier of this message

Timestamp: 64-bit Network Time Protocol (NTP) transmit timestamp, as specified in Section 6 of [RFC5905]

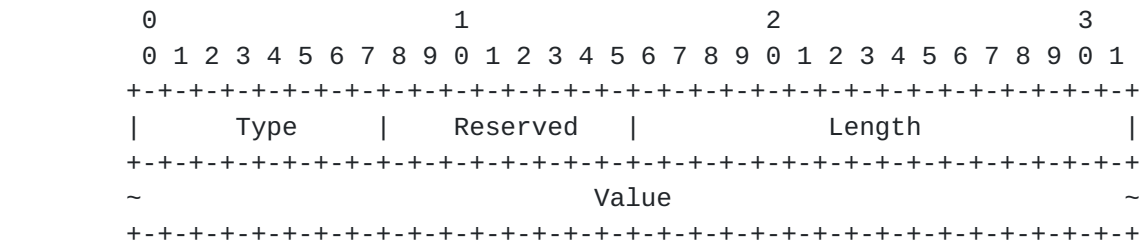
An ADB consists of one or more elements of the following format:



Application Data Block Element

In this format, the Application ID identifies the application this element describes; an IANA registry has been created to track the values for this field. Any two ADB elements in the same ADB SHALL have distinct Application IDs. The Element Length field specifies the total length in octets of this block element. The Lifetime field specifies how long, in seconds, the receiver should retain the data in this message.

The remainder of the Application Data Block element consists of a sequence of TLV objects, which are of the form:



TLV Object Format

The Type field identifies the TLV Object; an IANA registry has been created to track the values for this field, which are defined on a per-application basis. The Length field specifies the length in octets of the Value field.

It is permissible for the sequence of TLV objects in an ADB element to be empty. This is useful in conjunction with setting the Lifetime to zero in order to instruct the receiver to flush all data associated with this application.

GAP messages do not contain a checksum. If validation of message integrity is desired, the authentication procedures in Section 6 should be used.

4. G-ACh Advertisement Protocol TLVs

The GAP supports several TLV objects related to its own operation via the Application ID 0x0000. When an ADB element for the GAP is present in a GAP message, it MUST precede other elements.

4.1. Identifier TLVs

The following TLV objects are defined for purposes of conveying identification information associated with the transmitting device and the data channel:

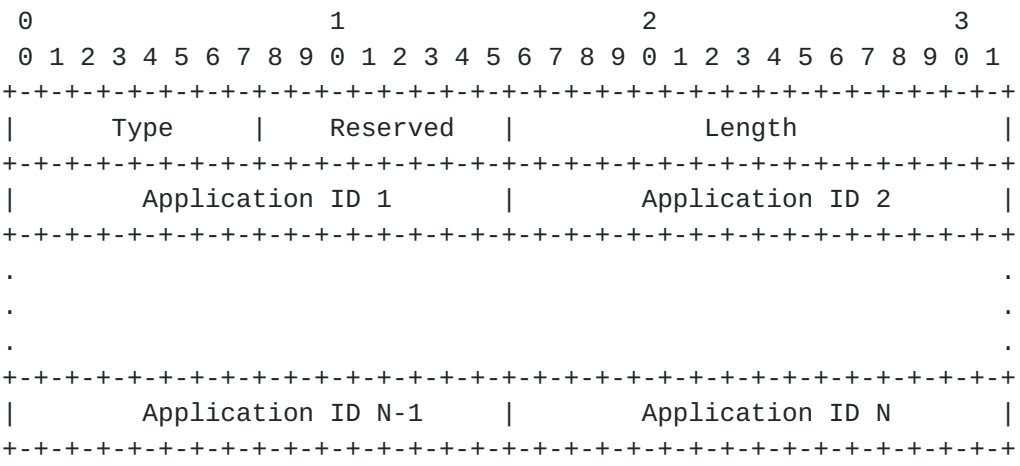
- Interface Identifier TLV
- LSP Identifier TLV
- Pseudowire Path Identifier TLV

The Value portion of these identifier objects follows the format of the respective identifier as defined in [RFC6370].

The LSP and Pseudowire Path Identifiers SHOULD be present in GAP messages transmitted over LSPs and pseudowires, respectively, and MUST NOT be present for other data channel types. The Interface Identifier SHOULD be present in GAP messages transmitted over data-link sections.

4.2. GAP Request TLV

This object is a request by the sender for the receiver to transmit an immediate unicast GAP update to the sender. If the Length field is zero, this signifies that an update for all applications is requested. Otherwise, the Value field specifies the applications for which an update is requested, in the form of a sequence of Application IDs:



GAP Request TLV Format

4.3. GAP Flush TLV

This object is an instruction to the receiver to flush the GAP data for all applications. It is a null object, i.e. its Length is set to zero. Note that data for a specific application can be flushed by sending an update for the application with the Lifetime set to zero.

The GAP Flush instruction does not apply to data contained in the message carrying the GAP Flush TLV object itself. Any application data contained in the same message SHALL be processed and retained by the receiver as usual.

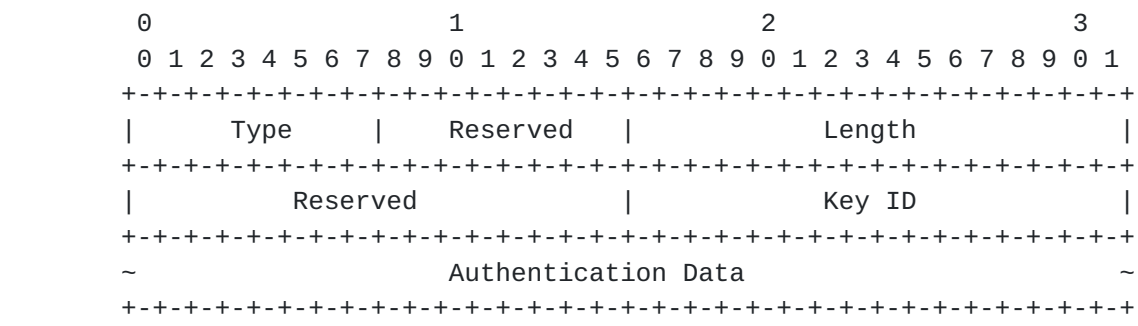
4.4. GAP Suppress TLV

This object is a request to the receiver to cease sending GAP updates to the transmitter over the current channel. The object format is the same as the GAP Request TLV object. If the Length is set to zero, suppression of all GAP messages is requested; otherwise suppression of only those updates pertaining to applications listed in the Value field is requested.

This object makes sense only for point-to-point channels or when the sender is receiving unicast GAP updates.

4.5. GAP Authentication TLV

This object is used to provide authentication and integrity validation for a GAP message. It has the following format:



GAP Authentication TLV Format

The data and procedures associated with this object are explained in Section 6.

5. Operation

5.1. G-ACh Advertisement Message Transmission

G-ACh Advertisement Protocol message transmission SHALL operate on a per-data-channel basis and be configurable by the operator accordingly.

Because GAP message transmission may be active for many logical channels on the same physical interface, message transmission timers SHOULD be randomized across the channels supported by a given interface so as to reduce the likelihood of large synchronized message bursts.

The Message Identifier uniquely identifies this message and is set at the sender's discretion. The Timestamp field SHALL be set to the time at which this message is transmitted.

The Lifetime field of each Application Data Block element SHALL be set to the number of seconds the receiver is advised to retain the data associated with this message and application.

Lifetimes SHOULD be set in such a way that at least three updates will be sent prior to Lifetime expiration. For example, if updates are sent at least every 60 seconds, a Lifetime of 185 seconds may be used.

In some cases additional reliability may be desired for the delivery of a GAP message. When this is the case, the RECOMMENDED procedure is to send three instances of the message in succession, separated by a delay appropriate to the application. This procedure SHOULD be used, if at all, only for messages that are in some sense

'exceptional'; for example when sending a flush instruction following device reset.

5.2. G-ACh Advertisement Message Reception

Upon receiving a G-ACh Advertisement Protocol message containing data for a set of applications, the receiver MUST discard any earlier data retained for each application in the set, and SHOULD retain the new data associated with each application in the set by this message for the number of seconds specified by the Lifetime field, or until a newer message describing the application is received.

The receiver MAY make use of the application data contained in a GAP message to perform some level of autoconfiguration, for example if the application is an OAM protocol. The implementation SHOULD, however, take care to prevent cases of oscillation resulting from each endpoint attempting to adjust its configuration to match the other. Any such autoconfiguration based on GAP information MUST be disabled by default.

6. Message Authentication

The GAP provides a means of authenticating messages and ensuring their integrity. This is accomplished by attaching a GAP Authentication TLV and including, in the Authentication Data field, the output of a cryptographic hash function, the input to which is the message together with a secret key known only to the sender and receiver. Upon receipt of the message, the receiver computes the same hash and compares the result with the hash value in the message; if the hash values are not equal, the message is discarded.

The remainder of this section gives the details of this procedure, which is based on the procedures for generic cryptographic authentication for the Intermediate System to Intermediate System (IS-IS) routing protocol as described in [RFC5310].

6.1. Authentication Key Identifiers

An Authentication Key Identifier (Key ID) is a 16-bit tag shared by the sender and receiver that identifies a set of authentication parameters. These parameters are not sent over the wire; they are assumed to be associated, on each node, with the Key ID by external means, such as via explicit operator configuration or a separate key-exchange protocol. Multiple Key IDs may be active on the sending and receiving nodes simultaneously, in which case the sender locally selects a Key ID from this set to use in an outbound message. This capability facilitates key migration in the network.

The parameters associated with a Key ID are:

- Authentication Algorithm: This signifies the authentication algorithm to use to generate or interpret authentication data. At present, the following values are possible: HMAC-SHA-1, HMAC-SHA-224, HMAC-SHA- 256, HMAC-SHA-384, and HMAC-SHA-512.

- Authentication Keystring: A secret string that forms the basis for the crytographic key used by the Authentication Algorithm.

6.2. Authentication Process

The authentication process for GAP messages is straightforward. First, a Key ID is associated on both the sending and receiving nodes with a set of authentication parameters. Following this, when the sender generates a GAP message, it sets the Key ID field of the GAP Authentication TLV accordingly. (The length of the Authentication Data field is also known at this point, because it is a function of the Authentication Algorithm.) The sender then computes a hash for the message as described below, and fills the Authentication Data field of the GAP Authentication TLV with the hash value. The message is then sent.

When the message is received, the receiver computes a hash for it as described below. The receiver compares its computed value to the hash value received in the Authentication Data field. If the two hash values are equal, authentication of the message is considered to have succeeded; otherwise it is considered to have failed.

This process suffices to ensure the authenticity and integrity of messages, but is still vulnerable to a replay attack, in which a third party captures a message and sends it on to the receiver at some later time. The GAP message header contains a Timestamp field which can be used to protect against replay attacks. To achieve this protection, the receiver checks that the time recorded in the timestamp field of a received and authenticated GAP message corresponds to the current time, within a reasonable tolerance that allows for message propagation delay, and accepts or rejects the message accordingly.

If the clocks of the sender and receiver are not synchronized with one another, then the receiver must perform the replay check against its best estimate of the current time according to the sender's clock. The timestamps that appear in GAP messages can be used to infer the approximate clock offsets of senders and, while this does not yield high-precision clock synchronization, it suffices for purposes of the replay check with an appropriately chosen tolerance.

6.3. Hash Computation

In the algorithm description below, the following nomenclature, which is consistent with [FIPS-198], is used:

Symbol	Definition
H	The specific hash algorithm, e.g. SHA-256
K	The Authentication Keystring
Ko	The cryptographic key used with the hash algorithm
B	The block size of H, measured in octets rather than in bits. Note that B is the internal block size, not the hash size. This is equal to 64 for SHA-1 and SHA-256, and to 128 for SHA-384 and SHA-512.
L	The length of the hash, measured in octets rather than in bits
XOR	The exclusive-or operation
Opad	The hexadecimal value 0x5c repeated B times
Ipad	The hexadecimal value 0x36 repeated B times
Apad	hexadecimal value 0x878FE1F3 repeated (L/4) times

1. Preparation of the Key

   In this application, Ko is always L octets long.

   If the Authentication Keystring (K) is L octets long, then Ko is equal to K. If the Authentication Keystring (K) is more than L octets long, then Ko is set to H(K). If the Authentication Keystring (K) is less than L octets long, then Ko is set to the Authentication Keystring (K) with zeros appended to the end of the Authentication Keystring (K) such that Ko is L octets long.

2. First Hash

   First, the Authentication Data field is filled with the value Apad.

   Then, a first hash, also known as the inner hash, is computed as follows:

      First-Hash = H(Ko XOR Ipad || (GAP Message))

   Here the GAP Message is the portion of the packet that follows the Associated Channel Header.

3. Second Hash

Then a second hash, also known as the outer hash, is computed as follows:

Second-Hash = H(Ko XOR Opad || First-Hash)

4. Result

The resulting second hash becomes the authentication data that is sent in the Authentication Data field of the GAP Authentication TLV. The length of the Authentication Data field is always identical to the message digest size of the specific hash function H that is being used.

This also means that the use of hash functions with larger output sizes will increase the size of the GAP message as transmitted on the wire.

7. Link-Layer Considerations

When the GAP is used to support device discovery on a data link, GAP messages must be sent in such a way that they can be received by other listeners on the link without the sender first knowing the link-layer addresses of the listeners. In short, they must be multicast. Considerations for multicast MPLS encapsulation are discussed in [RFC5332]. For example, Section 8 of [RFC5332] describes how destination Ethernet MAC addresses are selected for multicast MPLS packets. Since a GAP packet transmitted over a data link contains just one label, the G-ACh Label (GAL) with label value 13, the correct destination Ethernet address for frames carrying GAP packets intended for device discovery, according to these selection procedures, is 01-00-5e-80-00-0d.

8. Security Considerations

G-ACh Advertisement Protocol messages contain information about the sending device and its configuration, which is sent in cleartext over the wire. If an unauthorized third party gains access to the MPLS data plane or the lower network layers between the sender and receiver, it can observe this information. In general, however, the information contained in GAP messages is no more sensitive than that contained in other protocol messages, such as routing updates, which are commonly sent in cleartext. No attempt is therefore made to guarantee confidentiality of GAP messages.

A more significant potential threat is the transmission of GAP messages by unauthorized sources, or the unauthorized manipulation of messages in transit; this can disrupt the information receivers hold about legitimate senders. To protect against this threat, message authentication procedures are specified in this document that enable receivers to ensure the authenticity and integrity of GAP messages. These procedures include the means to protect against replay attacks, in which a third party captures a legitimate message and "replays" it to a receiver at some later time.

9. IANA Considerations

This document requests that IANA allocate an entry in the Pseudowire Associated Channel Types registry [RFC5586] for the G-ACh Advertisement Protocol, as follows:

Value	Description	TLV Follows	Reference
(TBD)	G-ACh Advertisement Protocol	No	(this draft)

This document also requests that IANA create a new registry, "G-ACh Advertisement Protocol Applications and Data Types", with fields and initial allocations as follows:

Application ID	Description	Type Name	Type ID	Reference
0x0000	G-ACh Advertisement Protocol	GAP Request	0	(this draft)
		GAP Flush	1	(this draft)
		GAP Suppress	2	(this draft)
		GAP Authentication	3	(this draft)

The allocation policy for this registry is IETF Review.

10. References

10.1. Normative References

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