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TM-RID Authentication Formats

Abstract

This document describes how to include trust into the proposed ASTM Remote ID specification defined in WK65041 by the F38 Committee under a Broadcast Remote ID (RID) scenario. It defines a few different message schemes (based on the authentication message) that can be used to assure past messages sent by a UA and also act as an assurance for UA trustworthiness in the absence of Internet connectivity at the receiving node.

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 21 August 2020.

Table of Contents

1. Introduction

UA Systems (UAS) are usually in a volatile environment when it comes to communication. UA are generally small with little computational (or flying) horsepower to carry standard communication equipment. This limits the mediums of communication to few viable options.

Observer systems (e.g. smartphones and tablets) place further constraints on the communication options. The Remote ID Broadcast messages MUST be available to applications on these platforms without modifying the devices.

The ASTM standard focuses on two ways of communicating to a UAS for RID: Broadcast and Network.

This document will focus on adding trust to Broadcast RID in the current authentication message format, using the Host Identity Protocol Version 2 (HIPv2) [RFC7401] Hierarchical HIT (HHIT) [I-D.moskowitz-hip-hierarchical-hit].

2. Terms and Definitions

2.1. Requirements Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2.2. Definitions

HI
: Host Identity. The public key portion of an assymetric keypair from HIP. In this document it is assumed that the HI is based on

a EdDSA25519 keypair. This is supported by new crypto defined in [I-D.moskowitz-hip-new-crypto].

HIT
Host Identity Tag. A 128 bit handle on the HI. Defined in HIPv2 [RFC7401].

HHIT
Hierarchical Host Identity Tag. A 128 bit handle on the HI contain extra information not found in a standard HIT. Defined in [I-D.moskowitz-hip-hierarchical-hit].

UA
Unmanned Aircraft. In this document UA's are typically though of as drones of commerical or military variety. This is a very strict definition which can be relaxed to include any and all aircraft that are unmanned.

UAS
Unmanned Aircraft System. Composed of Unmanned Aircraft and all required on-board subsystems, payload, control station, other required off-board subsystems, any required launch and recovery equipment, all required crew members, and C2 links between UA and the control station.

RID
Remote ID. A unique identifier found on all UA to be used in communication and in regulation of UA operation.

Observer
Referred to in other UAS documents as a "user", but there are also other classes of RID users, so we prefer "observer" to denote an individual who has observed an UA and wishes to know something about it, starting with its RID.

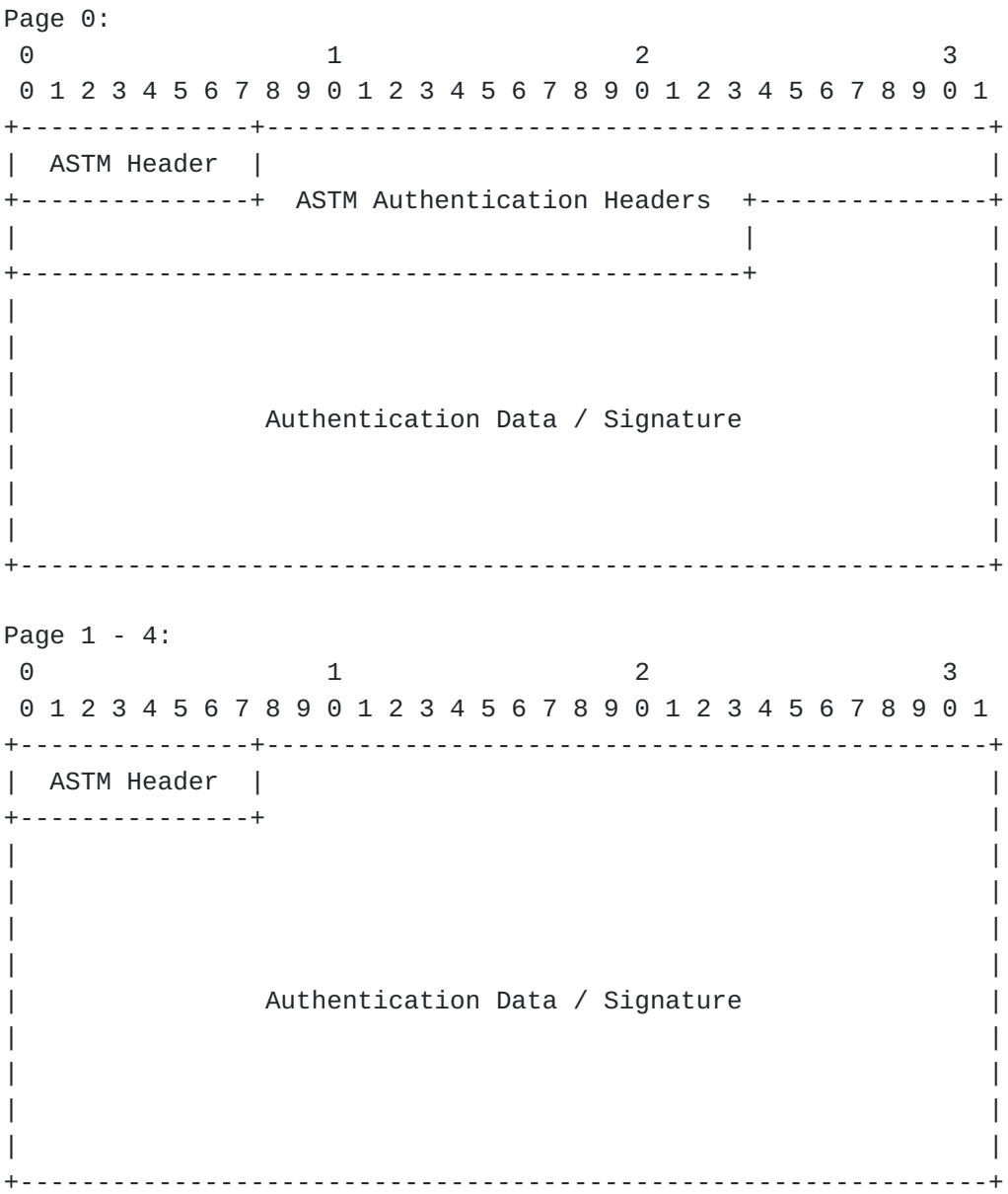
3. Background

3.1. Problem Space And Document Focus

The current draft standard for Remote ID (RID) does not, in any meaningful capacity, address the concerns of trust in the UA space with communication in the Broadcast RID environment. This is a requirement that will need to be addressed eventually for various different parties that have a stake in the UA industry.

The following subsections will provide a high level reference to the ASTM standard for authentication messages and how their current limitations effect trust in the Broadcast RID envirorment.

3.2. ASTM Authentication Message



ASTM Header (1 byte):
Contains basic ASTM information such as message type and protocol version.

ASTM Authentication Headers: (6 bytes)
Contains header information for the authentication message from ASTM UAS RID Standard.

Authentication Data / Signature: (109 bytes: 17+23*4)
Opaque authentication data.

The above diagram is the format defined by ASTM that is the frame which everything this document fits into. The specific details of the ASTM headers are abstracted away as they are not necessarily required for this document.

3.3. Thoughts on ASTM Authentication Message

The format proposed by the ASTM is designed with a few major considerations in mind, which the authors feel put significant limitations on the expansion of the standard.

The primary consideration (in this context) is the use of the Bluetooth 5.X Extended Frame format. This method allows for a 255 byte payload to be sent in what the ASTM refers to as a "Message Pack".

The idea is to include up to five standard ASTM Broadcast RID messages (each of which are 25 bytes) plus a single authentication message (5 pages of 25 bytes each) in the Message Pack. The reasoning is then the authentication message is for the entire Message Pack.

The authors have no issues with this proposed approach; this is a valid format to use for the authentication message provided by the ASTM. However, by limiting the authentication message to ONLY five pages in the standard it ignores the possibility of other formatting options to be created and used.

Another issue with this format, not fully addressed in this document is fragmentation. Under Bluetooth 4.X, each page is sent seperately which can result in lose of pages on the reciever. This is disasterous as the loss of even a single page means any signature is incomplete.

With the current limitation of 5 pages, Forward Error Correction (FEC) is nearly impossible without sacrificing the amount of data sent. More pages would allow FEC to be performed on the Authentation message pages so loss of pages can be mitigated.

All these problems are further amplified by the speed at which UA fly and the Oberserver's position to recieve transmissions. There is no guarentee that the Observer will recieve all the pages of even a 5 page Authentication Message in the time it takes a UA to traverse across their line of sight. Worse still is that is not including other UA in the area, which congestes the spectrum and could cause further confusion attempting to collate messages from various UA. This specific problem is out of scope for this document and our solutions in general, but should be noted as a design consideration.

4. HIP Based Extensions to the ASTM Authentication Message

The following section describes various methods that HIP can help enable more trustworthy communication using the Authentication Message as the base. Each diagram will show all pages of the format filled out.

4.1. HIP Based Authentication Wrapper

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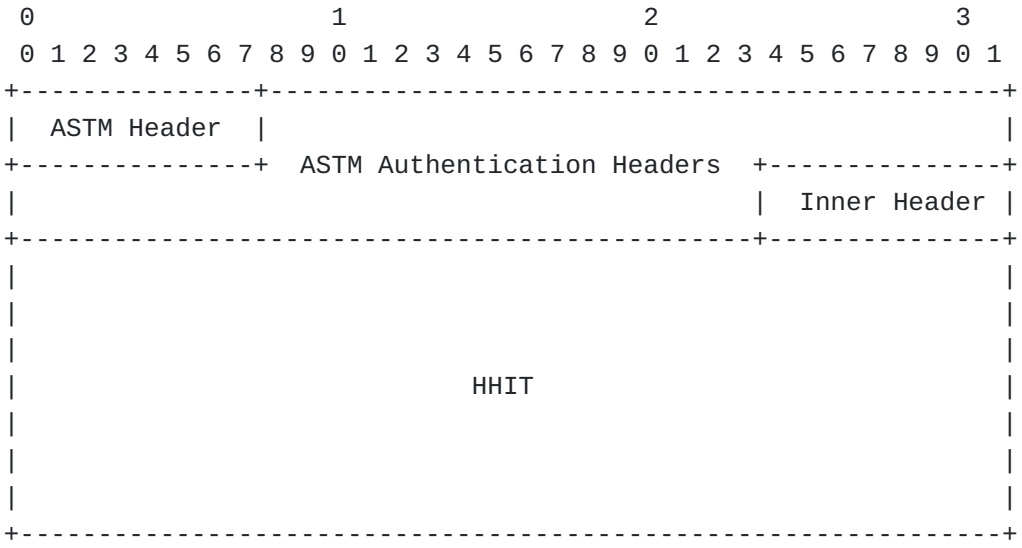

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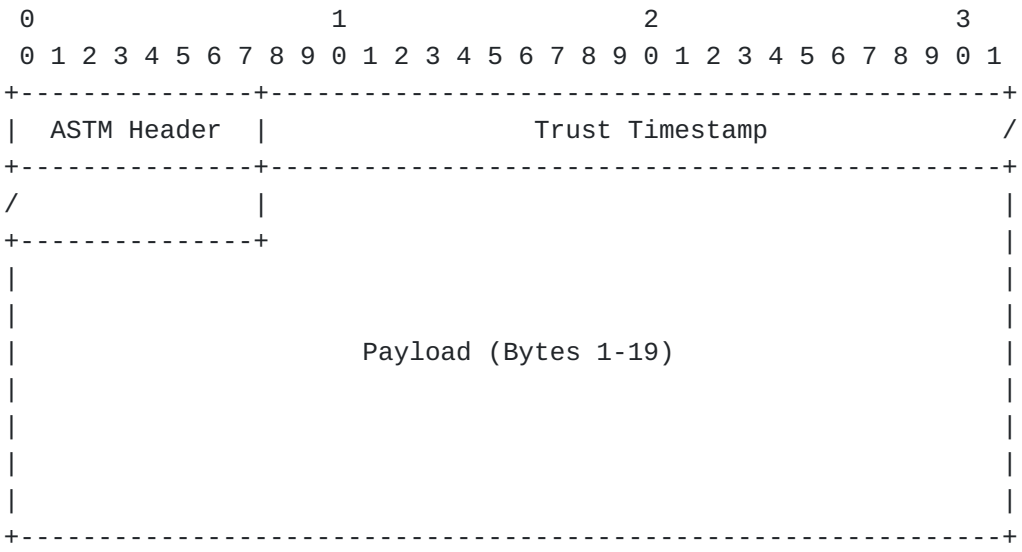

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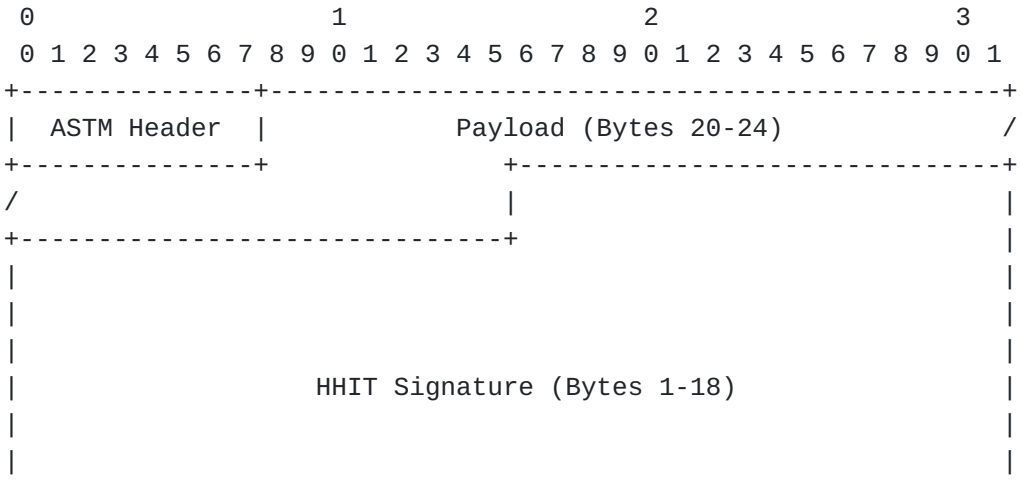

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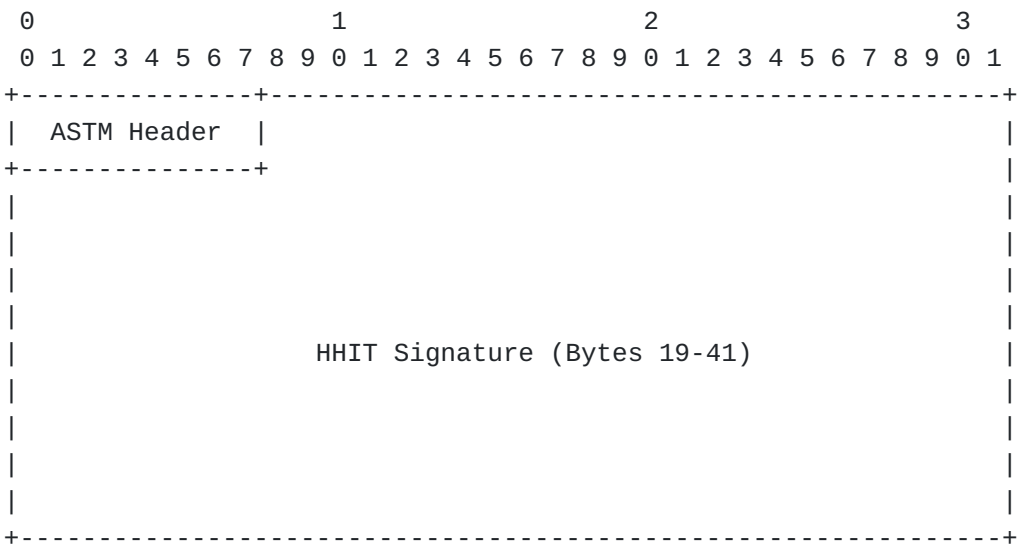

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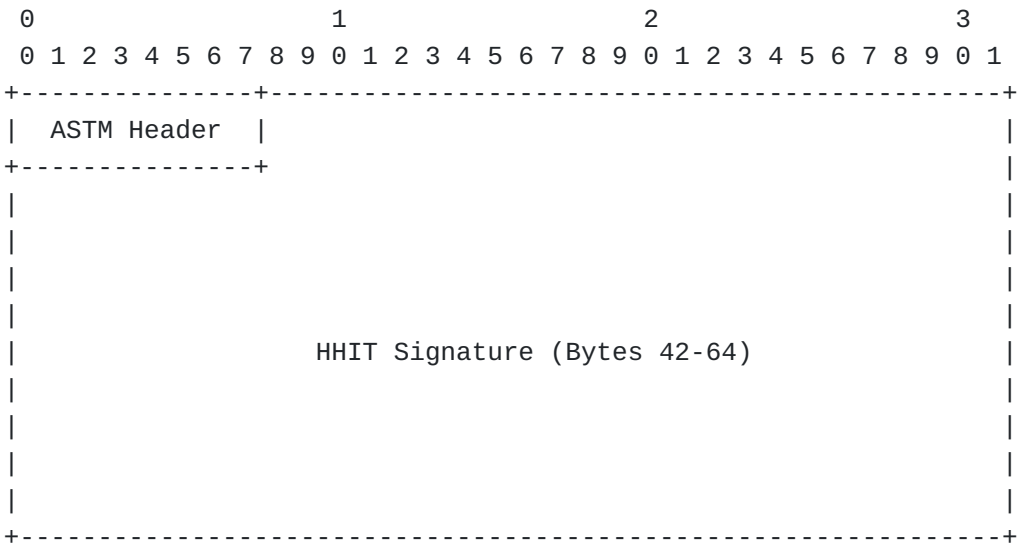

Inner Header (1 byte):
        See Inner Header section.

HHIT: (16 bytes)
    HHIT using the EdDSA25519 HI.

Trust Timestamp: (4 bytes)
    Timestamp denoting current time plus an offset to trust
    message to.

Payload: (24 bytes)
    Opaque payload data.

HHIT Signature: (64 bytes)

    Signature over precedding fields using the EdDSA25519 keypair.

When this authentication format is recieved the HHIT is first looked up in DNS by standard mechanisms to retrieve the HIP RR. From this the HI can be used to perform signature verifiction. The data signed is all the data preceding the 64 byte signature (excluding the ASTM Headers and ASTM Authentication Headers).

When there is no Internet connectivity on the Observers device the HI of the UA can be obtained by referencing the certificate sent in the Offline Based Authentication format, if sent by the UA.

4.1.1. Inner Header

When the payload is another ASTM message then the first byte of the full message should be used to fill in the Inner Header field. This byte can be signed but is primarily for identitying the inner message type (for unpacking purposes if desired by the Observer device).

Another use of the Inner Header byte is holding the H-Alg and H-Len fields if this format is used for Hashed Messages. See Section 5.2 for a detailed example of this. When this format is used all 24 bytes of the payload MUST be filled with hash values. This requirement means that only even numbered hash lengths can be used.

Any other wrapped messages that are not 24 bytes long and require padding on the payload MUST use the Inner Header to inform the reciever the length of payload in octets.

To accomadate payload differences the use of AuthType in the ASTM Header section SHOULD be set in the range of 0xA-F (which is availible for Private Use). Only recommended values are defined here, as the allocation in the reserved space of this header is controlled by ASTM.

AuthType	Values
Wrapped ASTM Message	A
Wrapped Hashes	B
Wrapped Message Length (octets)	C

4.1.2. Trust Timestamp

Trust Timestamp MUST be current UNIX time plus an offset into the future.

To avoid replay attacks the Trust Timestamp field must be well founded. When wrapping a vector (position) message the payload WILL contain (by ASTM rules) constantly changing data, this includes its

own timestamp. In this case the Trust Timestamp could be argued as superfoulous.

Other message types, such as Basic ID and Self-ID are static messages with no changing data. To protect a replay of these signed messages the Trust Timestamp is the field during signing to be guarenteed to change.

The offset used against the UNIX timestamp is not defined in this document. Best practices to identify a acceptable offset should be used taking into consideration the UA envirorment, and propgation characteristics of the messages being sent.

4.1.3. Payload

The payload can be anything that fits within the 24 byte limit. An example of what could be done with this format is found in Section 5.1. If the payload is less than 24 bytes, null padding MUST be used to fill up to 24 bytes and the AuthType of 0xC MUST be used to identity message size.

4.2. Signed Hash Lists

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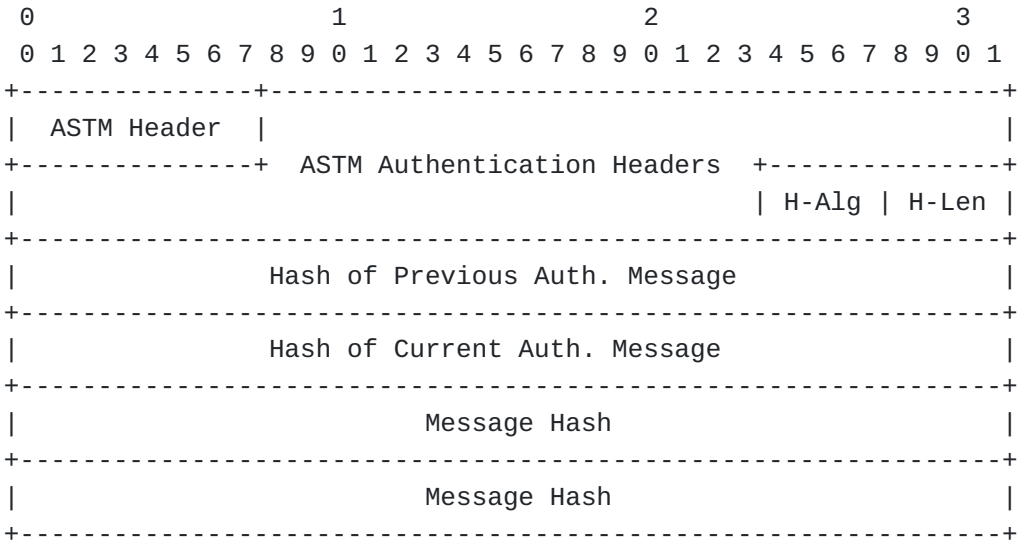

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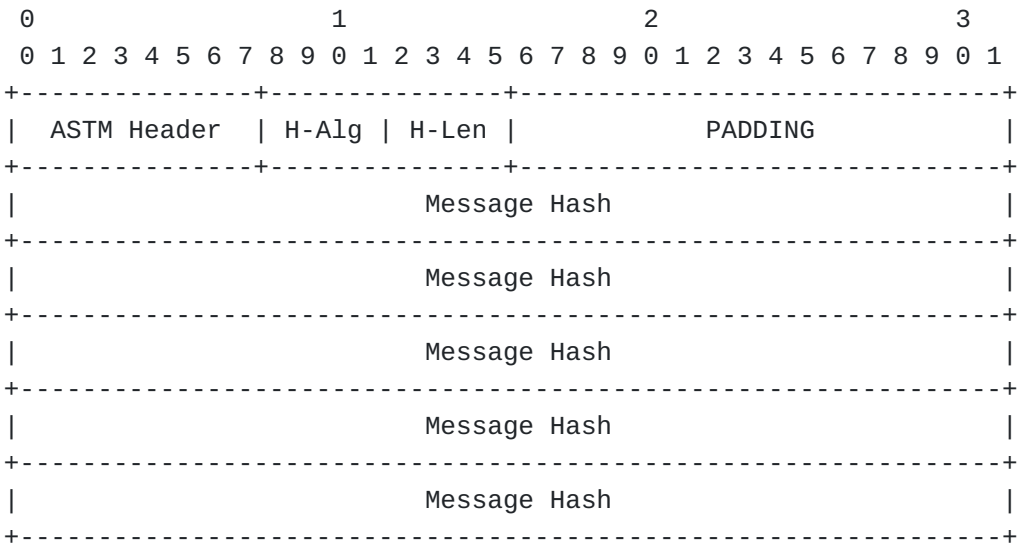

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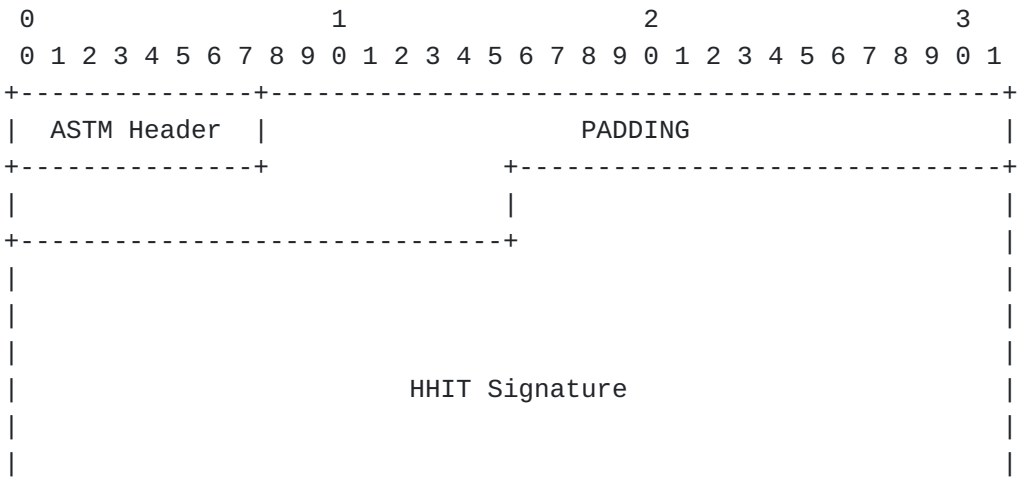

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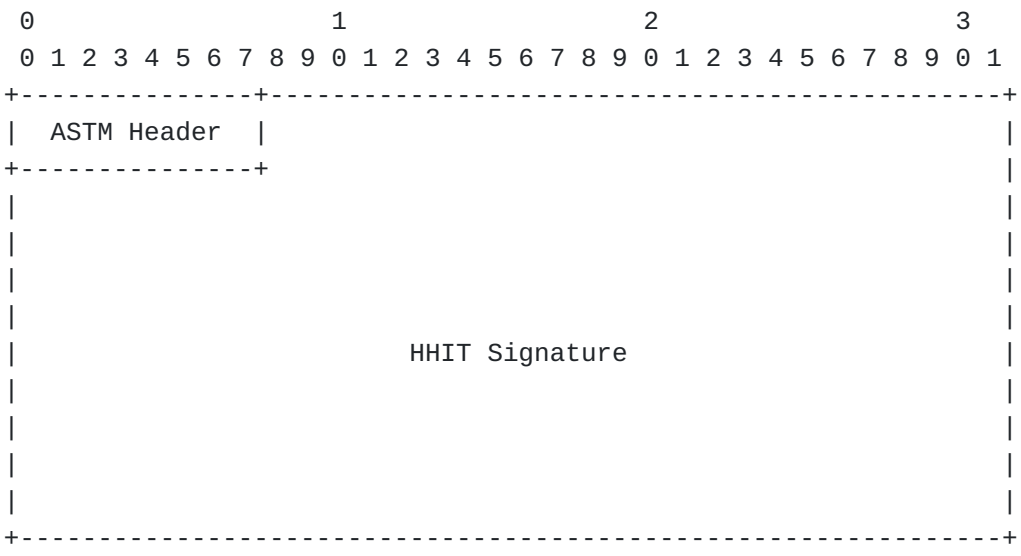

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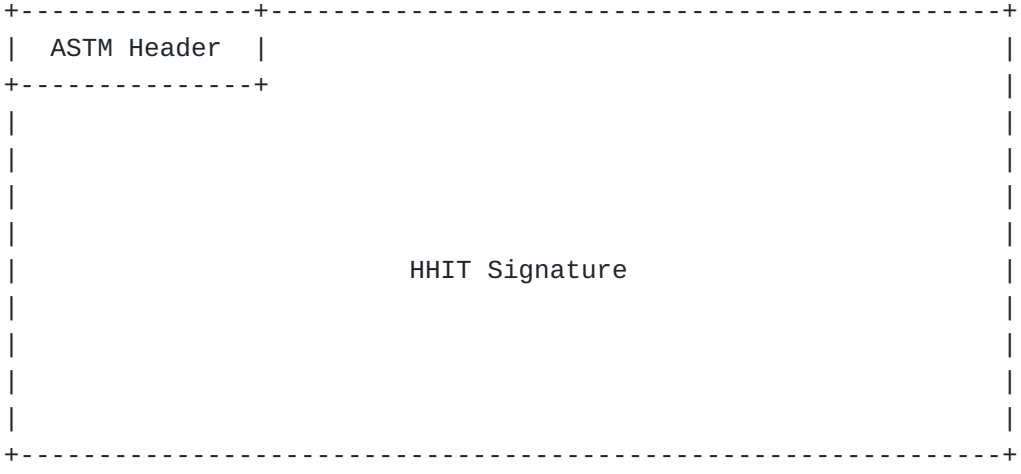

H-Alg, H-Len: (4 bits), (4 bits)

These are fields for relaying information of the Hash algorithm used for the messages and the Hash length (in octets). For this example of the format a length of 4 bytes is used.

H-Alg	Values
RESERVED	0
cSHAKE128	1 [SP800-185] (RECOMMENDED)

Hash of Previous Auth. Message: (4 bytes)

A hash of the previously sent Authentication message.

Hash of Current Auth. Message: (4 bytes)
A hash of the current Authentication message.

Message Hash: (4 bytes)
A hash of a previously sent message.

HHIT Signature: (64 bytes)
EdDSA25519 signature using an EdDSA25519-based HI from HIP.

This format is designed to provide provenance to Broadcast RID messages sent by a given UAS. It should be noted that the HHIT is not provided in the format like others specified here - instead it must be obtained via the Basic ID Message in a detached fashion.

By hashing previously sent messages and signing them we gain trust in UAS previous reports. An observer who has been listening for any length of time can hash received messages and cross check against listed hashes. The signature is signed across the list of hashes.

4.2.1. Hash Operation

With cSHAKE128 NIST SP 800-185 [NIST.SP.800-185], the hash is computed as follows:

```
cSHAKE128(MAC|Message, 8*H-Len, "", "RemoteID Auth Hash")
```

The message MAC is prepended to the message, as the MAC is the only information that links a UA's messages from a specific UA.

4.2.2. Pseudo-blockchain Hashes

Two special hashes are included; a previous authentication hash, which links to the previous signed hash list message, as well as a current hash. This gives a pseudo-blockchain provenance to the authentication message that could be traced back if the observer was present for extended periods of time.

In regards to the creation and use of the current authentication hash field:

> During creation and signing of this message format this field MUST be set to 0. So the signature will be based on this field being 0, as well as its own hash. It is an open question of if we compute the hash, then sign or sign then compute.
>
> There a few different ways to cycle this message. We can "roll up" the hash of 'current' to 'previous' when needed or to completely recompute the hash. This mostly depends on the previous note.

4.2.3. Limitations

With the current format proposed by ASTM only 7 messages can be hashed reasonably in the above format. PADDING and redundant H-Alg, H-Len fields could be removed. This would increase the total list of hashes to 9 while losing word alignment of the hashes in each page.

To address this problem properly the authors feel that the Authentication Messages needs to have a max bound of 10 pages, instead of 5.

4.3. HIP Based Offline Authentication

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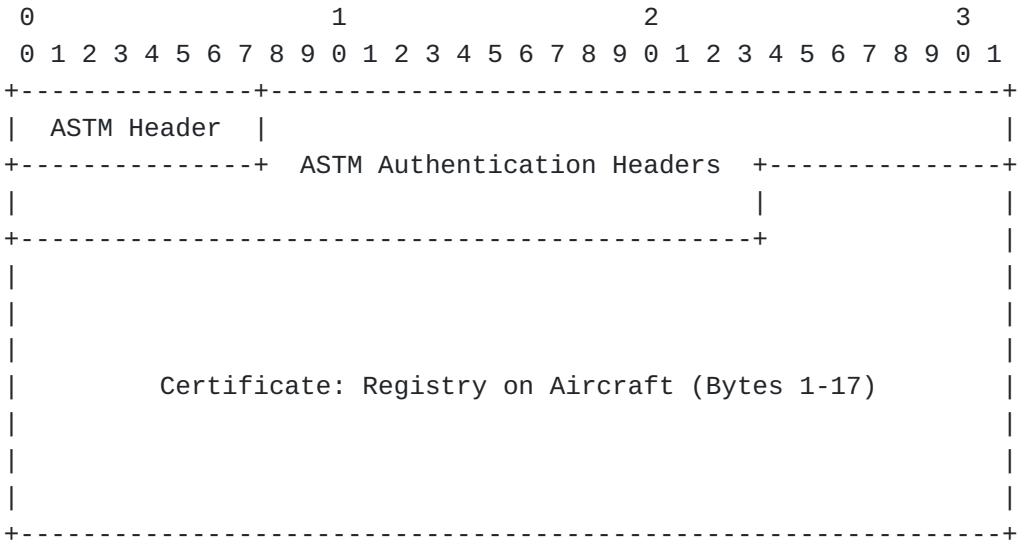

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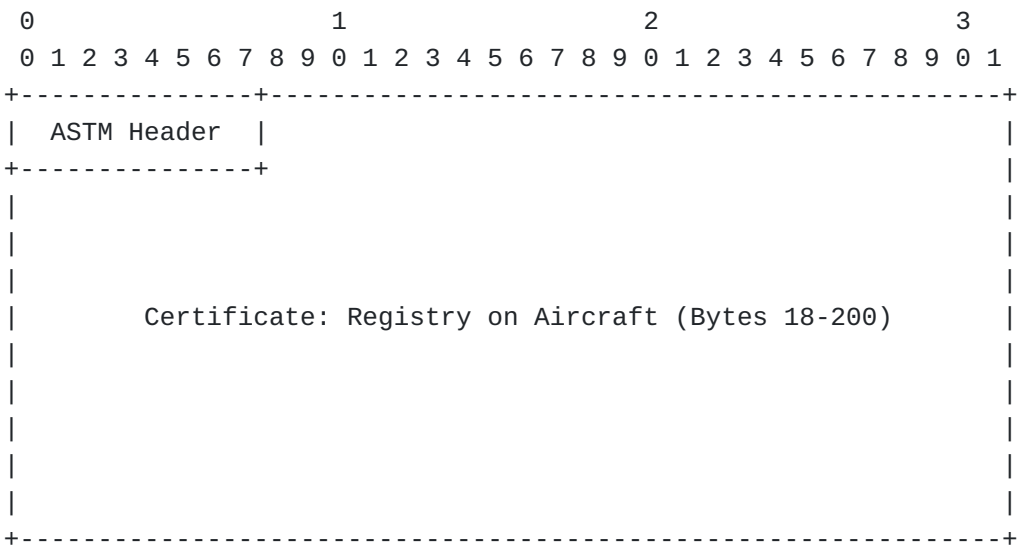

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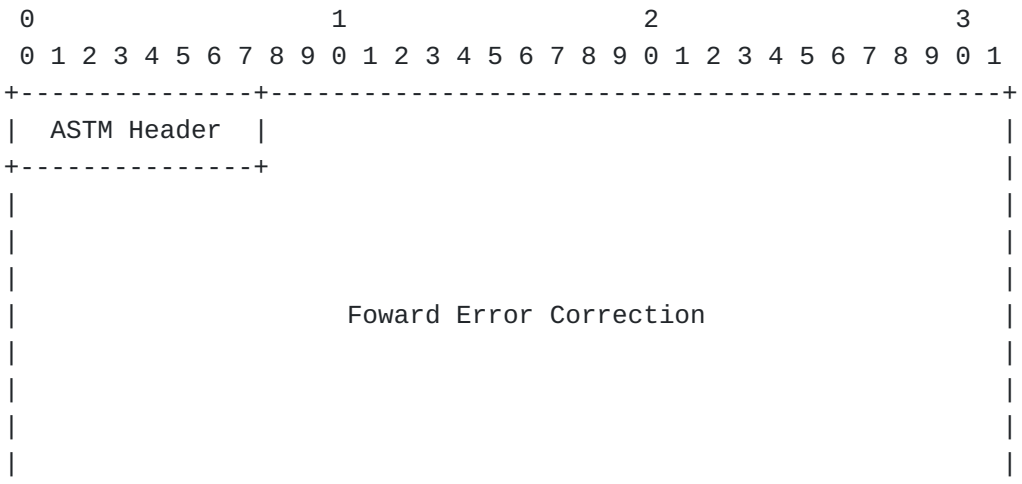


Certificate: Registry on Aircraft (200 bytes):
: A certificate granted by the Registry that asserts the binding of UA to the given Registry. Note that Page 8's final byte is actually padding.

Foward Error Correction (FEC) (23 bytes):
: FEC on the previous 9 pages.

This specific format does not currently fit within the ASTM specification. Requiring a minimum of 200 bytes, this would require the Authentication Message to have 10 pages, instead of the current 5 page limit. The rest of this section assumes 10 pages to demonstrate how this message is laid out and works.

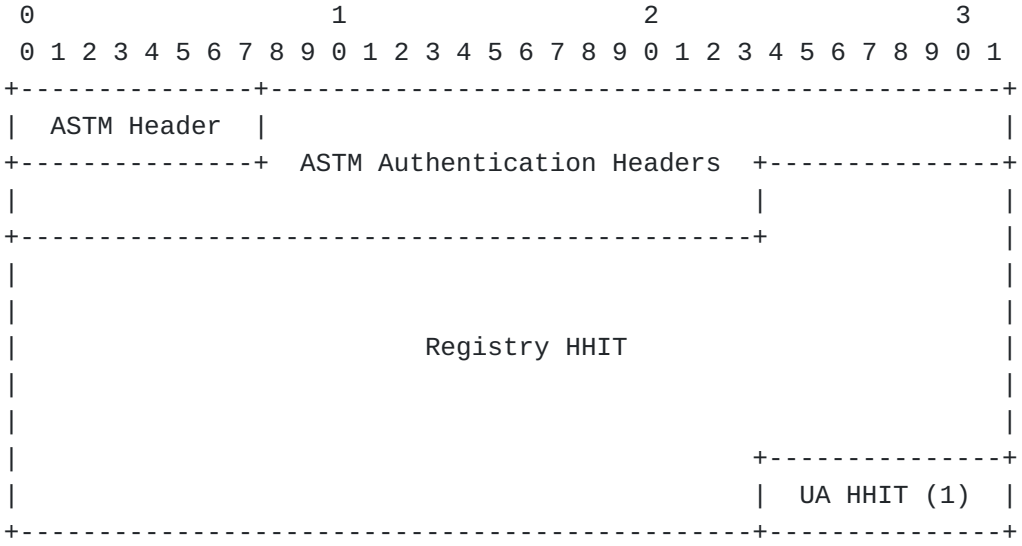
What this grants is the ability to authenticate UA information when the receiving device of the observer (e.g. a smartphone with a dedicated RID application) has no Internet service (e.g. LTE signal).

By including the device HI along with a signature from the registry the UA is under, we can assert trust of a given UA without requiring the need for immediate reverse lookups online.

4.3.1. Certificate: Registry on Aircraft

The bulk of this message is made up with the 200 byte certificate titled "Registry on Aircraft" (henceforth refered to as "Cra"). Below is Cra fully marked out inside the ASTM Authentication Message.

Page 0:



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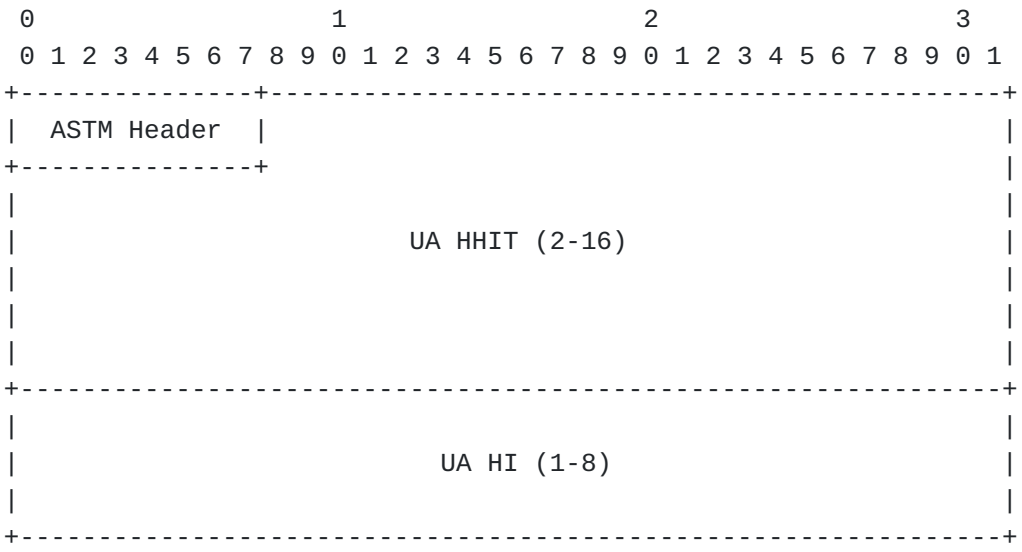

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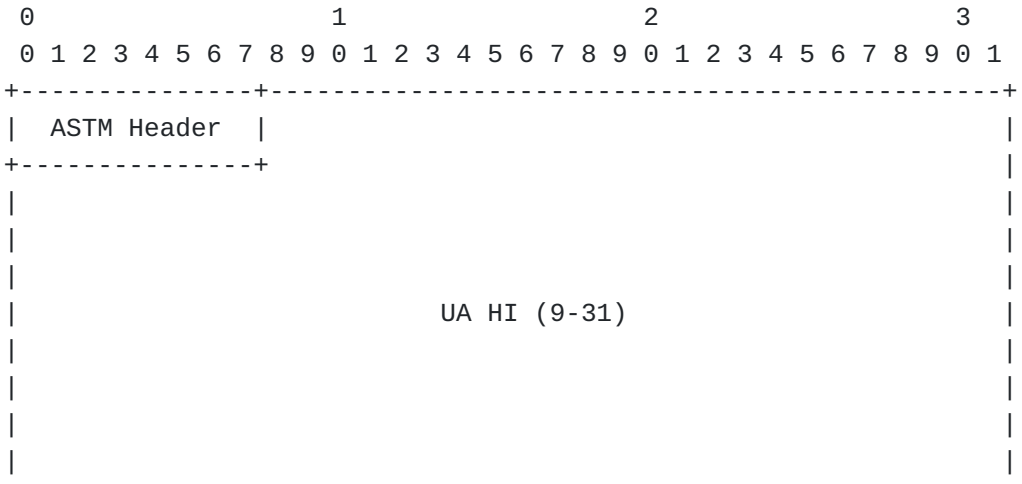

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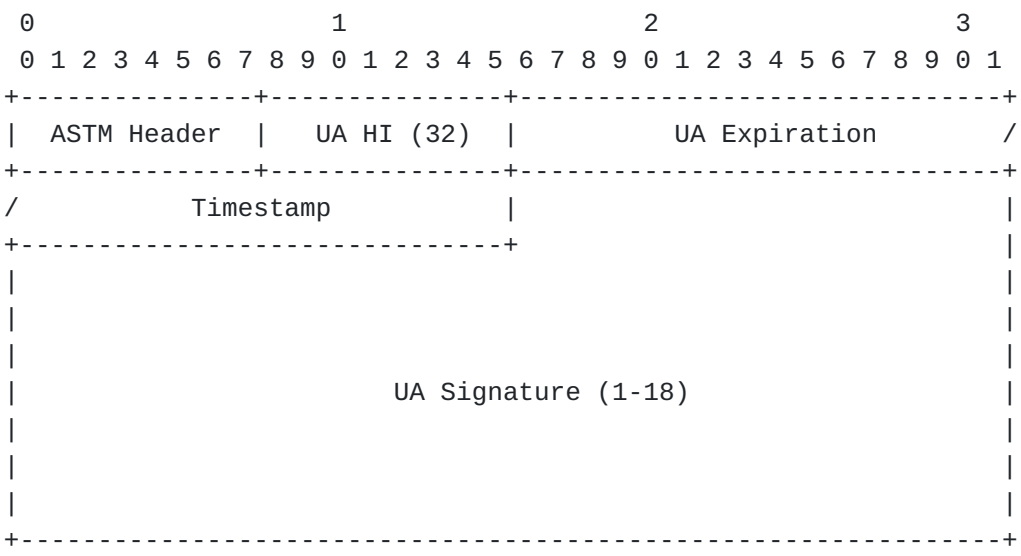

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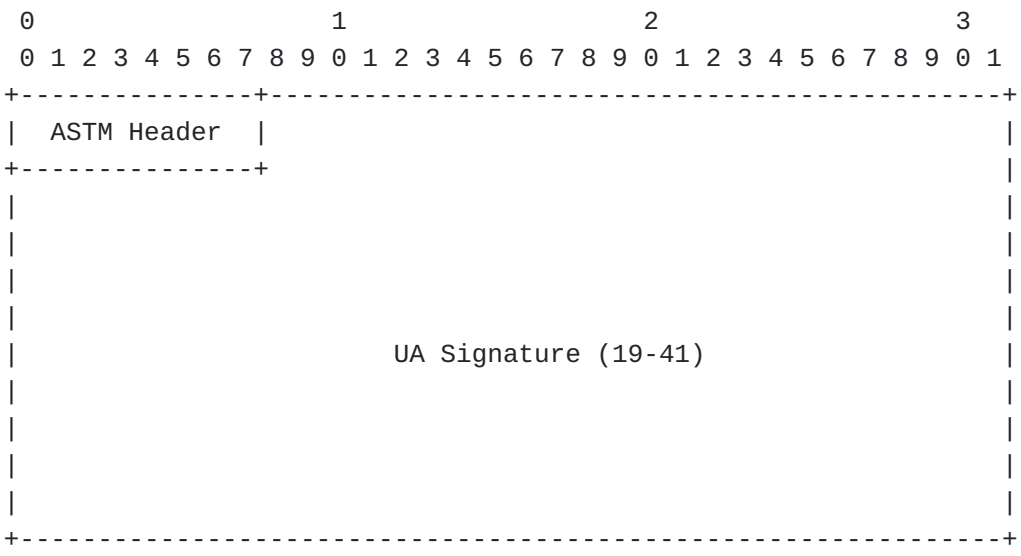

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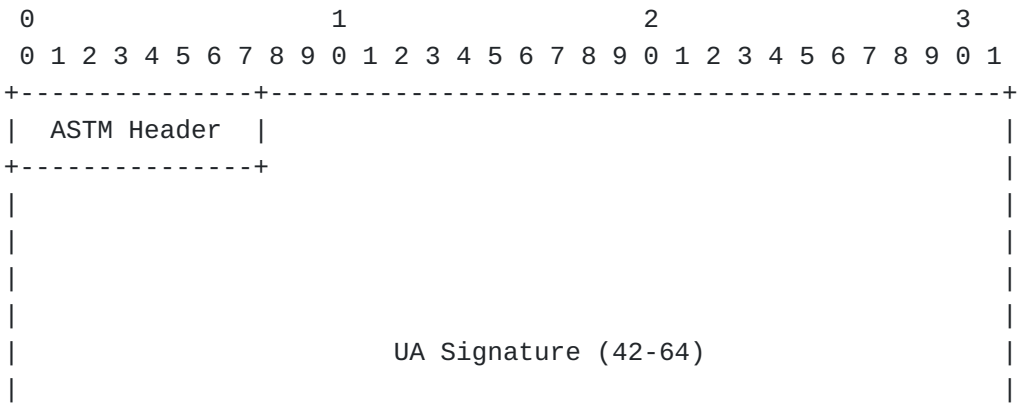

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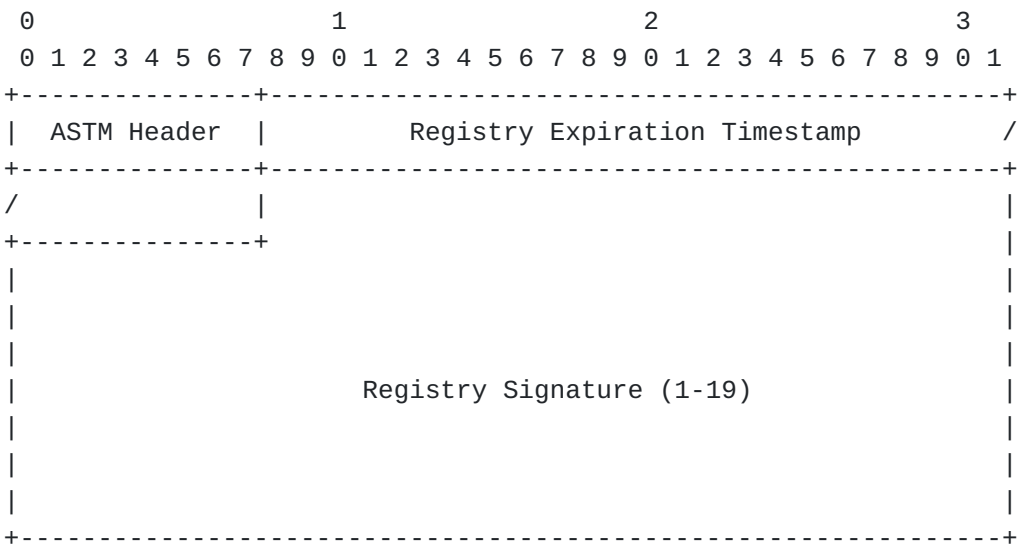

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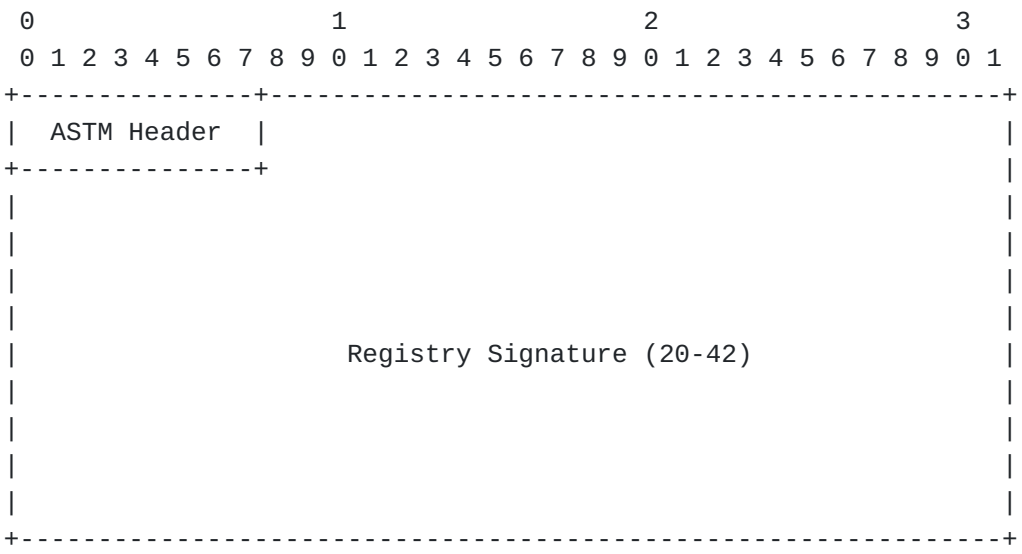

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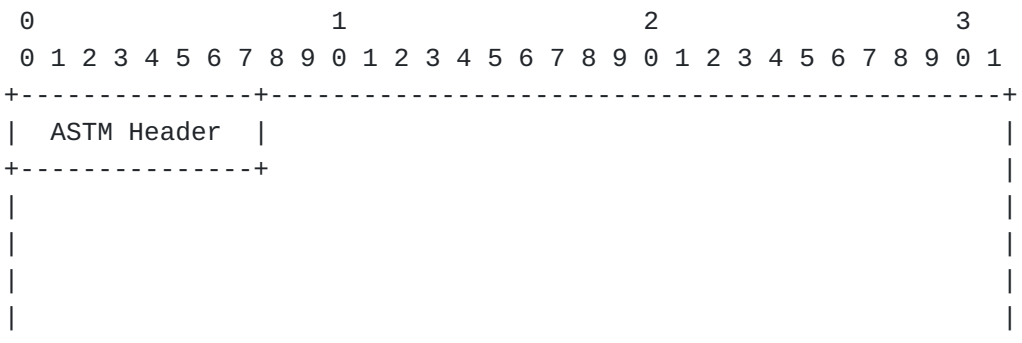
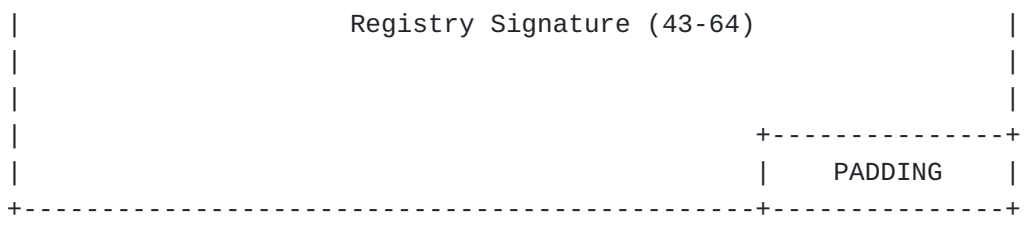




Registry HHIT (16 bytes):
        Registry HHIT that UA is registered under and handle
        for the HI used in the signing of full certificate.

Certificate: Aircraft on Aircraft [Caa] (116 bytes):
        UA HHIT (16 bytes):
                Nominally the Aircraft HHIT (specificed here as UA)

        UA HI (32 bytes):
                Public half of EdDSA-25519 asymmetric keypair used
                to sign Caa.

        UA Expiration Timestamp (4 bytes):
                UNIX current time (at time of signing) + offset

        UA Signature (64 bytes):
                Signature with UA keypair using the data of UA HHIT,
                UA HI and UA Expiration Timestamp.

Registry Expiration Timestamp (4 bytes):
        UNIX current time (at time of signing) + offset

Registry Signature (64 bytes):
        Signature with Registry keypair using the data of
        Registry HHIT, Caa and Registry Expiration Timestamp.

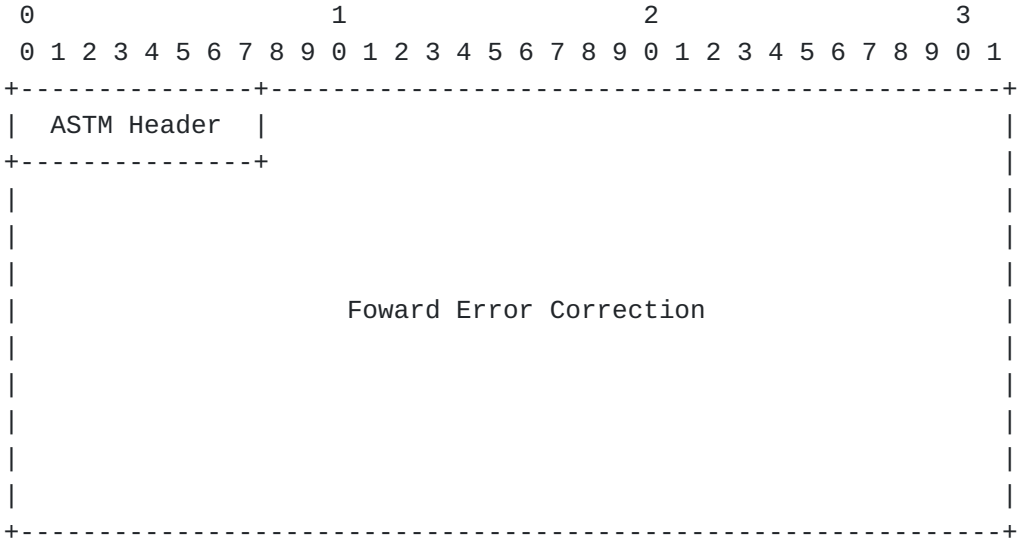
Cra is in practice a binding certificate between the Registry and the Aircraft, asserting the relationship between the two entities. Cra signs another certificate, Caa (Certificate: Aircraft on Aircraft), that is created during UA provisioning.

Importantly this certificate allows Offline signature verification from the UA. This is as the UA HI is included in the certificate. Also included is the HHIT of the Registry to check the local shortlist of Registries that the Observer device trusts (mapping HHITs to HIs).

More details about Caa, Cra and other certificates and the provisioning process can be found HERE.

4.3.2. Foward Error Correction

Page 9:



TBD

5. Example Use Cases

This section introduces potentional use cases of the HIP based extensions to the proposed ASTM standard authentication message.

5.1. Trusted Messages

Using the HIP Based Authentication Wrapper any single Broadcast RID message defined by ASTM can become what the authors refer to as a "Trusted Message".

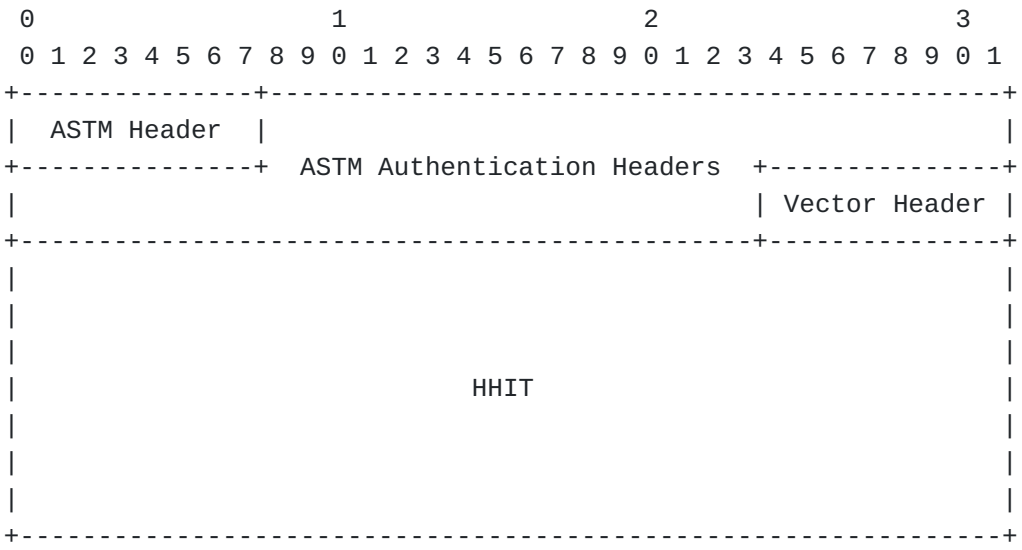
One specific use case that is useful in the UAS RID space is the creation of a "Trusted Vector Message". By placing a previous [or

new] vector message into the payload section of this format a verifiable broadcast can be created.

Due to being signed this creates an authentic vector that is hard to spoof, which can confirm flight paths in near real time.

The figure below is a example of a "Trusted Vector Message".

Page 0:



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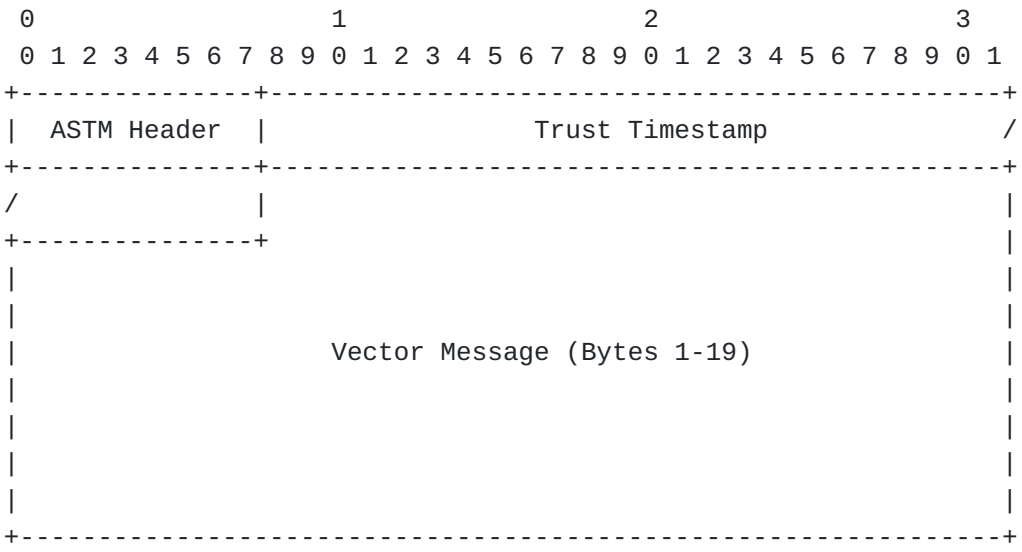

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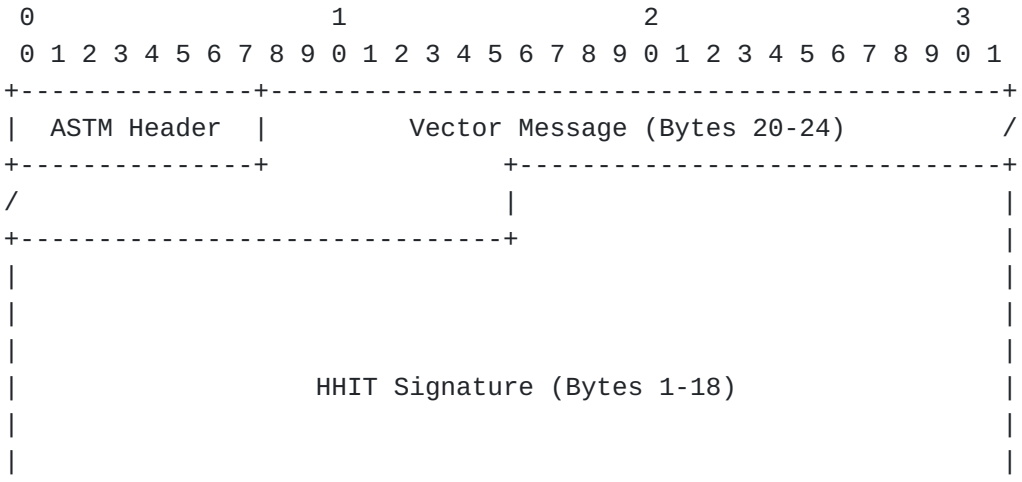

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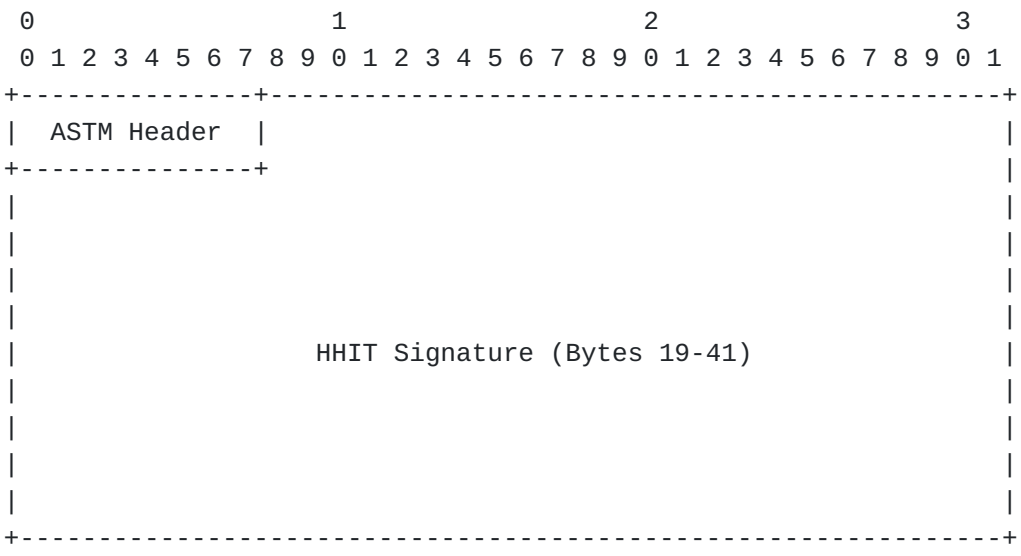
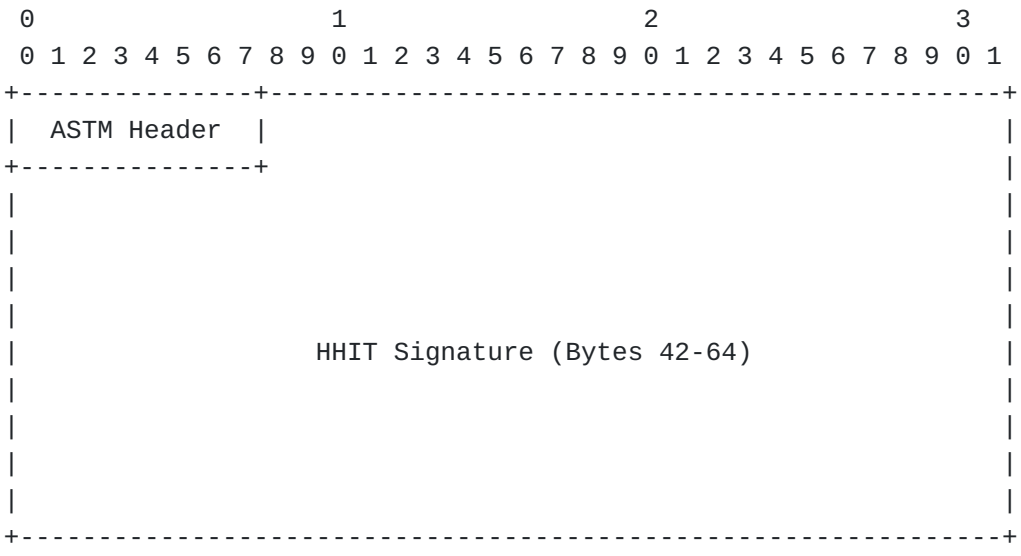

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
ASTM Header
HHIT Signature (Bytes 19-41)

Page 4:


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
ASTM Header
HHIT Signature (Bytes 42-64)

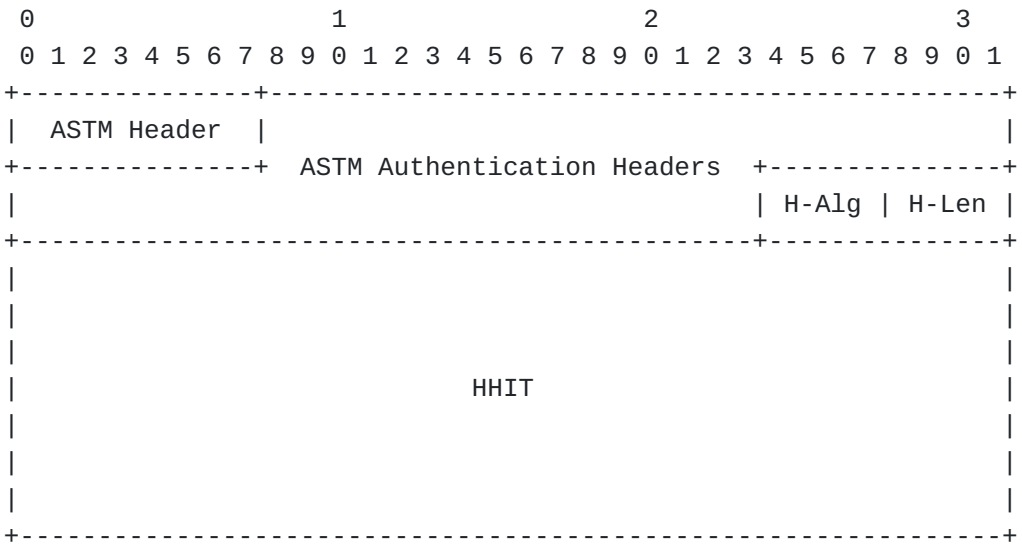
5.2. Wrapped Signed Hashes

Using the HIP Based Authentication Wrapper a [short] list of hashes can be signed. These hashes are of previous individual RID messages.

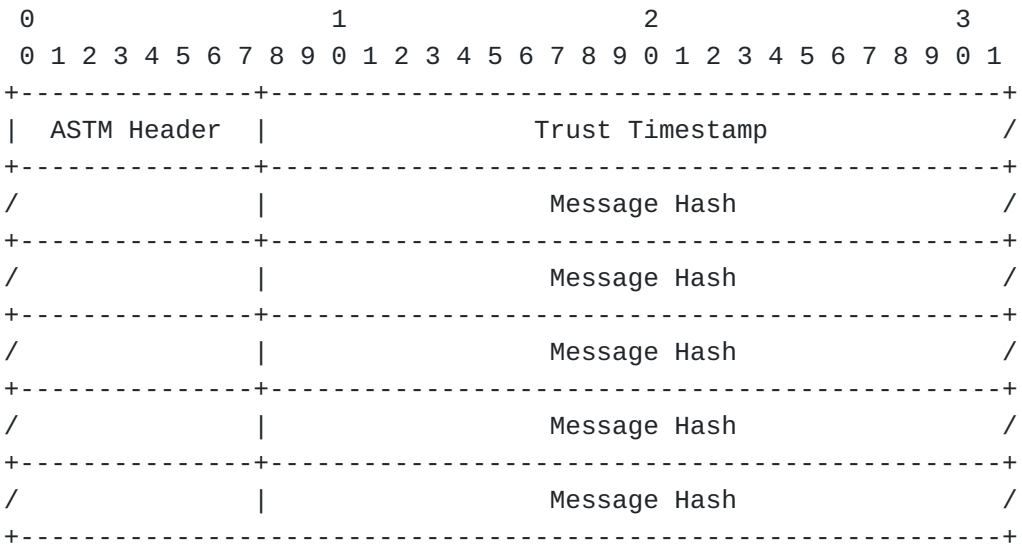
This follows the format of the Signed Hash List, excluding the psuedo-blockchain hashes found in the Signed Hash List.

To the authors, this format has limited use due to numerous concerns of replay attacks. It is suggested to instead use the full Signed Hash List format.

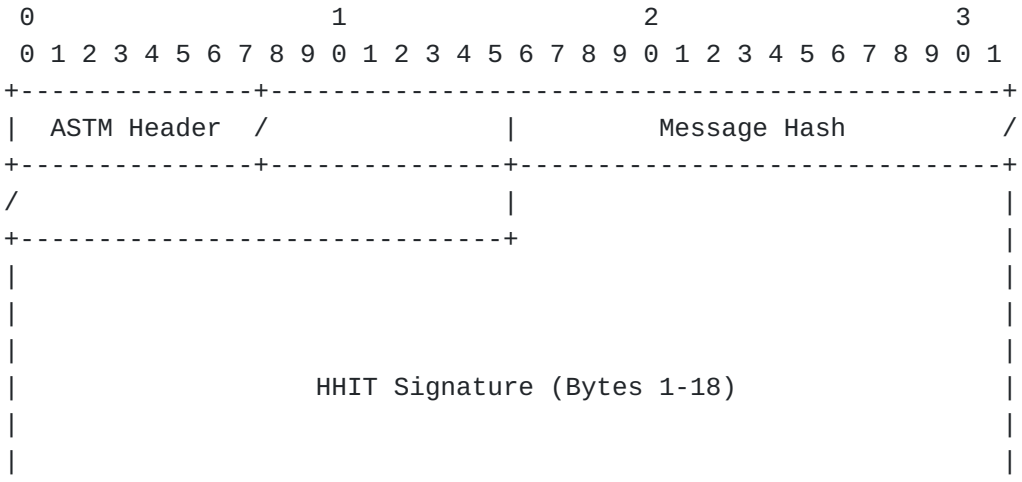
Page 0:



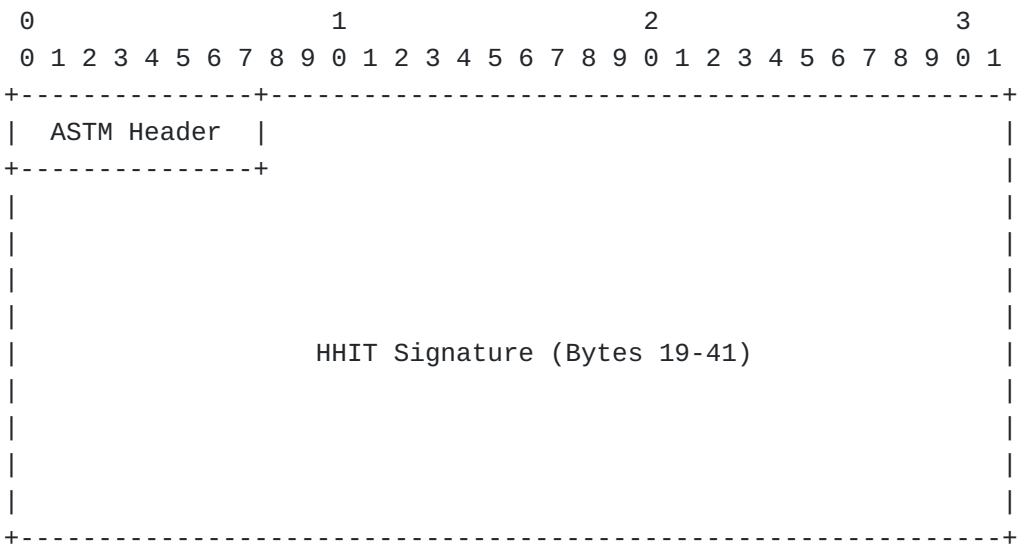
Page 1:



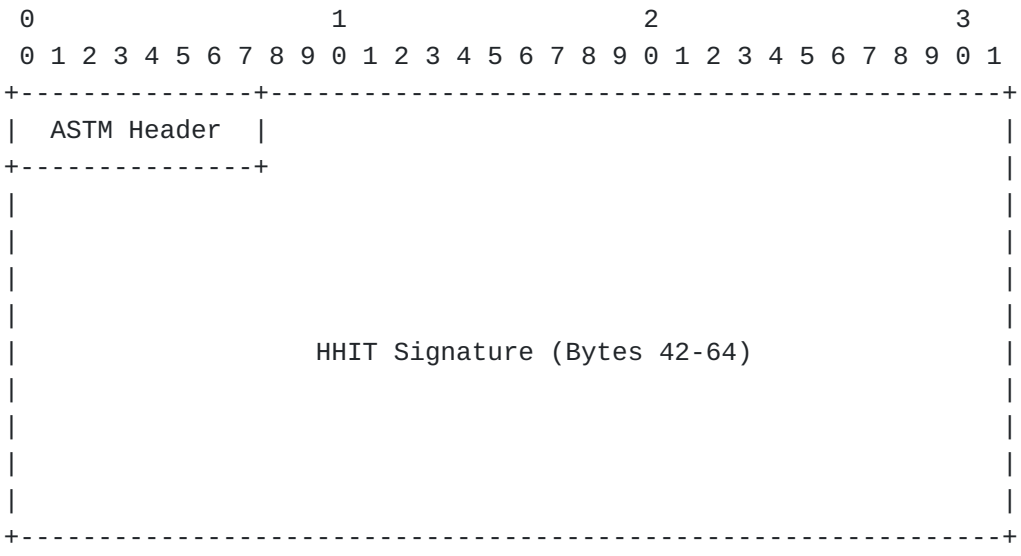
Page 2:



Page 3:


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
ASTM Header
HHIT Signature (Bytes 19-41)

Page 4:


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
ASTM Header
HHIT Signature (Bytes 42-64)

6. IANA Considerations

TBD

7. Security Considerations

TBD

8. Acknowledgments

Ryan Quigly and James Mussi for early prototyping to find holes in the draft specifications.

9. References

9.1. Normative References

[NIST.SP.800-185] Kelsey, J., Change, S., and R. Perlner, "SHA-3 derived functions: cSHAKE, KMAC, TupleHash and ParallelHash", National Institute of Standards and Technology report, DOI 10.6028/nist.sp.800-185, December 2016, <https://doi.org/10.6028/nist.sp.800-185>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

9.2. Informative References

[I-D.moskowitz-hip-hhit-registries]
Moskowitz, R., Card, S., and A. Wiethuechter, "Hierarchical HIT Registries", Work in Progress, Internet-Draft, draft-moskowitz-hip-hhit-registries-01, 17 October 2019, <https://tools.ietf.org/html/draft-moskowitz-hip-hhit-registries-01>.

[I-D.moskowitz-hip-hierarchical-hit]
Moskowitz, R., Card, S., and A. Wiethuechter, "Hierarchical HITs for HIPv2", Work in Progress, Internet-Draft, draft-moskowitz-hip-hierarchical-hit-03,

16 December 2019, <https://tools.ietf.org/html/draft-moskowitz-hip-hierarchical-hit-03>.

[I-D.moskowitz-hip-new-crypto]
Moskowitz, R., Card, S., and A. Wiethuechter, "New Cryptographic Algorithms for HIP", Work in Progress, Internet-Draft, draft-moskowitz-hip-new-crypto-04, 23 January 2020, <https://tools.ietf.org/html/draft-moskowitz-hip-new-crypto-04>.

[RFC7401] Moskowitz, R., Ed., Heer, T., Jokela, P., and T. Henderson, "Host Identity Protocol Version 2 (HIPv2)", RFC 7401, DOI 10.17487/RFC7401, April 2015, <https://www.rfc-editor.org/info/rfc7401>.

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