DRIP Implementation Drafts

draft-wiethuechter-drip-auth-03

draft-wiethuechter-drip-identity-claims-01

Adam Wiethuechter

DRIP WG – SEP20 Interim; 23 SEP 2020

From the DRIP Charter

DRIP’s goal is to specify how RID can be made trustworthy and available in both Internet and local-only connected scenarios

The DRIP HHIT Solution

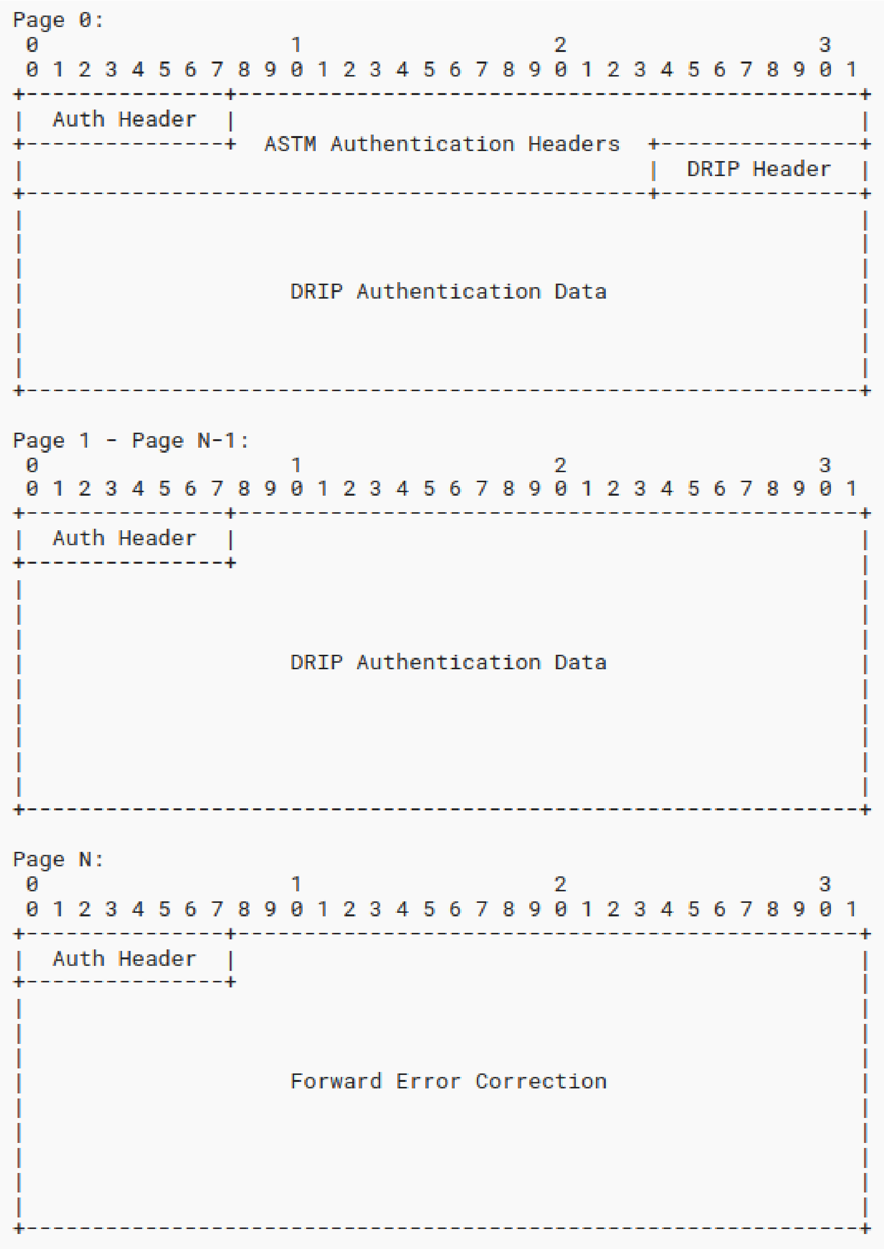
- Use the HHIT as the UAS ID
  - See draft-moskowitz-drip-uas for details
- Use the small signature size of EdDSA25519
  - Easily fits in ASTM Authentication Message
    - UA HHIT (16) + Timestamp (4) + Signature (64) = 84 bytes out of 109 bytes
    - 25 bytes left for data to be signed
  - GEN 2: Provable Binding (when using HHIT as UAS ID)
- Increase Auth. Page limit from 5 to 10
  - We have approached ASTM and they have been receptive to this change
- Add Forward Error Correction to help loss of pages in Bluetooth 4.X
- Send short Certificate via Authentication Message making RID trustworthy in local-only scenarios
  - GEN 1: Provable Ownership; GEN 3: Provable Registration

DRIP Authentication Framing

General Frame, Wrapper Frame

General Frame

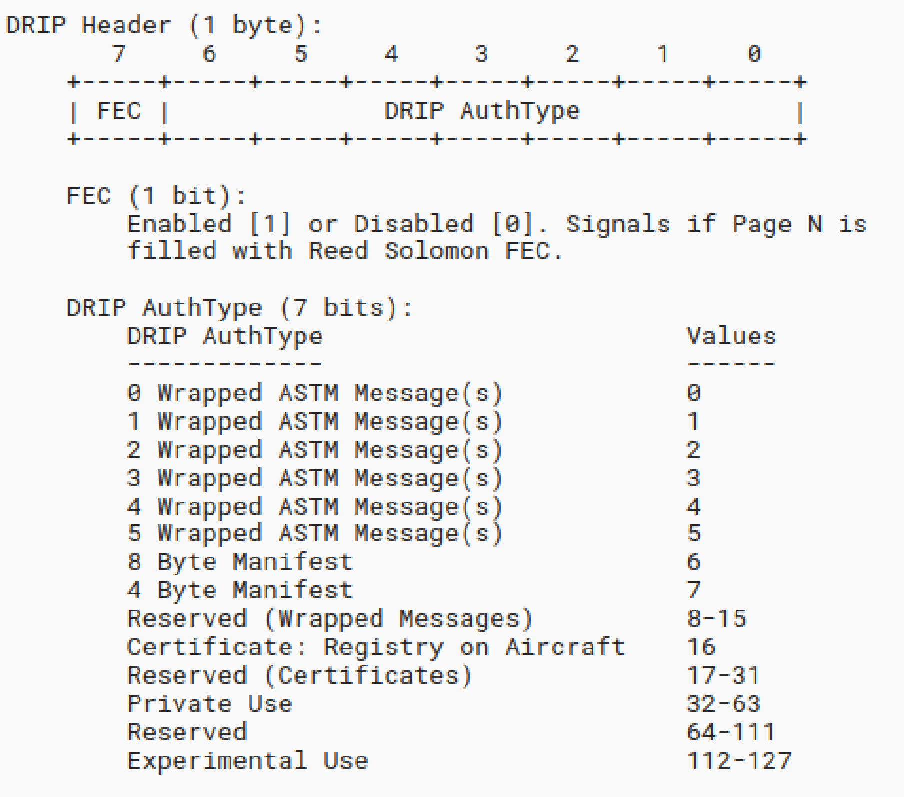
- Reed Solomon FEC always fills last page
  - Taken over all pages (inc. headers)
  - SHOULD on Bluetooth 4
  - SHOULD NOT on Bluetooth 5
- 223 bytes of data w/o FEC
- 200 bytes of data w/FEC



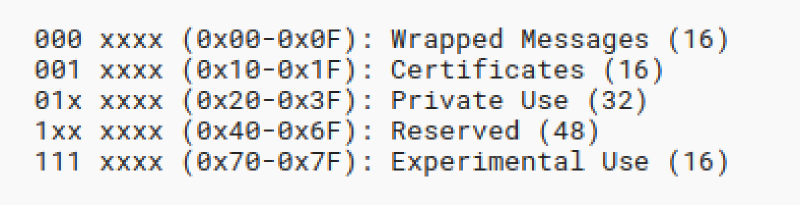
```
Page 0:
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+-----------------------------------------------+
|  Auth Header  |                                               |
+---------------+  ASTM Authentication Headers  +---------------+
|                                               |  DRIP Header  |
+-----------------------------------------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                   DRIP Authentication Data                    |
|                                                               |
|                                                               |
|                                                               |
+---------------------------------------------------------------+

Page 1 - Page N-1:
 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
+---------------+-----------------------------------------------+
|  Auth Header  |                                               |
+---------------+                                               |
|                                                               |
|                                                               |
|                                                               |
|                   DRIP Authentication Data                    |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------------------------------------------------------+

Page N:
 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
+---------------+-----------------------------------------------+
|  Auth Header  |                                               |
+---------------+                                               |
|                                                               |
|                                                               |
|                                                               |
|                   Forward Error Correction                    |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------------------------------------------------------+
```

DRIP Header

- Independent FEC flag
  - Each DRIP AuthType specifies if using FEC
- 7 bit space broken into 5 areas
  - Half (8) of Wrapped Messages defined
  - One (1) Certificate defined
- 128 possible DRIP AuthTypes
  - 9 total currently defined



```
DRIP Header (1 byte):
      7     6     5     4     3     2     1     0
    +-----+-----+-----+-----+-----+-----+-----+-----+
    | FEC |               DRIP AuthType             |
    +-----+-----+-----+-----+-----+-----+-----+-----+

    FEC (1 bit):
        Enabled [1] or Disabled [0]. Signals if Page N is
        filled with Reed Solomon FEC.

    DRIP AuthType (7 bits):
        DRIP AuthType                        Values
        -------------                        ------
        0 Wrapped ASTM Message(s)            0
        1 Wrapped ASTM Message(s)            1
        2 Wrapped ASTM Message(s)            2
        3 Wrapped ASTM Message(s)            3
        4 Wrapped ASTM Message(s)            4
        5 Wrapped ASTM Message(s)            5
        8 Byte Manifest                      6
        4 Byte Manifest                      7
        Reserved (Wrapped Messages)          8-15
        Certificate: Registry on Aircraft    16
        Reserved (Certificates)              17-31
        Private Use                          32-63
        Reserved                             64-111
        Experimental Use                     112-127
```



```
000 xxxx (0x00-0x0F): Wrapped Messages (16)
001 xxxx (0x10-0x1F): Certificates (16)
01x xxxx (0x20-0x3F): Private Use (32)
1xx xxxx (0x40-0x6F): Reserved (48)
111 xxxx (0x70-0x7F): Experimental Use (16)
```

FEC & Bluetooth

- Bluetooth (both 4 and 5) have a 3 byte CRC in every frame
  - Full frame is dropped if CRC check fails within Bluetooth stack
  - No signal to upper layers that a frame is being dropped
- To RID applications, we missed;
  - Under BT4 a full message or *Authentication page*
  - Under BT5 a full Message Pack

How does this help us?

- Authentication pages are numbered (part of the Auth. Header already defined by ASTM) so we know which pages are missing in a set
    - sets are defined using the AD Counter
- Reed Solomon can correct 23 bytes of error when we know positions of data lost (known as *erasures*) – which we do!
    - So if we rebuild frames filling in known header bytes (Message Type, ASTM Version, Authentication Type and Page Number) we can correct for 23 bytes which is missing page data

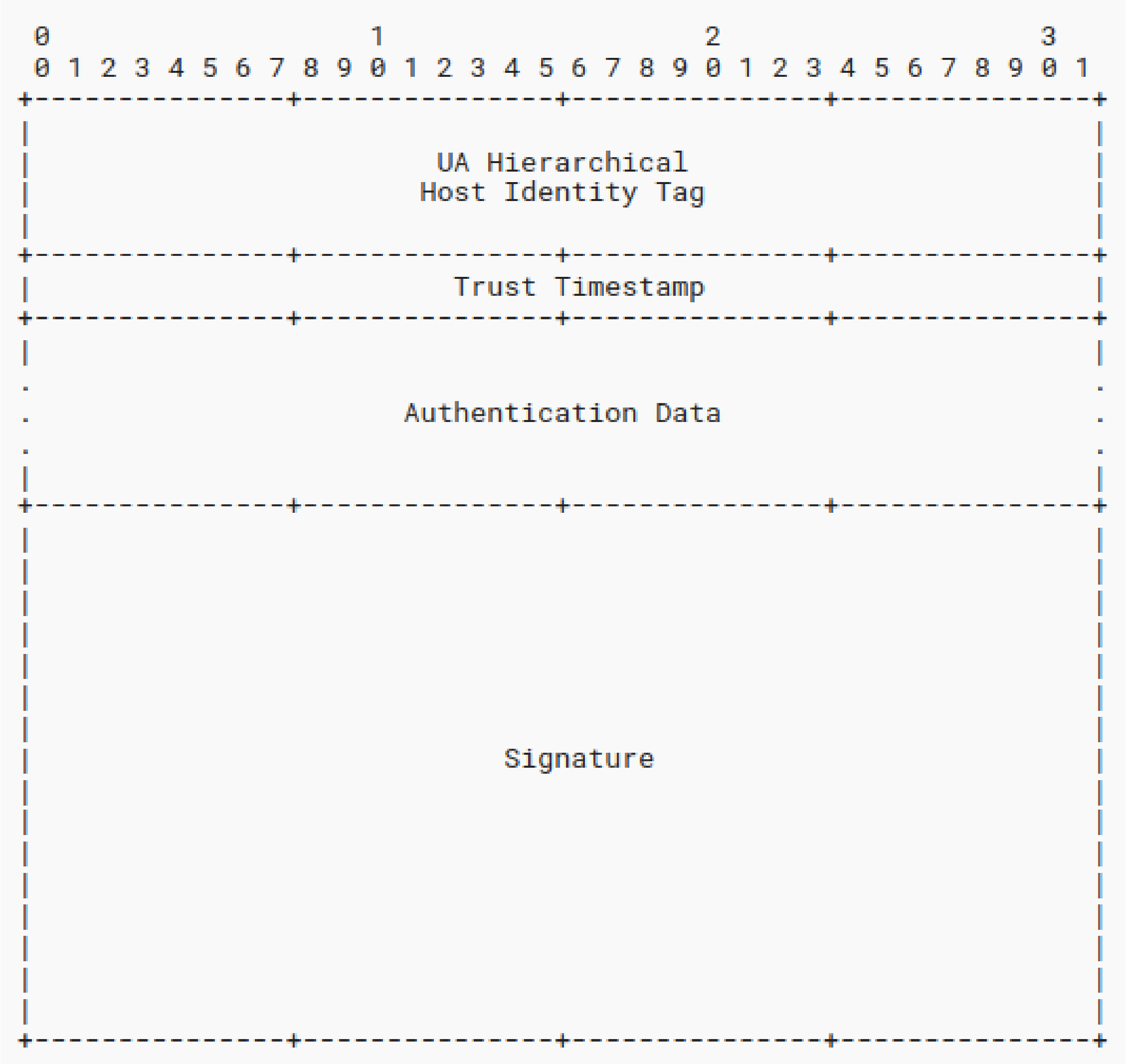
End results…

- For Bluetooth 4, FEC gives us an advantage of recovery if any single page is lost in transmission
  - If any more are lost recovery is impossible but if that happens probably more issues going on anyways

- For Bluetooth 5, FEC is useless as it already has FEC at the frame level before CRC check
  - Only with LE Coded PHY, which is what is specified by ASTM
- Also for Bluetooth 5, FEC is useless as per ASTM the Message Pack must be used
  - This uses the 255 byte extended Bluetooth 5 payload to fit multiple ASTM Messages in single frame
  - So if we lose a Bluetooth 5 frame we are already losing anyways as a full Authentication Message was together, not physically paged like Bluetooth 4

Wrapper Frame

- Fits inside General Frames DRIP Auth. Data
- Authentication Data
  - 116 bytes with FEC
  - 139 bytes w/o FEC
- Signature computed over all preceding data fields in Wrapper Frame
  - Avoid DRIP Header as can change (FEC bit) after signing



```
 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
+---------------+---------------+---------------+---------------+
|                                                               |
|                       UA Hierarchical                         |
|                      Host Identity Tag                        |
|                                                               |
+---------------+---------------+---------------+---------------+
|                        Trust Timestamp                        |
+---------------+---------------+---------------+---------------+
|                                                               |
.                                                               .
.                      Authentication Data                      .
.                                                               .
|                                                               |
+---------------+---------------+---------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                          Signature                            |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------+---------------+---------------+---------------+
```

[Trust] Timestamp Details

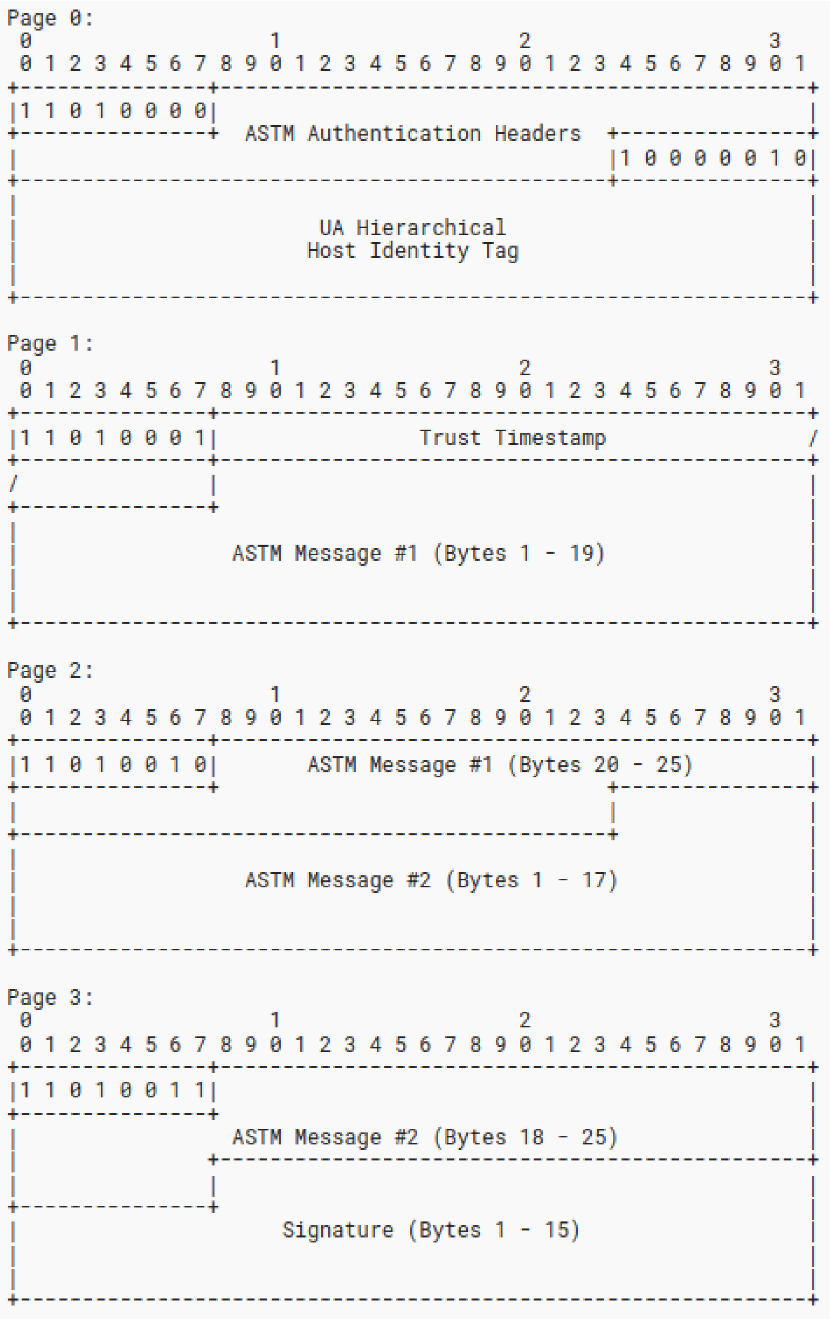
- Different types of timestamp in ecosystem:
    - ASTM Authentication Message [4 bytes]
        - Offset from 01/01/2019 00:00:00
    - 32 bit unsigned UNIX [4 bytes]
    - UTM (ISO8601) [? bytes]
- Discussion on list concluded: use ASTM style for everything
    - No need for anything before 2019-01-01, so ASTM way of doing things is reasonable

Bluetooth 4.X Auth. Formats

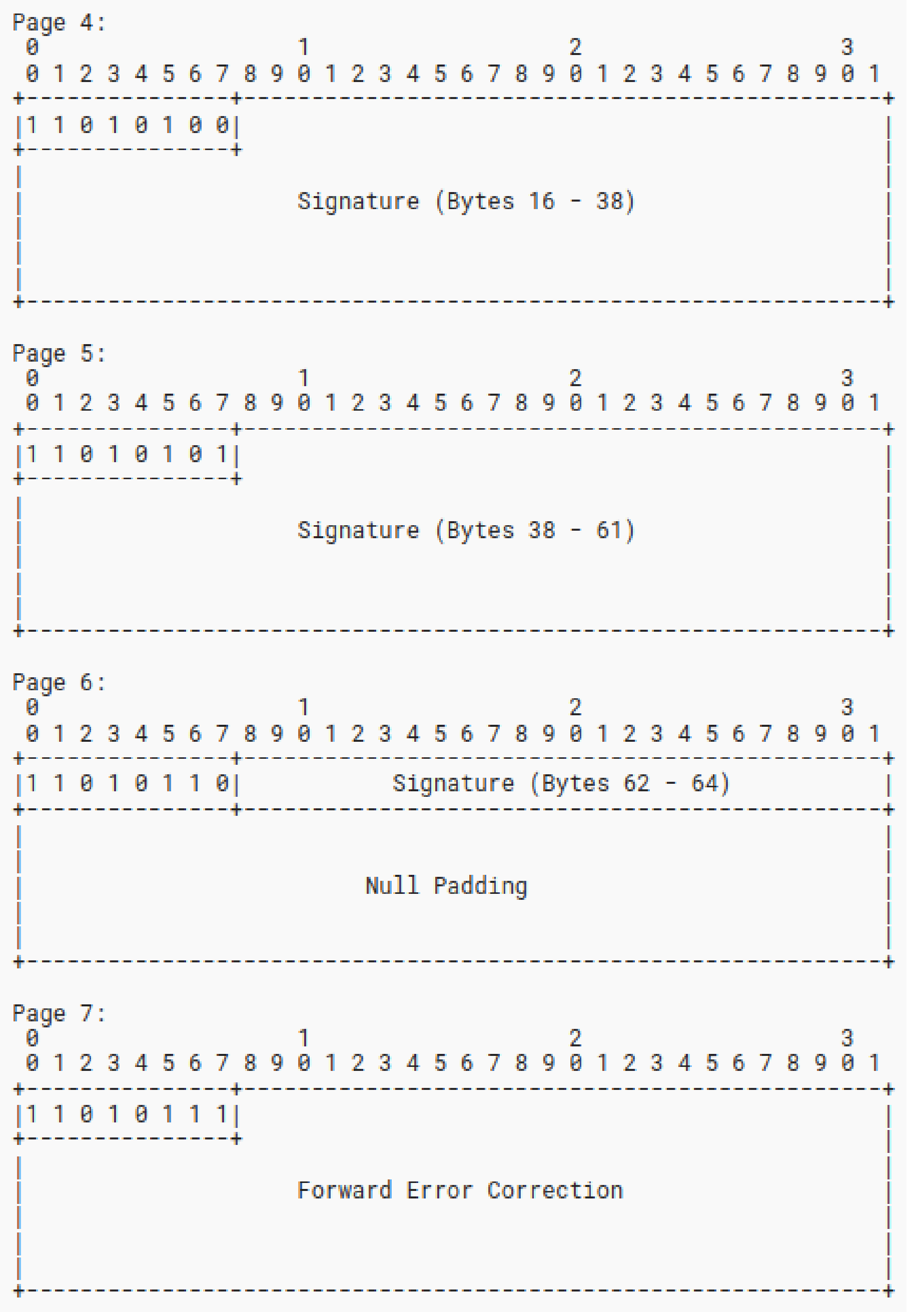
Wrapped ASTM Message(s), Certificate, Manifest(s)

1-5 Wrapped ASTM Message(s)

- DRIP AuthTypes 1-5
  - AuthType signals number of messages being wrapped
- Wrapper Frame Auth. Data filled with ASTM Messages
  - Messages must be in Message Type order
- Special Case: 5 Wrapped Messages
  - Acts as a pseudo-ASTM Message Pack (Type 0xF) over Bluetooth 4
  - FEC MUST be disabled to fit all messages
  - Can fit all ASTM Messages excluding an Auth. Message



```
Page 0:
 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
+---------------+-----------------------------------------------+
|1 1 0 1 0 0 0 0|                                               |
+---------------+  ASTM Authentication Headers  +---------------+
|                                               |1 0 0 0 0 0 1 0|
+-----------------------------------------------+---------------+
|                                                               |
|                        UA Hierarchical                        |
|                       Host Identity Tag                       |
|                                                               |
+---------------------------------------------------------------+

Page 1:
 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
+---------------+-----------------------------------------------+
|1 1 0 1 0 0 0 1|                Trust Timestamp                /
+---------------+-----------------------------------------------+
/               |                                               |
+---------------+                                               |
|                                                               |
|                ASTM Message #1 (Bytes 1 - 19)                 |
|                                                               |
+---------------------------------------------------------------+

Page 2:
 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
+---------------+-----------------------------------------------+
|1 1 0 1 0 0 1 0|       ASTM Message #1 (Bytes 20 - 25)         |
+---------------+                               +---------------+
|                                               |               |
+-----------------------------------------------+               |
|                                                               |
|                 ASTM Message #2 (Bytes 1 - 17)                |
|                                                               |
+---------------------------------------------------------------+

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
+---------------+-----------------------------------------------+
|1 1 0 1 0 0 1 1|                                               |
+---------------+                                               |
|                ASTM Message #2 (Bytes 18 - 25)                |
|               +-----------------------------------------------+
|               |                                               |
+---------------+                                               |
|                   Signature (Bytes 1 - 15)                    |
|                                                               |
+---------------------------------------------------------------+
```



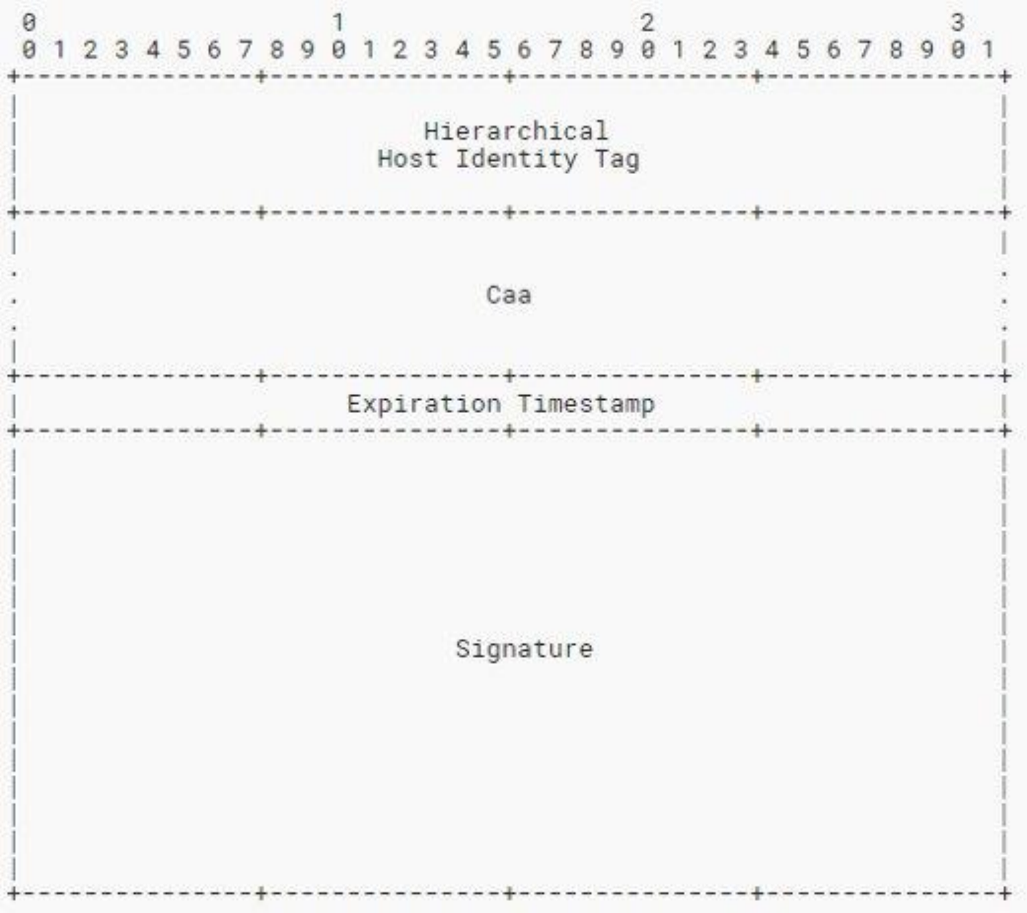
```
Page 4:
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+-----------------------------------------------+
|1 1 0 1 0 1 0 0|                                               |
+---------------+                                               |
|                                                               |
|                   Signature (Bytes 16 - 38)                   |
|                                                               |
|                                                               |
+---------------------------------------------------------------+

Page 5:
 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
+---------------+-----------------------------------------------+
|1 1 0 1 0 1 0 1|                                               |
+---------------+                                               |
|                                                               |
|                   Signature (Bytes 38 - 61)                   |
|                                                               |
|                                                               |
+---------------------------------------------------------------+

Page 6:
 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
+---------------+-----------------------------------------------+
|1 1 0 1 0 1 1 0|          Signature (Bytes 62 - 64)            |
+---------------+-----------------------------------------------+
|                                                               |
|                         Null Padding                          |
|                                                               |
+---------------------------------------------------------------+

Page 7:
 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
+---------------+-----------------------------------------------+
|1 1 0 1 0 1 1 1|                                               |
+---------------+                                               |
|                                                               |
|                   Forward Error Correction                    |
|                                                               |
+---------------------------------------------------------------+
```

Manifests

- DRIP AuthTypes 6, 7
- Wrapper Frame Auth. Data filled with hashes
  - Hashes are of previous non-paged messages sent
- Two special hashes for pseudo-blockchain
  - Links manifests together
  - Hash of previous manifest
  - Hash of current manifest
    - Order of operations?
- Two variants based on hash length; 8 bytes and 4 bytes
  - 27 hashes with 4 bytes, 12 hashes with 8 bytes
  - Uses same hash algorithm as HHIT (in UAS RID this is cSHAKE128)
    - Can use OGA ID of HHIT to signal different hashing methods

Certificate: Registry on Aircraft (Cra)

- DRIP AuthType 16
- General Frame DRIP Auth. Data filled with Cra
  - Exactly 200 bytes in length
  - Binding between entities, asserting trust
  - Contains HI of UA; instant verification of UA
  - Registry HHIT used for lookup on local cached Registry list
    - On Observer device, only ones trusted by User
- See draft-wiethuechter-drip-identity-claims for details



```
 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
+---------------+---------------+---------------+---------------+
|                                                               |
|                         Hierarchical                          |
|                       Host Identity Tag                       |
|                                                               |
+---------------+---------------+---------------+---------------+
|                                                               |
.                                                               .
.                              Caa                              .
.                                                               .
|                                                               |
+---------------+---------------+---------------+---------------+
|                     Expiration Timestamp                      |
+---------------+---------------+---------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                           Signature                           |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------+---------------+---------------+---------------+
```

Bluetooth 5.X Auth. Formats

0 Wrapped ASTM Message(s), Certificate

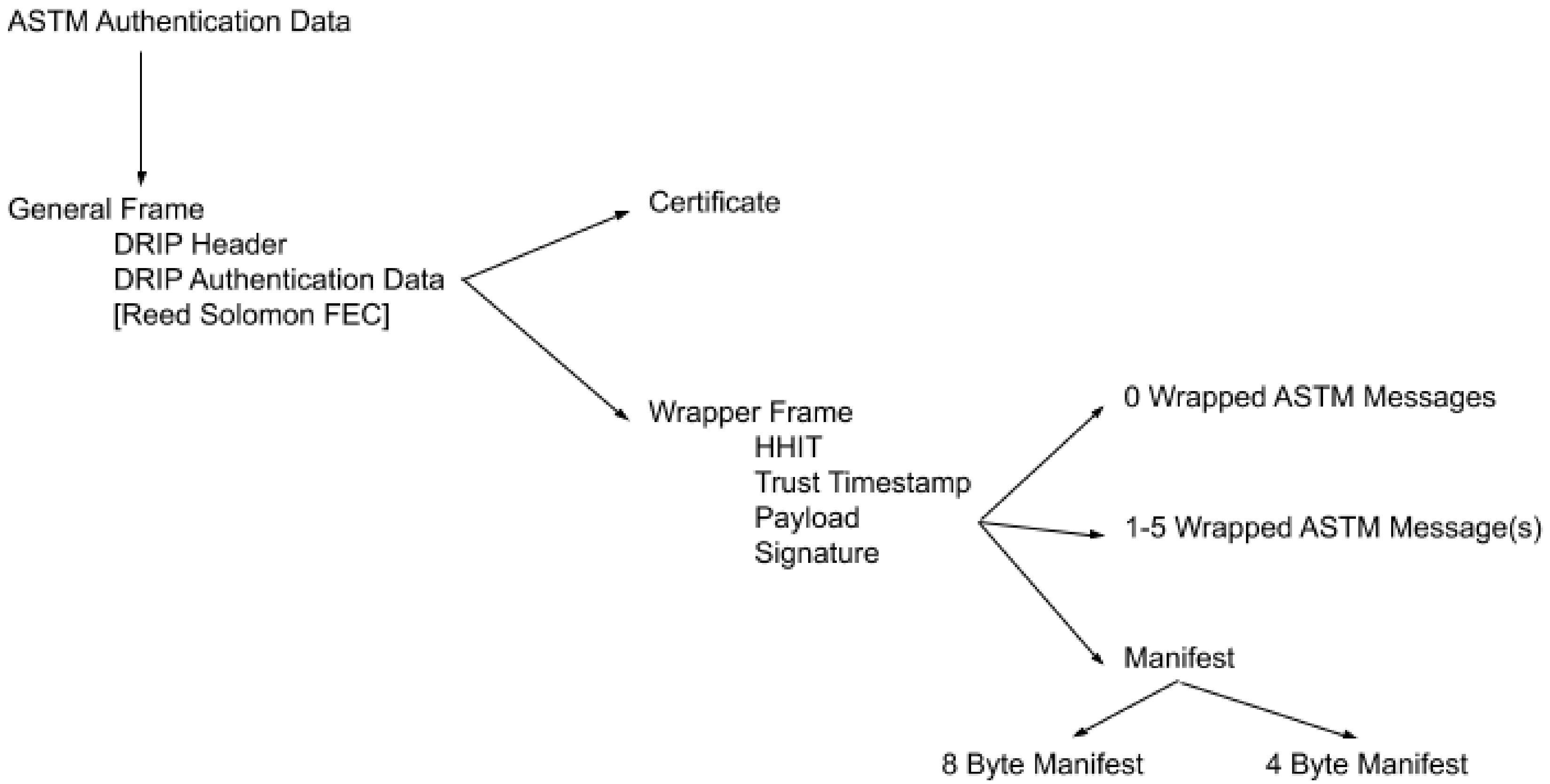
Certificate: Registry on Aircraft (Cra)

- DRIP AuthType 16
- General Frame DRIP Auth. Data filled with Cra
  - See draft-wiethuechter-drip-identity-claims
- Last 25 bytes of Message Pack can be filled with another ASTM Message
  - Suggested to use Location Message

0 Wrapped ASTM Message(s)

- DRIP AuthType 0
- Special case of Wrapped ASTM Message(s) format
  - Only used for Message Pack under Bluetooth 5.X
- Wrapper Frame Auth. Data *virtually* filled with ASTM Messages in Message Pack
  - Messages must be in Message Type order

DRIP AuthType Tree



ASTM Authentication Data

General Frame
DRIP Header
DRIP Authentication Data
[Reed Solomon FEC]

Certificate

Wrapper Frame
HHIT
Trust Timestamp
Payload
Signature

0 Wrapped ASTM Messages

1-5 Wrapped ASTM Message(s)

Manifest

8 Byte Manifest

4 Byte Manifest

Identity Claims/Certificates

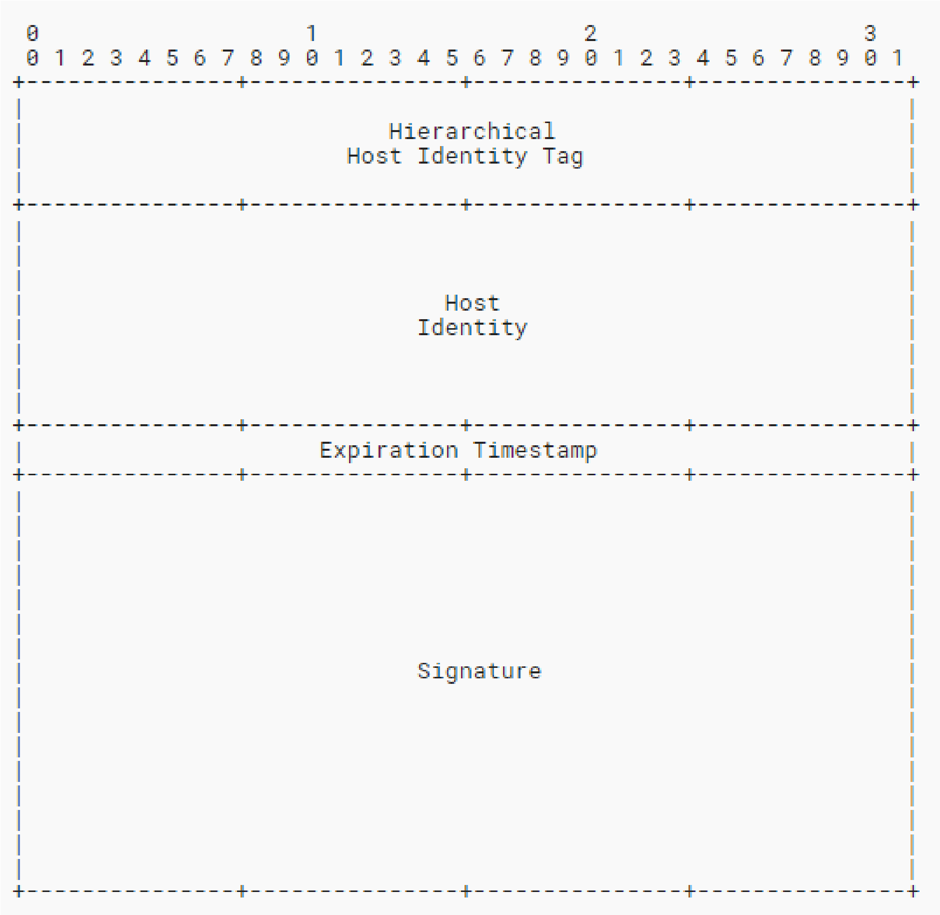
Building a trustworthy chain for Broadcast RID

Overview

- Claim vs Certificate
  - Claim was chosen initially as “certificate” has a pre-establish connotation
  - Legal and technology baggage with the term and want to avoid confusion
  - This decision is in flux and we would like feedback on it! (we are now back on Certificate)
- Special to the UAS ecosystem for Remote ID
  - Asserts bindings between entities and objects
  - Created during provisioning of UA/Operator/Registry

Form Cxx

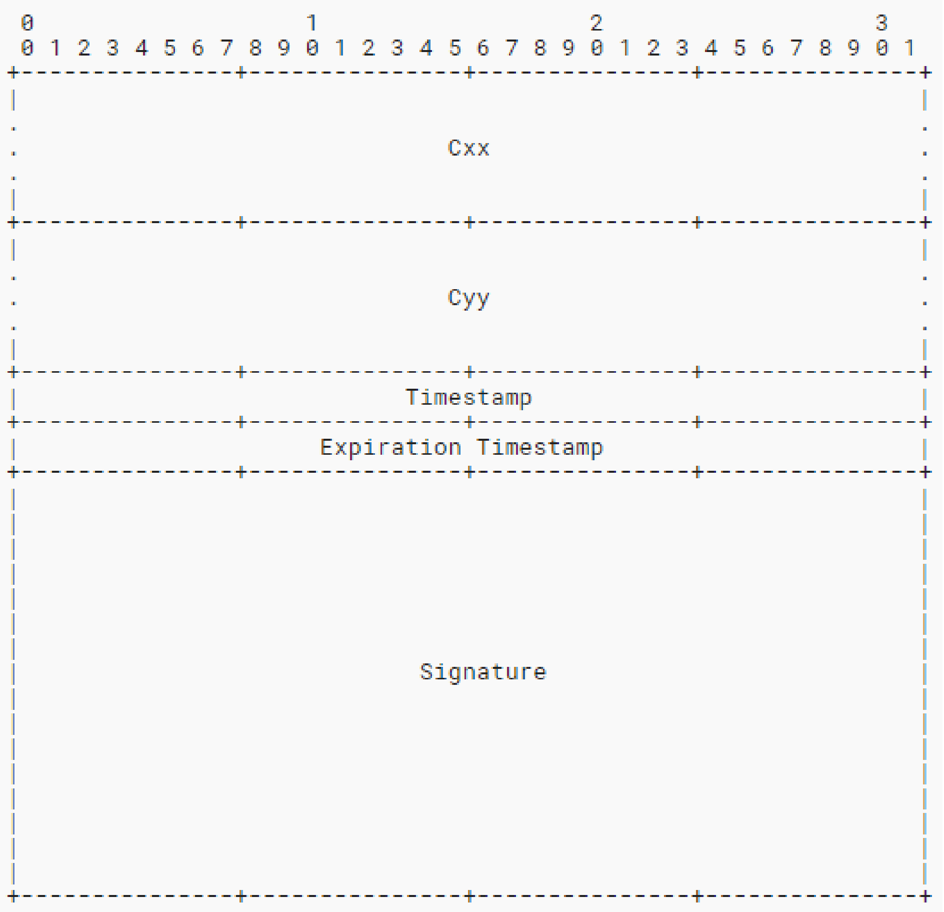
- Self-signed unverified claim
- Used to assert binding of HHIT/HI to a given entity (x)
    - Contains: HHIT, HI, Expiration Timestamp, Signature
    - 116 bytes in length
- Three specific entities:
    - Aircraft on Aircraft (Caa)
    - Operator on Operator (Coo)
    - Registry on Registry (Crr)
- Used in other forms



```
 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
+---------------+---------------+---------------+---------------+
|                                                               |
|                         Hierarchical                          |
|                      Host Identity Tag                        |
|                                                               |
+---------------+---------------+---------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                             Host                              |
|                           Identity                            |
|                                                               |
|                                                               |
|                                                               |
+---------------+---------------+---------------+---------------+
|                     Expiration Timestamp                      |
+---------------+---------------+---------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                           Signature                           |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------+---------------+---------------+---------------+
```

Form Cxy

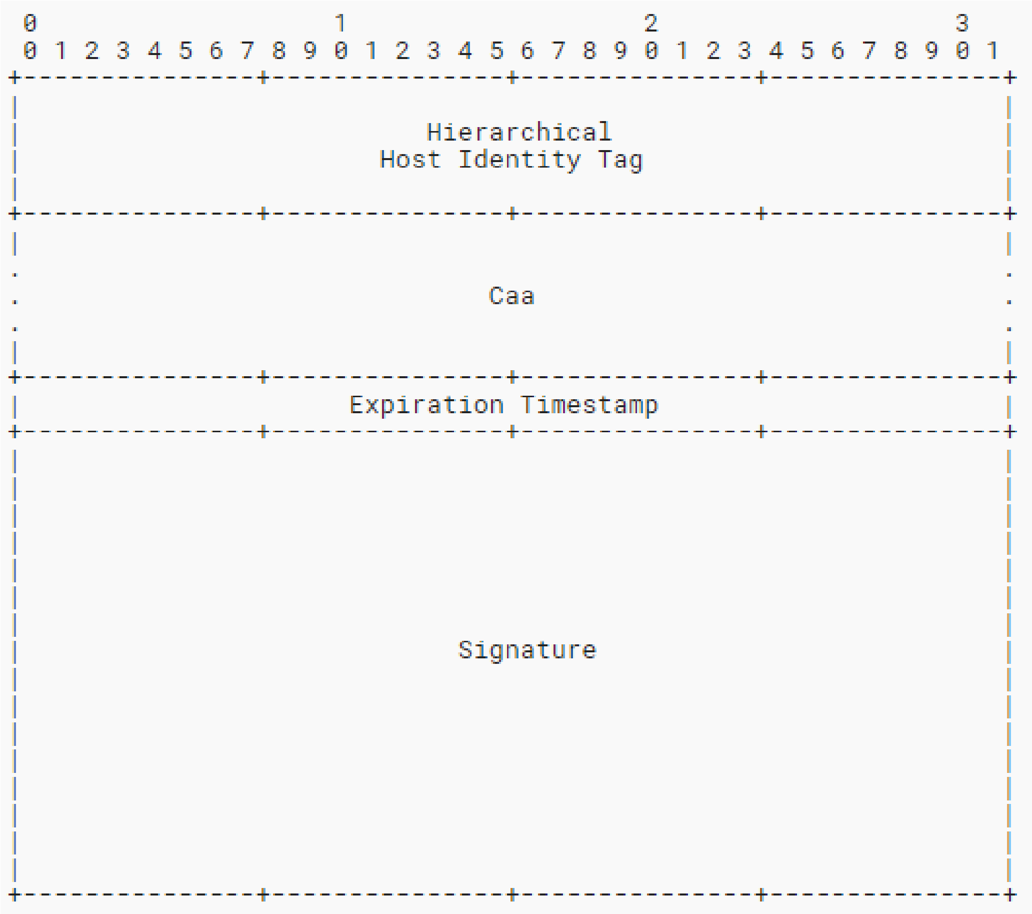
- Asserts binding between two entities (x and y)
  - Generally ‘x’ is an entity attesting ‘y’s claim (or adding a relationship)
  - Contains: Cxx, Cyy, Timestamp, Expiration Timestamp, Signature
  - 304/608 bytes in length
- 3 specific implementations of this form:
  - Registry on Operator (Cro)
  - Operator on Aircraft (Coa)
  - Registry on Operator on Aircraft (Croa)



```
 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
+---------------+---------------+---------------+---------------+
|                                                               |
.                                                               .
.                              Cxx                              .
.                                                               .
|                                                               |
+---------------+---------------+---------------+---------------+
|                                                               |
.                                                               .
.                              Cyy                              .
.                                                               .
|                                                               |
+---------------+---------------+---------------+---------------+
|                           Timestamp                           |
+---------------+---------------+---------------+---------------+
|                     Expiration Timestamp                      |
+---------------+---------------+---------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                           Signature                           |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------+---------------+---------------+---------------+
```

Certificate: Registry on Aircraft

- Special as it is used in authentication messages of Broadcast RID
  - Contains: HHIT of Registry, Caa, Expiration Timestamp, Signature
  - 200 bytes long
- Asserts the binding between a Registry and Aircraft

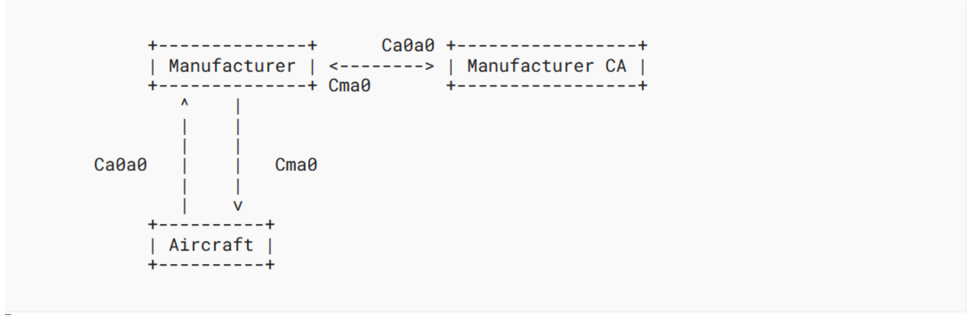


```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|                                                               |
|                         Hierarchical                          |
|                       Host Identity Tag                       |
|                                                               |
+---------------+---------------+---------------+---------------+
|                                                               |
.                                                               .
.                             Caa                               .
.                                                               .
|                                                               |
+---------------+---------------+---------------+---------------+
|                    Expiration Timestamp                       |
+---------------+---------------+---------------+---------------+
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                           Signature                           |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------+---------------+---------------+---------------+
```

Provisioning Process

Based on work in the DI WG for IATF under ICAO

Manufacturer Provisioning



```
     +--------------+       Ca0a0 +-----------------+
     | Manufacturer | <--------> | Manufacturer CA |
     +--------------+ Cma0        +-----------------+
        ^    |
        |    |
        |    |
Ca0a0   |    |   Cma0
        |    |
        |    v
     +----------+
     | Aircraft |
     +----------+
```

Aircraft CREATED

Manufacturer GENERATES: A0(A0_pub, A0_priv), C[A0, A0]

Manufacturer TX to Manufacturer CA: C[A0, A0]

Manufacturer CA GENERATES: C[M, A0]

- This does not need to be a DRIP style certificate – it could be X.509!
- Key point: ID (whatever it is) is being bound to Manufacturer!

Manufacturer CA TX to Manufacturer: C[M, A0]

Manufacturer INJECTS into Aircraft:A0(A0_pub, A0_priv), C[A0, A0], C[M, A0]

Aircraft PACKAGED

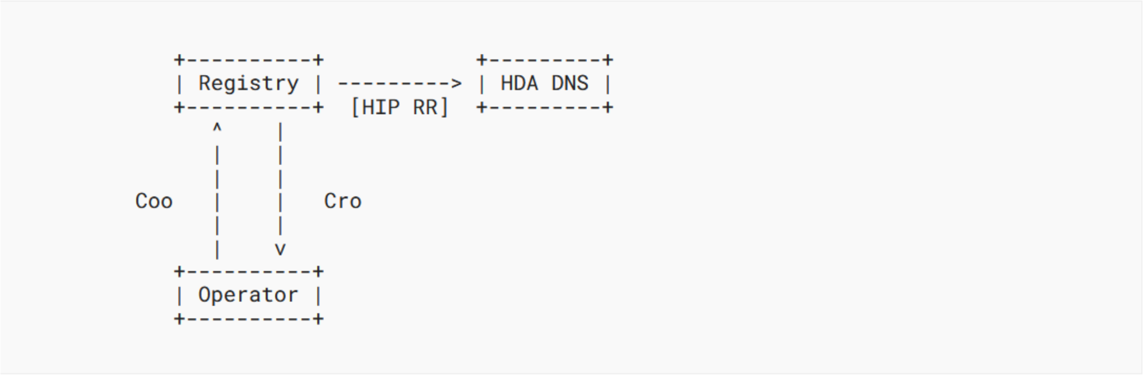
Aircraft SHIPPED to Retailer

Retailer SELLS Aircraft to Operator

Registry (RAA, HDA) Provisioning

- RAA GENERATES: R(R_pub, R_priv), C[R, R]
- HDA GENERATES: H(H_pub, H_priv), C[H, H]
- HDA TX to RAA: C[H, H]
- RAA CHECKS: C[H, H]
- RAA GENERATES using C[R, R] and C[H, H]: C[R, H]
- RAA TX to HDA: C[R, H]
    - Note from this point on Registry == HDA

Operator Provisioning



```
    +----------+                 +---------+
    | Registry |  --------->  | HDA DNS |
    +----------+   [HIP RR]   +---------+
         ^    |
         |    |
         |    |
Coo      |    |    Cro
         |    |
         |    v
    +----------+
    | Operator |
    +----------+
```

- Keypair generation
- HHIT derived from HI (public half of keypair)
  - Select Registry and use RAA/HDA to format valid HHIT
- Create Coo, send to Registry
- Registry perform verification check and adds HHIT/HI to DNS in the form of HIP RR
  - Verification check MUST include looking for HHIT collisions in current database of Registered HHITs
- Registry if successful, creates Cro and sends it back to Operator
- Registry if failed, sends error back asking to start over

Aircraft Provisioning (Operator Assisted)

Operator GENERATES: An(An_pub, An_priv), C[An, An]

Operator INJECTS into Aircraft: An(An_pub, An_priv), C[An, An]

Aircraft GENERATES using C[A0, A0] and C[An, An]: C[A0, An]

Operator EXTRACTS from Aircraft: C[M, A0], C[A0, An]

Operator GENERATES using C[O, O] and C[An, An]: C[O, An]

Operator TX to Registry: C[R, O], C[O, An], C[M, A0], C[A0, An]

Registry CHECKS: C[R, O], C[O, An], C[M, A0], C[A0, An]

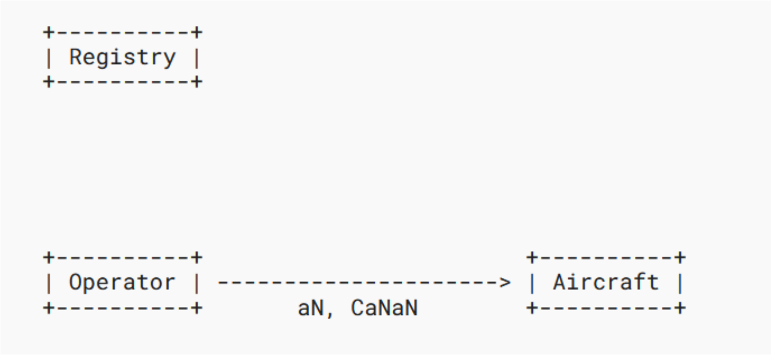
C[M, A0] is checked using external systems (Manufacturer CA)

Registry GENERATES using C[H, H] and C[O, An] or C[A0, An]: C[R, O, An], C[R, An]

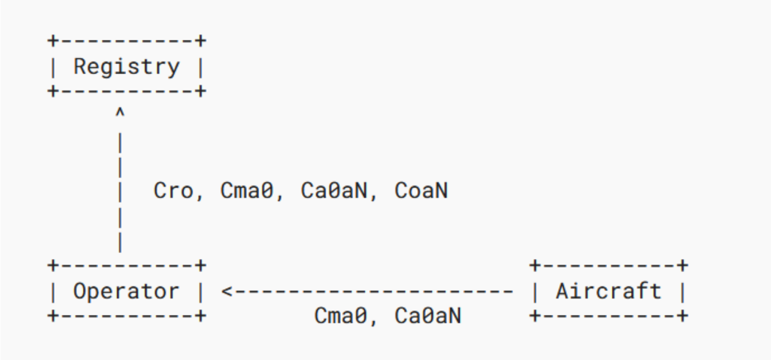
An is extracted from either C[O, An] or C[A0, An] and used to create C[R, An]

Registry TX to Operator: C[R, O, An], C[R, An]

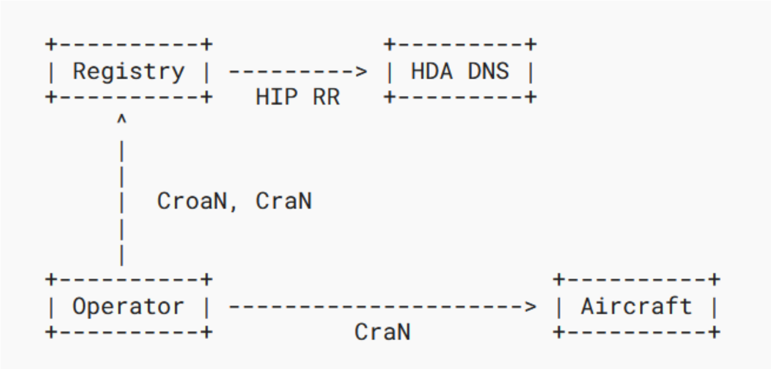
Operator INJECTS into Aircraft: C[R, An]



```
+----------+
| Registry |
+----------+




+----------+                         +----------+
| Operator | ----------------------> | Aircraft |
+----------+        aN, CaNaN        +----------+
```



```
+----------+
| Registry |
+----------+
     ^
     |
     |
     |  Cro, Cma0, Ca0aN, CoaN
     |
     |
+----------+                         +----------+
| Operator | <---------------------- | Aircraft |
+----------+        Cma0, Ca0aN      +----------+
```



```
+----------+            +----------+
| Registry | ---------> | HDA DNS  |
+----------+   HIP RR   +----------+
     ^
     |
     |
     |  CroaN, CraN
     |
     |
+----------+                         +----------+
| Operator | ----------------------> | Aircraft |
+----------+           CraN          +----------+
```

Aircraft Provisioning

Operator COMMANDS Aircraft: GENERATE NEW KEYPAIR

Aircraft GENERATES: An(An_pub, An_priv), C[An, An]

Aircraft GENERATES using C[A0, A0] and C[An, An]: C[A0, An]

Operator EXTRACTS from Aircraft: C[An, An]

Operator GENERATES using C[O, O] and C[An, An]: C[O, An]

Operator TX to Registry: C[R, O], C[O, An]

Registry CHECKS: C[R, O]

Registry TX to Operator: P_TOKEN

Operator INJECTS into Aircraft: P_TOKEN

Operator COMMANDS Aircraft: CONTINUE PROVISIONING

Aircraft TX to Registry: P_TOKEN, C[M, A0], C[A0, An]

Registry CHECKS: P_TOKEN, C[M, A0], C[A0, An], C[O, An]

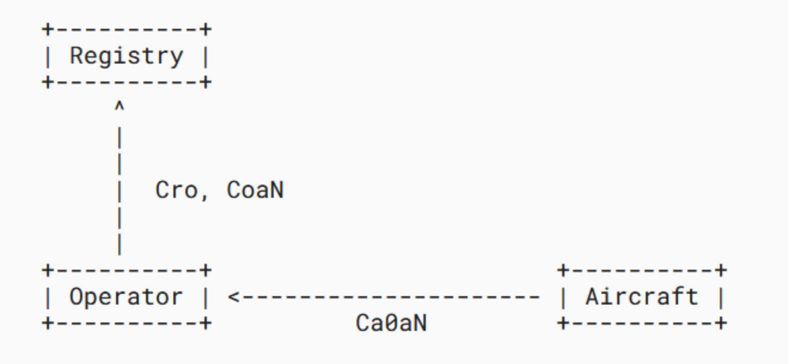
C[M, A0] is checked using external systems (Manufacturer CA)

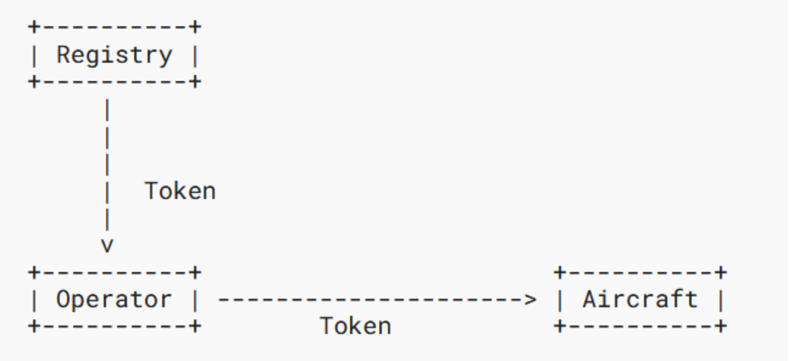
Registry GENERATES using C[H, H] and C[O, An] or C[A0, An]: C[R, O, An], C[R, An]

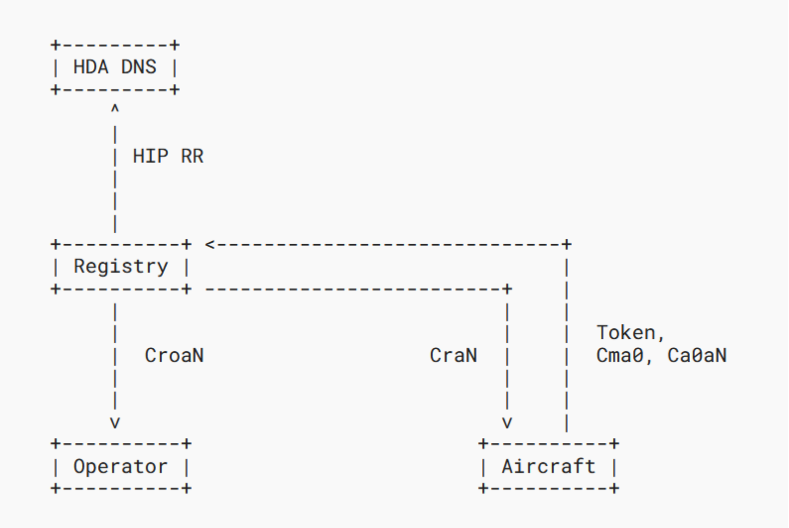
An is extracted from either C[O, An] or C[A0, An] and used to create C[R, An]

Registry TX to Operator: C[R, O, An]

Registry TX to Operator: C[R, An]







Implementation Progress

AX Enterprize Implementation

- ASTM F3411-19 for Broadcast RID (Python 3)
- Trustworthy Multipurpose Remote ID (TMRID)
  - Specific implementation of DRIP drafts at AX Enterprize (Python 3)
  - Supporting drafts
    - auth-00 (ugrading to 03 soon^{TM})
    - identity-claims-00
    - uas-rid-06
- HHIT Registry
  - Identity-claims-00
  - API endpoint to provision aircraft and store HHIT/HIs in BIND9 zone semi-dynamically
- Been flying and demoing since June 2020

Responsible Behavior

HEY, I JUST GOT HOME FROM THE PARTY
THE ONE WITH THE IRC FOLKS?
YEAH.
HOW WAS IT?
GOT TOO DRUNK. I SCREWED UP, BAD.
WHAT HAPPENED?
THERE WAS A GIRL. NO IDEA WHO SHE WAS. DON'T EVEN KNOW HER NAME. I WAS TOO DRUNK TO CARE.
AND WHAT, YOU SLEPT WITH HER?
NO.
I SIGNED HER PUBLIC KEY.
SHIT, MAN.

Title text: Never bring tequila to a key-signing party.

https://xkcd.com/364/

Discussion

Questions, Comments, Concerns?

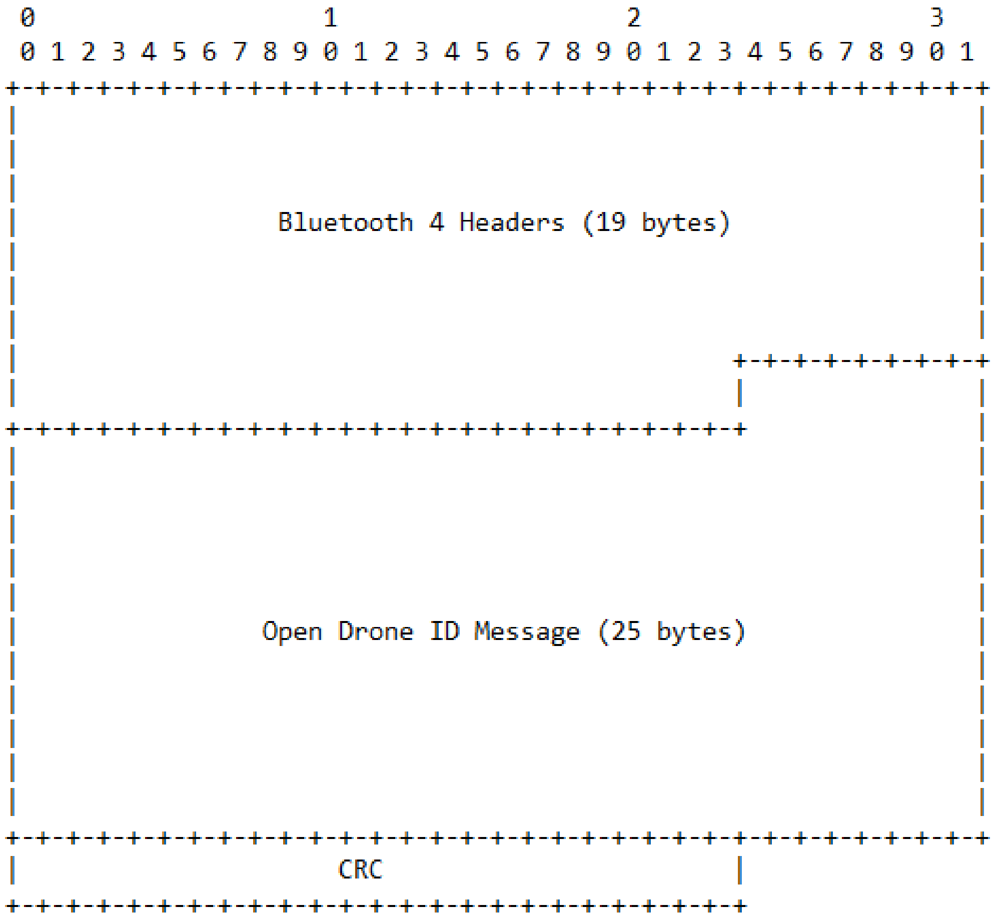
Backup Slides

Background & Problem

- ASTM F3411-19 Broadcast RID
  - Disjointed information delivery
    - Identity information of UA sent in Basic ID
    - Position information of UA sent in Location
      - But no ID in the Location Message
    - Authentication information of UA sent in Auth
    - All of these are sent and received separately (under Bluetooth 4.X)!
  - Fragmented data across Authentication Message pages
- Overall a lack of trust in Broadcast messages
  - Especially in Bluetooth 4.X

Bluetooth Background

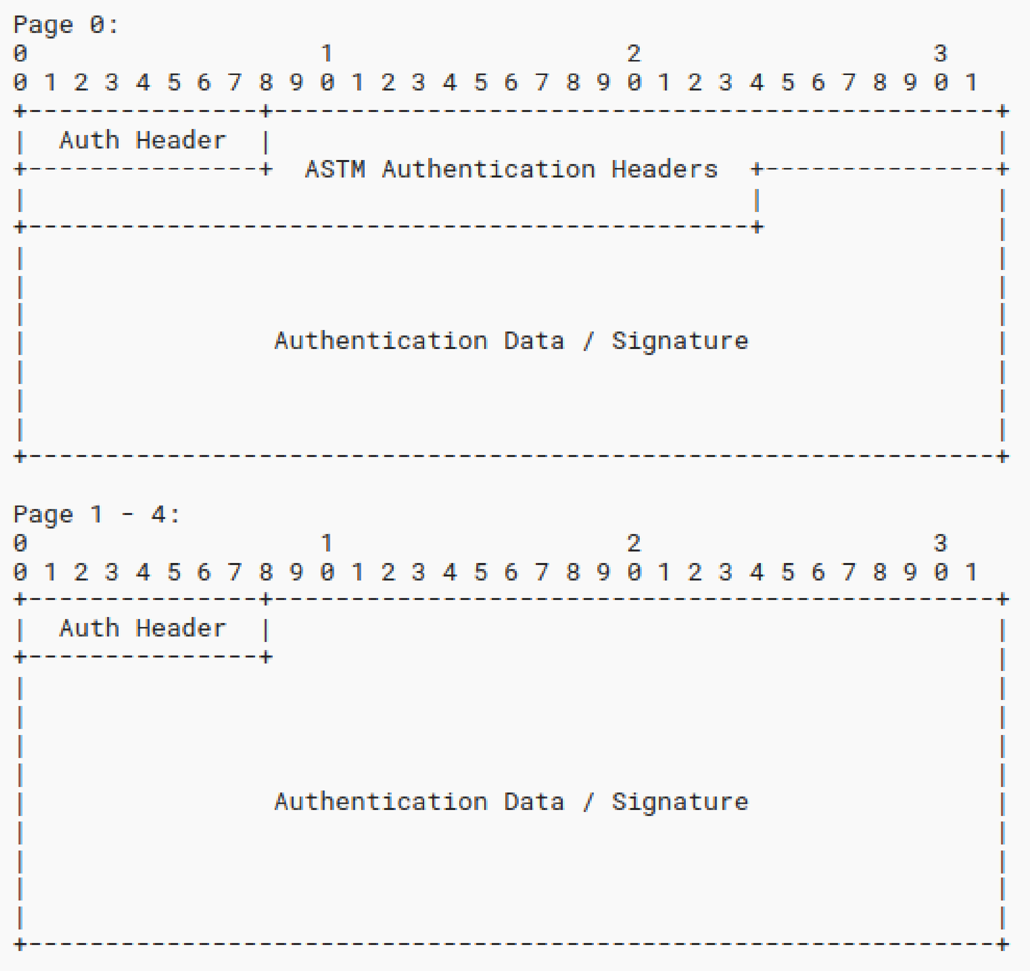
- Why so small?
  - Bluetooth 4 legacy frames only give 25 bytes to play with (after Bluetooth headers)
  - 1 byte is for a main header in ASTM format that is always present – now only 24 bytes of data to work with per frame/page



```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                                                               |
|                                                               |
|                 Bluetooth 4 Headers (19 bytes)                |
|                                                               |
|                                                               |
|                                                               |
|                                               +-+-+-+-+-+-+-+-+
|                                               |               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                Open Drone ID Message (25 bytes)               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     CRC                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

ASTM Authentication

- ASTM F3411-19 “Standard Specification for Remote ID and Tracking”
- Authentication Message
  - 5 pages long with a 109 byte max payload (17 + 23 * 4)
  - Designed to authenticate Message Packs (of up to 5 messages in Bluetooth 5.X frame)



```
Page 0:
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
+---------------+-----------------------------------------------+
|  Auth Header  |                                               |
+---------------+  ASTM Authentication Headers  +---------------+
|                                               |               |
+-----------------------------------------------+               |
|                                                               |
|                                                               |
|                                                               |
|                Authentication Data / Signature                |
|                                                               |
|                                                               |
|                                                               |
+---------------------------------------------------------------+

Page 1 - 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
+---------------+-----------------------------------------------+
|  Auth Header  |                                               |
+---------------+                                               |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
|                Authentication Data / Signature                |
|                                                               |
|                                                               |
|                                                               |
|                                                               |
+---------------------------------------------------------------+
```