Heartbeat Mechanism

draft-ietf-dots-signal-channel

IETF#105 Montreal, July 2019

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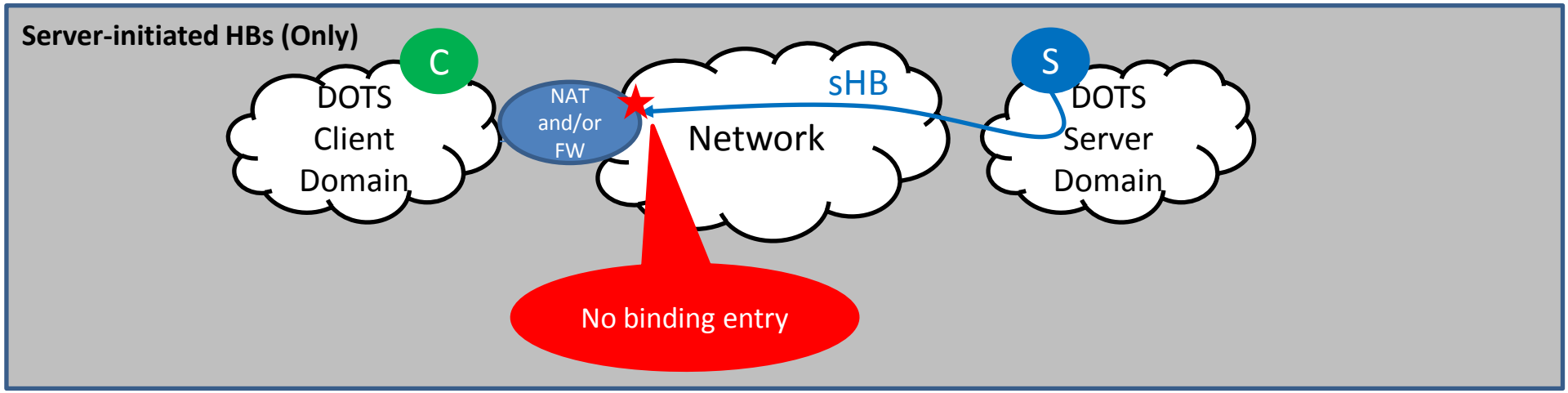
Why Heartbeats are Needed?

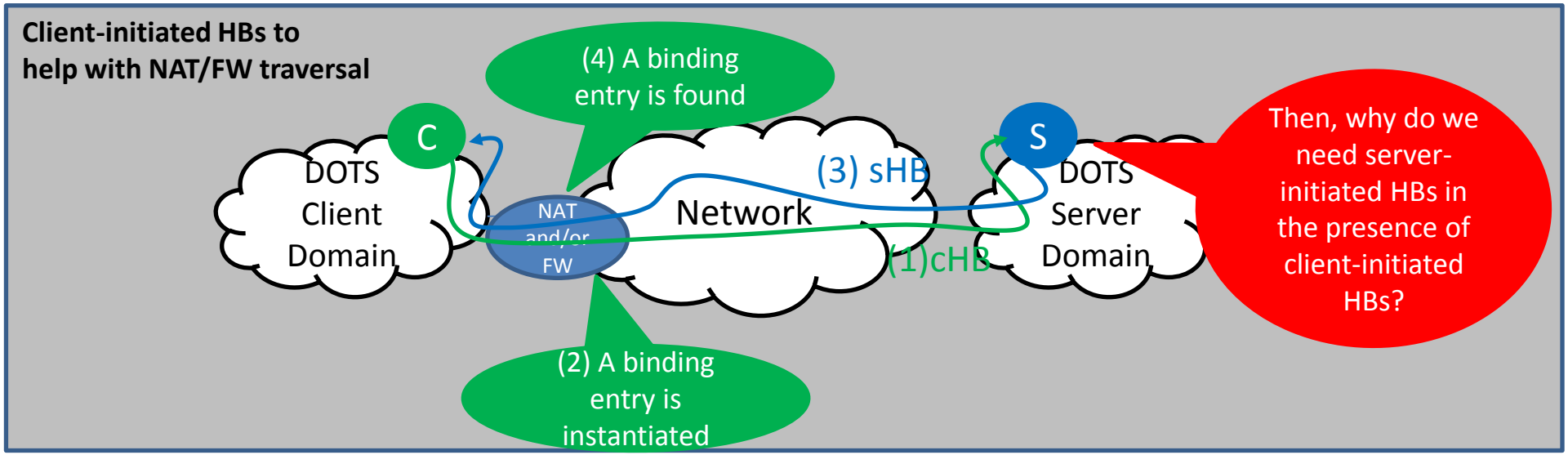
- Assess if the remote peer is defunct or alive
- Maintain any state in on-path NATs or firewalls

Why?

- To that aim, ***bidirectional HBs*** are exchanged between DOTS peers
  - DOTS agents regularly send heartbeats to each other

On The Importance of Client-Initiated Heartbeats

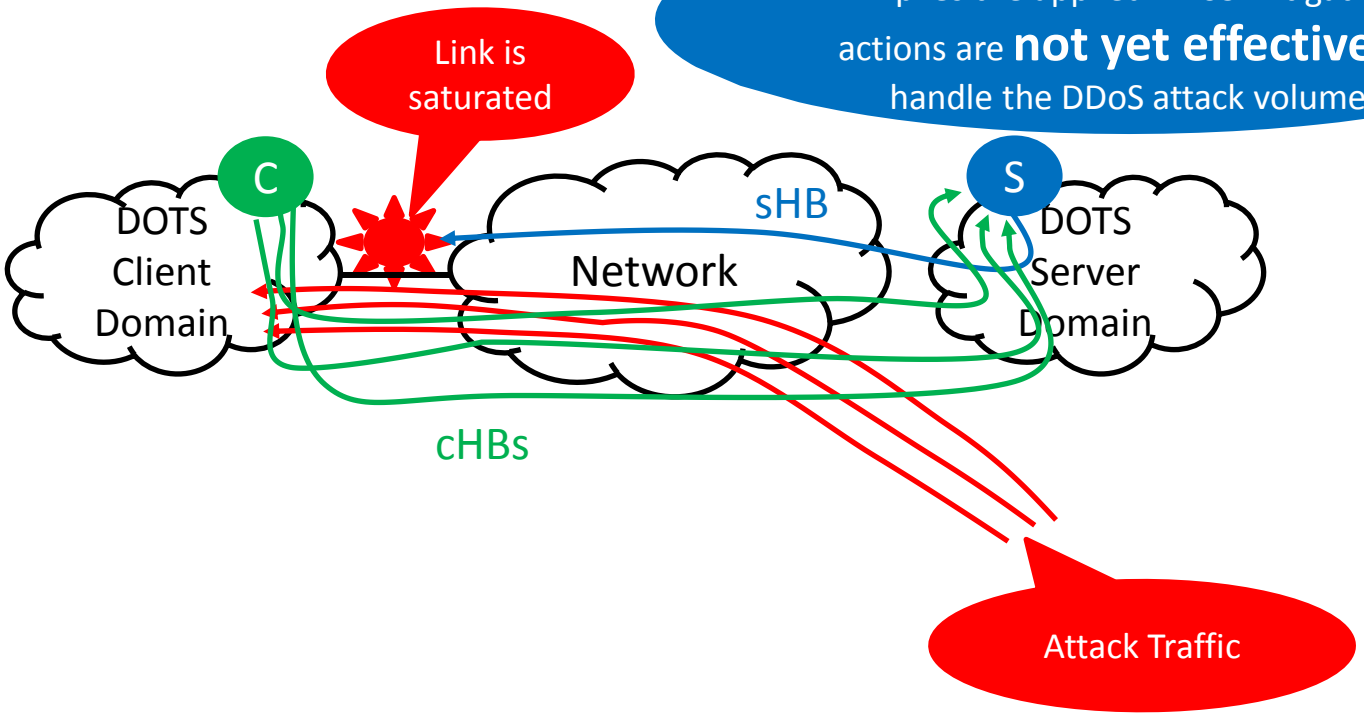




On The Importance of Server-Initiated Heartbeats for DOTS

(1) The DOTS server can identify:
- The DOTS client domain is under attack
- The inbound link to the DOTS client domain is **saturated**.

(2) If an attack mitigation is in progress, it implies the applied DDoS mitigation actions are **not yet effective** to handle the DDoS attack volume



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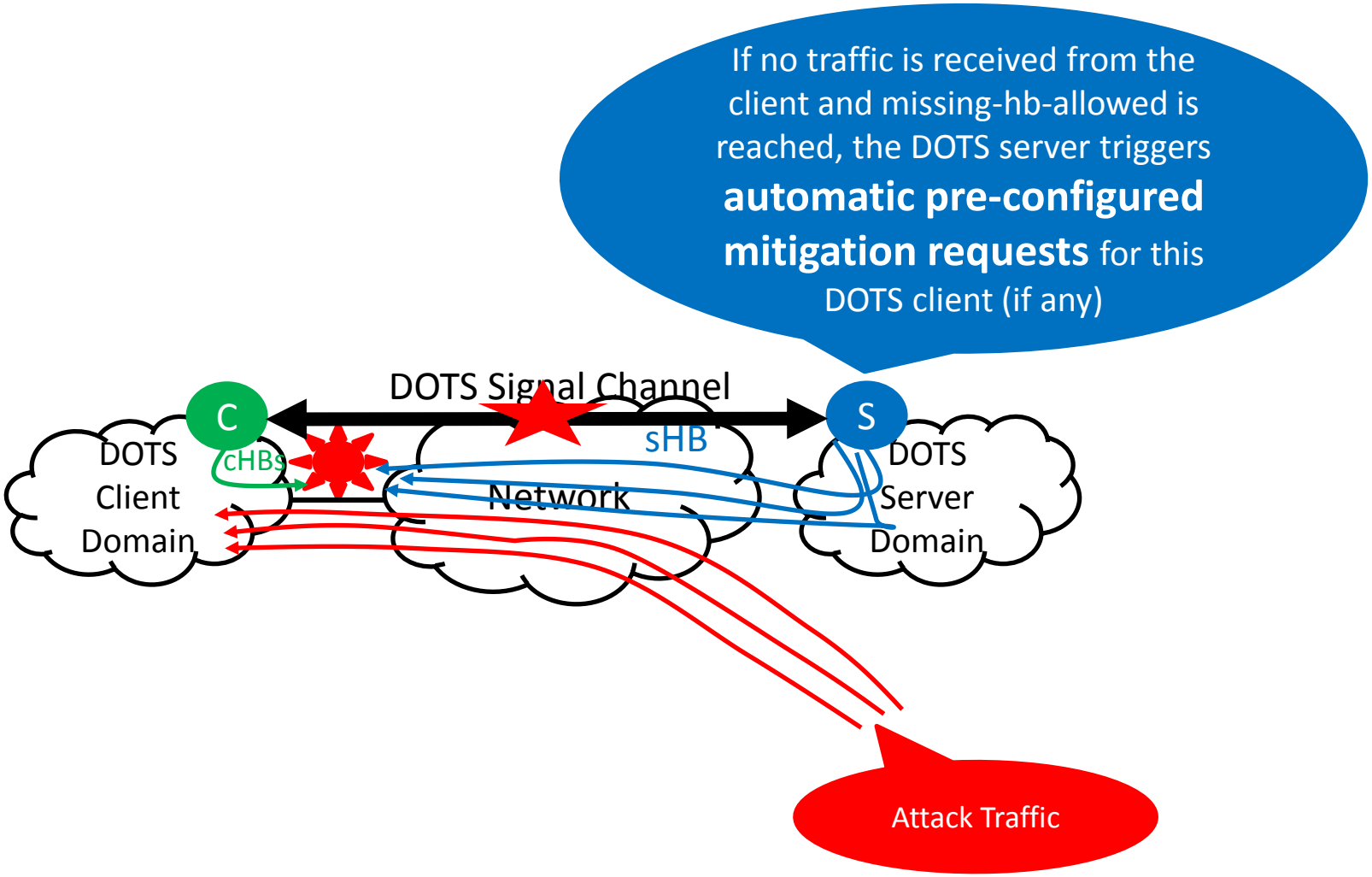

DOTS Session Configuration

```
+--:(signal-config)
          |  +--rw sid                    uint32
          |  +--rw mitigating-config
          |  +--rw idle-config
```

A DOTS server might want to **reduce** heartbeat frequency or **cease** heartbeat exchanges when an active DOTS client has not requested mitigation (RFC8612)

DOTS agents **automatically switch** to the other configuration upon a change in the mitigation activity

DOTS Session Configuration

Unreliable Transport

```
+--:(signal-config)
          |  +--rw sid                          uint32
          |  +--rw mitigating-config
          |  |  +--rw heartbeat-interval
          |  |  +--rw missing-hb-allowed
          |  |  +--rw max-retransmit
          |  |  +--rw ack-timeout
          |  |  +--rw ack-random-factor
          |  +--rw idle-config
          |     +--rw heartbeat-interval
          |     +--rw missing-hb-allowed
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          |     +--rw ack-random-factor
```

CoAP Retransmission Parameters

A maximum number of missing heartbeats is allowed.

HBs can be ***disabled***

DOTS Session Configuration

Flexible Retry Configuration for Unreliable Transports (1)

```
+--:(signal-config)
          |  +--rw sid                          uint32
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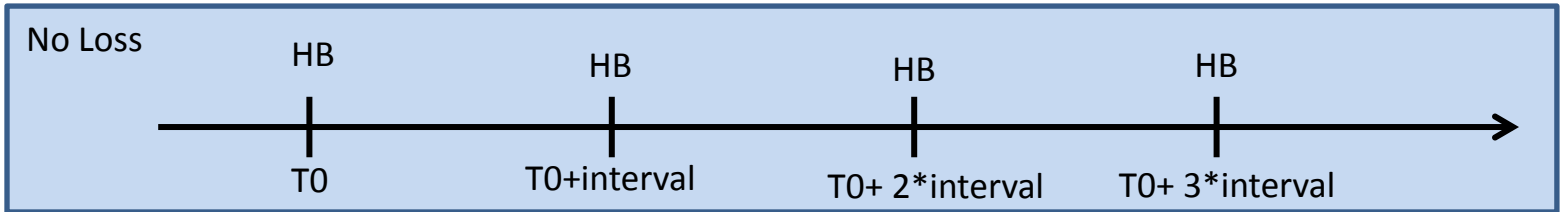
          |     +--rw ack-random-factor
```

e.g., Set to 5

e.g., Set to 3



DOTS Session Configuration

Flexible Retry Configuration for Unreliable Transports (2)

```
+--:(signal-config)
        |  +--rw sid                          uint32
        |  +--rw mitigating-config
        |  |  +--rw heartbeat-interval
        |  |  +--rw missing-hb-allowed
        |  |  +--rw max-retransmit
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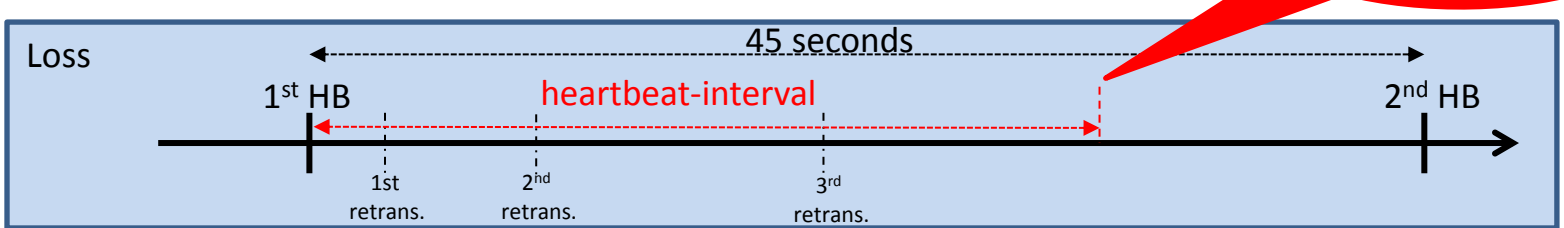
        |     +--rw missing-hb-allowed
        |     +--rw max-retransmit
        |     +--rw ack-timeout
        |     +--rw ack-random-factor
```

e.g., Set to 5

e.g., Set to 3

MUST NOT transmit a HB while waiting for the previous HB



DOTS Session Configuration

Flexible Retry Configuration for Unreliable Transports (3)

```
+--:(signal-config)
        |  +--rw sid                          uint32
        |  +--rw mitigating-config
        |  |  +--rw heartbeat-interval
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        |  |  +--rw ack-random-factor
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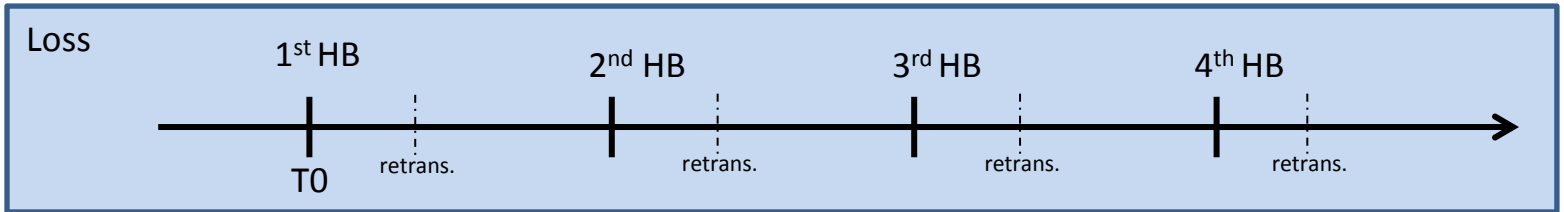
        |     +--rw missing-hb-allowed
        |     +--rw max-retransmit
        |     +--rw ack-timeout
        |     +--rw ack-random-factor
```

e.g., Set to 15

e.g., Set to 1



DOTS Session Configuration

Flexible Retry Configuration for Unreliable Transports (4)

```
+--:(signal-config)
        |  +--rw sid                          uint32
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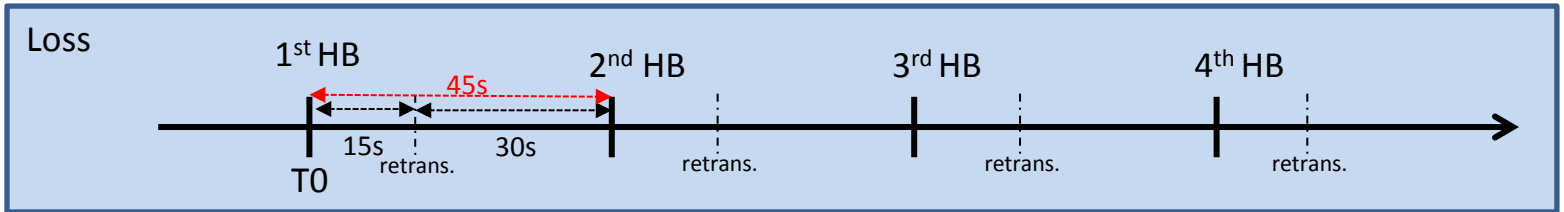
        |     +--rw max-retransmit
        |     +--rw ack-timeout
        |     +--rw ack-random-factor
```

e.g., Set to 7

e.g., Set to 1

e.g., Set to 10

e.g., Set to 1.5



DOTS Session Configuration

Flexible Retry Configuration for Unreliable Transports

```
+--:(signal-config)
          |  +--rw sid                    uint32
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```

NEW text (-36):

The specification allows for a flexible retry configuration when an unreliable transport is in use. For example, a server may be tweaked to return a lower 'missing-hb-allowed' (e.g., 5) value but delegate the retransmission to the underlying CoAP library by setting 'max-retransmit' to a high value (e.g., 3). The server may also be configured to return a 'max-retransmit' set to '1' and higher 'missing-hb-allowed' value (e.g., 15).

DOTS Session Configuration

Reliable Transport

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          |     +--rw max-retransmit
          |     +--rw ack-timeout
          |     +--rw ack-random-factor
```

HBs can be ***disabled***

Since the underlying TCP connection provides retransmissions

DOTS Session Configuration

Reliable Transport

Echoing this text from RFC8323:

"there is no need for the reliability mechanisms provided by CoAP over UDP"

NEW text (-36):

When the DOTS signal channel is established over a reliable transport (e.g., TCP), there is no need for the reliability mechanisms provided by CoAP over UDP since the underlying TCP connection provides retransmissions and deduplication [RFC8323]. As a reminder, CoAP over reliable transports does not support Confirmable or Non-confirmable message types. As such, the transmission-related parameters (missing-hb-allowed and acceptable signal loss ratio) are negotiated only for DOTS over unreliable transports.

DOTS Session Configuration

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Which Heartbeat for DOTS?

- DOTS over reliable transports
  - Connection Health based on Ping/Pong messages defined in RFC8323

- DOTS over unreliable transports
  - Relies upon CoAP Ping: Empty Confirmable message and the peer DOTS agent will respond by sending a Reset message

When to Declare Failure During an Attack? Reliable Transport

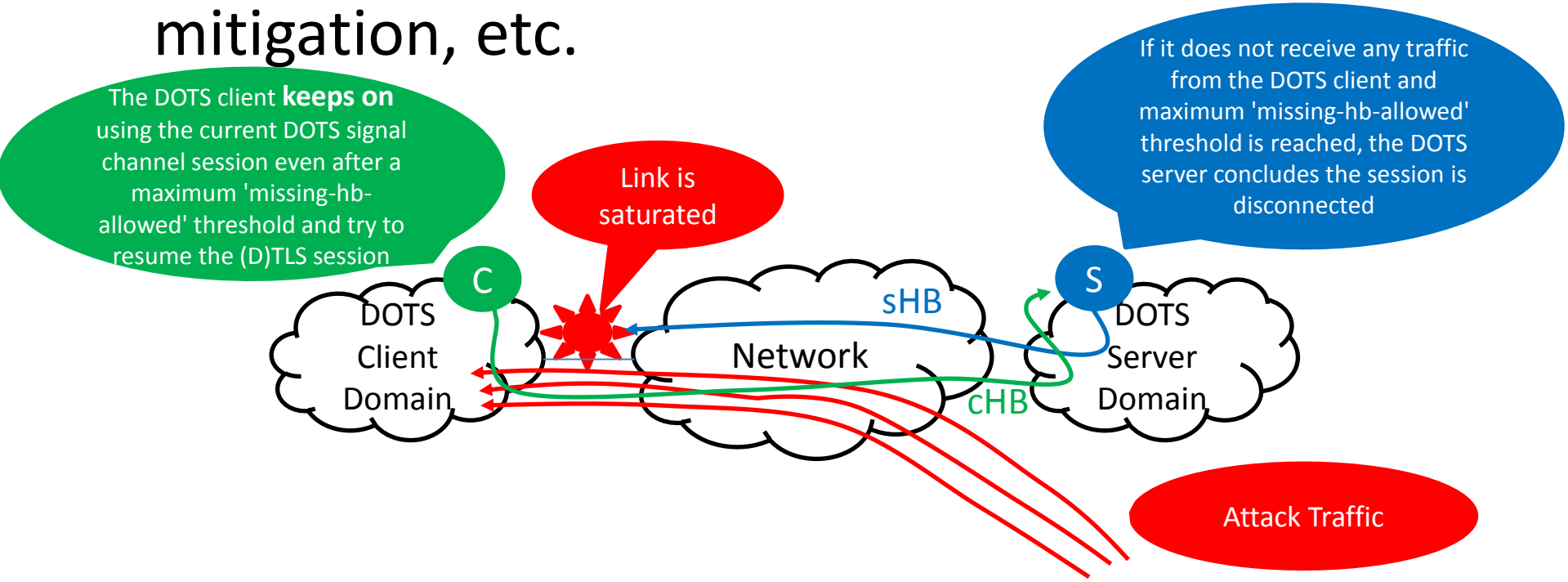
- The DOTS application ***has control over the Pong timeout***; hence when to declare failure based on heartbeat-interval

Quoting RFC8323:

"the present specification does not define any specific maximum time that the sender of a Ping message has to allow when waiting for a Pong reply. ***Any limitations on patience for this reply are a matter of the application making use of these messages,*** *as is any approach to recover from a failure to respond in time."*

When to Declare Failure During an Attack? Unreliable Transport

- The DOTS application ***owns the decision when to declare failure*** based on various parameters, e.g., missing-hb-allowed, attack mitigation, etc.



An Alternative Approach? (1)

- A Proposal from Mirja Kuehlewind
  - "I believe there are flaws in the design. First it's a layer violation, but if more an idealistic concern but usually designing in layers is a good approach. But more importantly, you end up with un-frequent messages which may still terminate the connection at some point, while what you want is to simply send messages frequently in an *unreliable fashion* but a low rate until the attack is over"

That is, use non-confirmable messages

An Alternative Approach? (2)

- Requires the DOTS server to send **non-confirmable messages**, but
  - Given that DOTS client is a CoAP Client and DOTS server is a CoAP Server
  - And Section 1.2 of RFC7252 indicates:
    - *Client: The originating endpoint of a request; the destination endpoint of a response.*
    - *Server: The destination endpoint of a request; the originating endpoint of a response.*
    - *Empty Message: A message with a Code of 0.00; neither a request nor a response.*
  - The server can **only send Empty requests**

But, is it possible to send non-confirmable empty requests?

An Alternative Approach? (3)

- Section 4.3 in RFC7252:
  - A Non-confirmable message always carries either a request or response and MUST NOT be Empty

Summary

- The intended heartbeat functionality is naturally provided by existing CoAP messages
  - Informed WG decision (next slide, for example)
  - Implemented
  - Tested with interoperable implementations
  - The DOTS application has the full control on the intended functionality
- The proposed alternative approach violates RFC7252
- Any objection with the assessment?
- What's Next for handling Mirja's pending DISCUSS point?
  - Report to Mirja the decision of the WG
  - Ben/Chairs?

From an Email sent by Med to the List (10/2017)

- https://mailarchive.ietf.org/arch/msg/dots/3mL8TjLlipWU8YOd6FRwWqd9vj8
  - “Should we rely solely on the missing-hb-allowed to detect a session problem?
  - Should we get rid of missing-hb-allowed, but rely on the retransmission to declare failure or not?
  - What is the advantage of cumulating both missing-hb-allowed and the retransmission procedure to declare a channel out?”