LHIP: Lightweight Authentication for HIP
draft-heer-hip-lhip-00.txt

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Motivation

- HIP is great!
- Host authentication
- End-to-end encryption
- Mobility (MM extension)
- Multihoming (MM extension)
- ....

But: quite much PK cryptography involved

Some Numbers

- Nokia N770
  - CPU: ARM 220 Mhz
- Benchmarks
  - RSA
  - DSA
  - DH

Some Numbers (cont'd)

Initiator	Responder
BEX	
2x Verify	1x Verify
1x Sign	1x Sign
1x DH	1x DH
Update	
1x Verify	1x Verify
1x Sign	1x Sign
Close	
1x Verify	1x Verify
1x Sign	1x Sign

„Off-the-shelve“ N770 as Initiator

HI initiator: RSA 1024
HI responder: DSA 1536

DH key-length: 384

- **BEX**: 797 ms
- **Update**: 469 ms
- **Close**: 469 ms

Why are These Numbers Problematic?

- Not just one HIP association!
  - UPDATEs (several open HIP associations)
  - Simultaneous BEXes
- Can't we just reduce the key length?
  - Weak keys?
  - Servers: multiple keys for multiple classes of clients?
- Won't time heal it?
  - Over-provision devices just for HIP?
  - More HIP hosts – more HIP associations

Lightweight HIP

- Idea was floating around for a while
- Master's thesis
  - Protocol proposal
  - Implementation
  - Performance evaluation

- Is this LHIP what the HIP folks want/need?

What is LHIP?

- HIP without PK
  - No host authentication
  - No encryption
- Reuse HIP namespace
  - ID locator split
  - Same name for LHIP and HIP
  - But don't break HIP!
- Support for MM
  - Authenticated UPDATEs
- Upgrade from LHIP to HIP

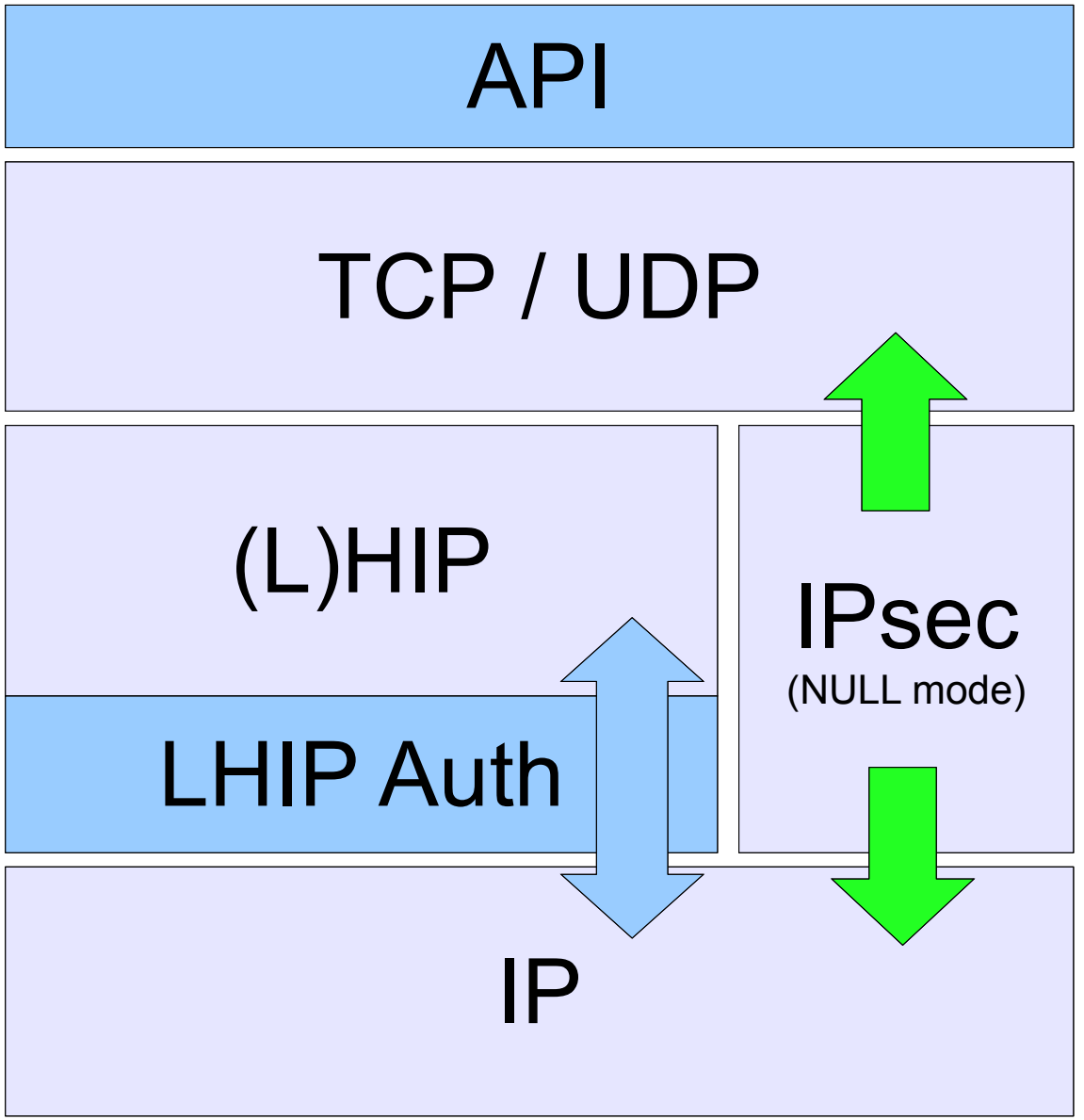
What LHIP can/can't do without PK

- LHIP cannot:
  - ... authenticate a host's identity (w/o PK)
  - ... encrypt payload
  - ... protect against MITM during BEX
- LHIP can:
  - ... authenticate succeeding messages
  - ... integrity protect control messages
  - ... protect against MITM after BEX
  - Middleboxes can verify LHIP control messages

Outline

- LHIP authentication
- LHIP associations (BEX)
- Closing an LHIP association
- Upgrade from LHIP to HIP
- Open questions

LHIP in the Stack



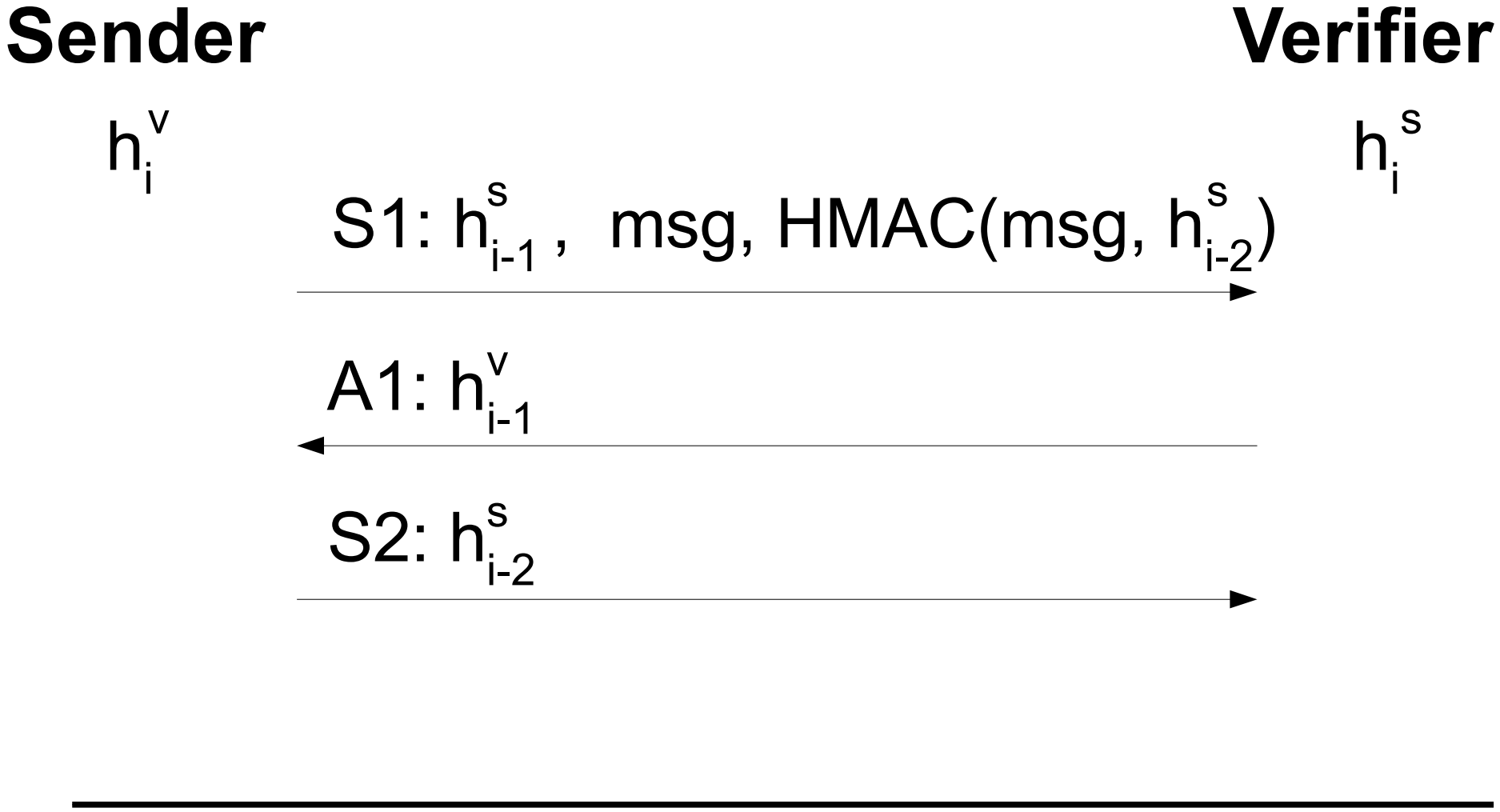
How to Substitute RSA/DSA/DH?

- No shared keys anymore:
  - Authentication of HIP control packets?
  - e.g. UPDATE from new IP?
- Interactive Hash Chain (IHC) based signatures
- Similar to Weak Identifier Multihoming Protocol
  - 2004: draft-ylitalo-multi6-wimp-00
- Very low processing cost to sign & verify
- BUT: One additional RTT per signed packet

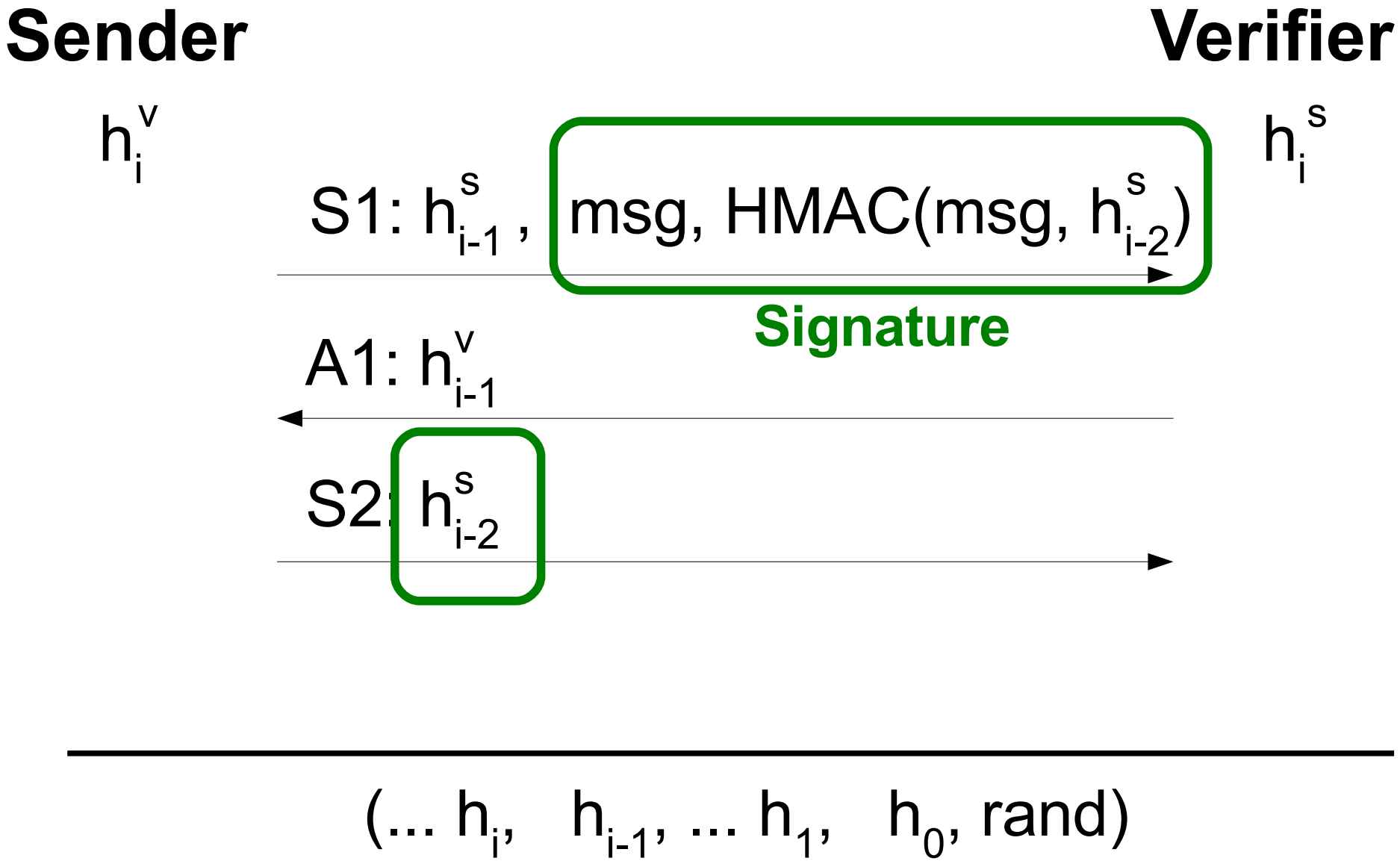
Hash Chains

- Cryptographic hash function H
- $h_0 = H(rand)$
- $h_1 = H(h_0) = H(H(rand))$
- ...
- $h_n = H(h_{n-1}) = H(...H(H(rand))...)$
- $(h_n, h_{n-1}, ... h_1, h_0, rand)$
- Can be used for authentication
- h_n is denoted anchor

IHC Based Signatures



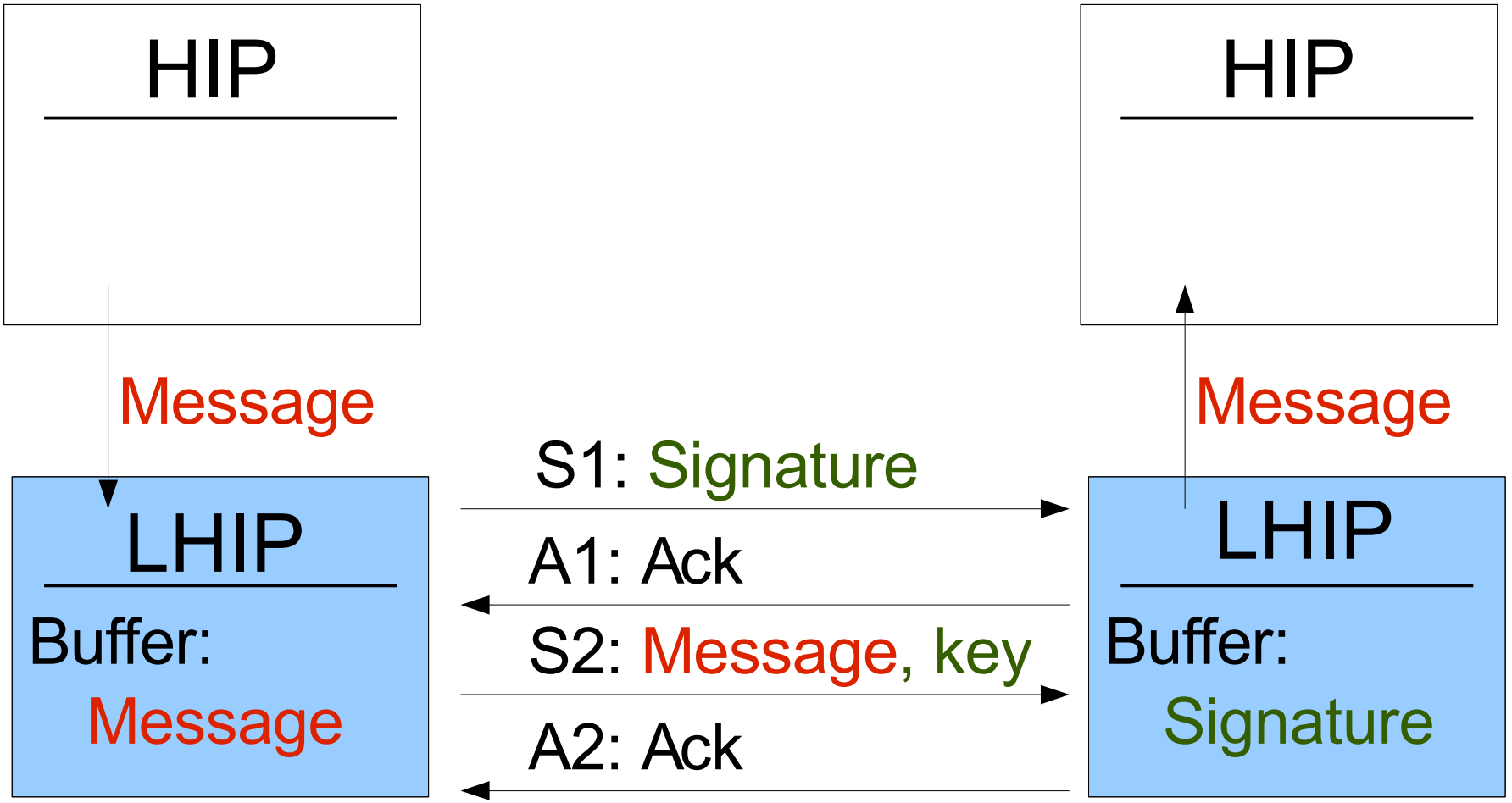
IHC Based Signatures



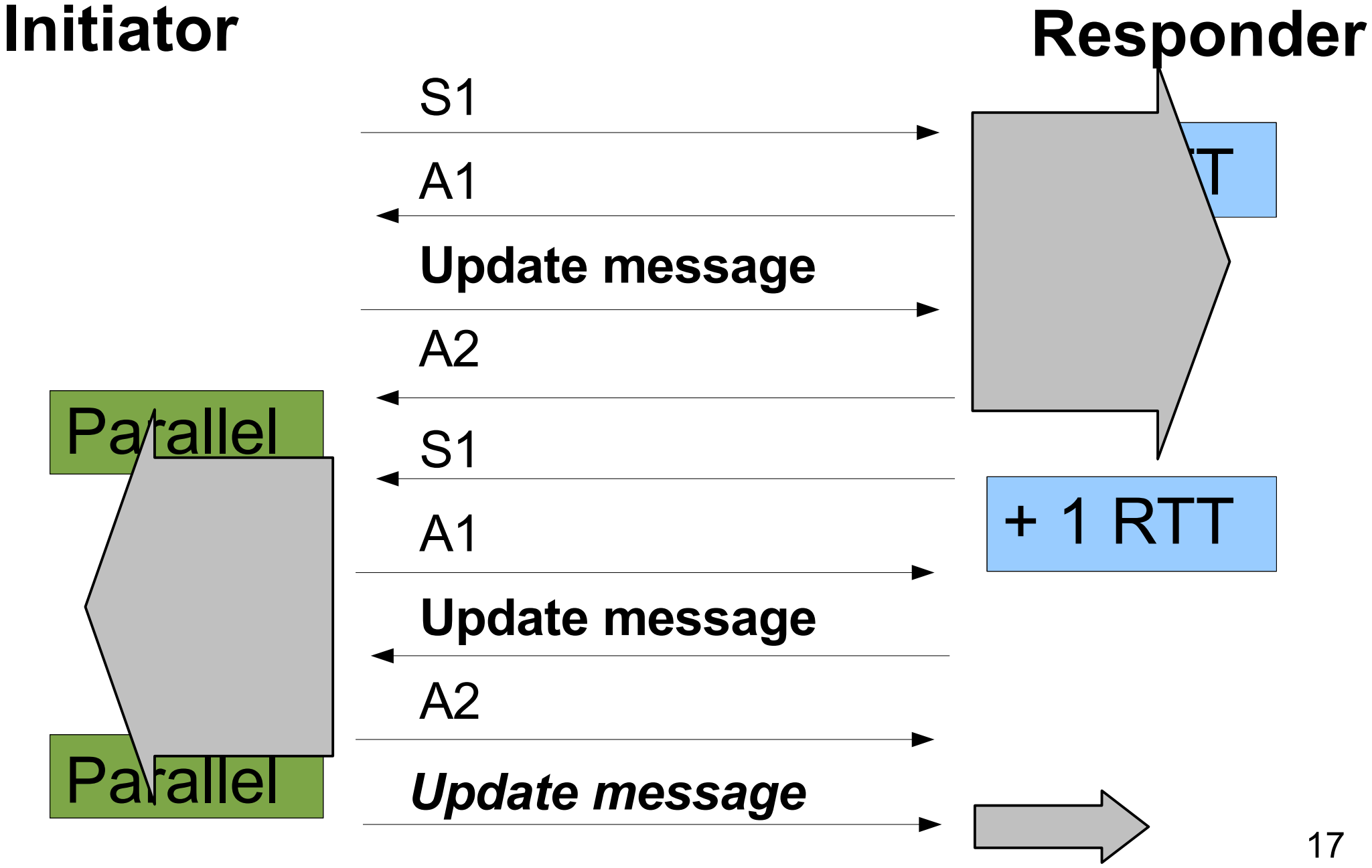
LHIP & IHC Based Signatures

- LHIP uses a variant of the IHC based signature
  - Easier to handle for middleboxes
  - Eliminated a possibility for a MITM attack
- Authenticated duplex channel
- LHIP signs the HIP HMAC parameter
  - 0..0 as HMAC key
  - HIP HMAC is used as message digest
  - Same semantics

LHIP Control Message Authetication



LHIP Mobility Update



Predefined Signals

- Simple signaling with predefined output
  - e.g. CLOSE
    - Close association if sent
    - No additional information needed
    - Protection required
- Exchange h_0^c = H(*rand*) during BEX
- Disclose *rand* if predefined signal is sent
  - e.g. add *rand* to CLOSE message
- Peer and middleboxes can authenticate signal

LHIP BEX

- Similar to HIP BEX
  - 4 way
  - I1 identical for both
  - Additional parameters in R1, I2, R2
    - Hash chain anchors
  - Modified parameters
    - HIP_TRANSFORM: new LHIP suite
    - Mandatory ECHO_REQUEST
  - Unused parameters (during BEX)
    - Diffie-Hellman public keys is still present

HIT Blocking Attack

1. Attacker:
Connect, ***HI V***

X

2. Victim:
Connect, **HI V**

HIT Stealing Attack

Server: **HI S**

1. Attacker:
Connect, ***HI S***

2. Victim:
Connect to ***HI S***

RSA/DSA is Required (in some cases)

- Protect the HIP namespace
- Protect pure HIP hosts in particular
- PK authentication is required...
  - In case of collisions:
    - second LHIP host must authenticate
  - During association establishment:
    - Authenticate incoming or outgoing comm.
- Optional request for host authentication
  - Signaled in R1 and I2

LHIP Payload

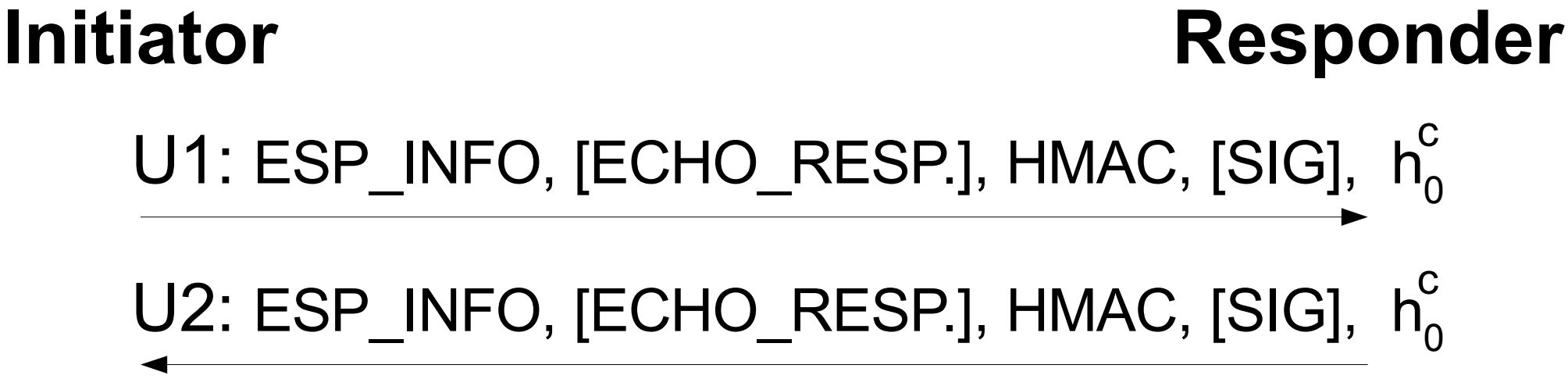
- IPsec
  - No symmetric keys available
  - ESP NULL mode w/o AH?
  - Simpler to implement
  - Same payload handling for HIP & LHIP
- IP
  - No keys.... that's okay!
  - How to “catch” and process packets?
  - Harder to implement

LHIP Payload (cont'd)

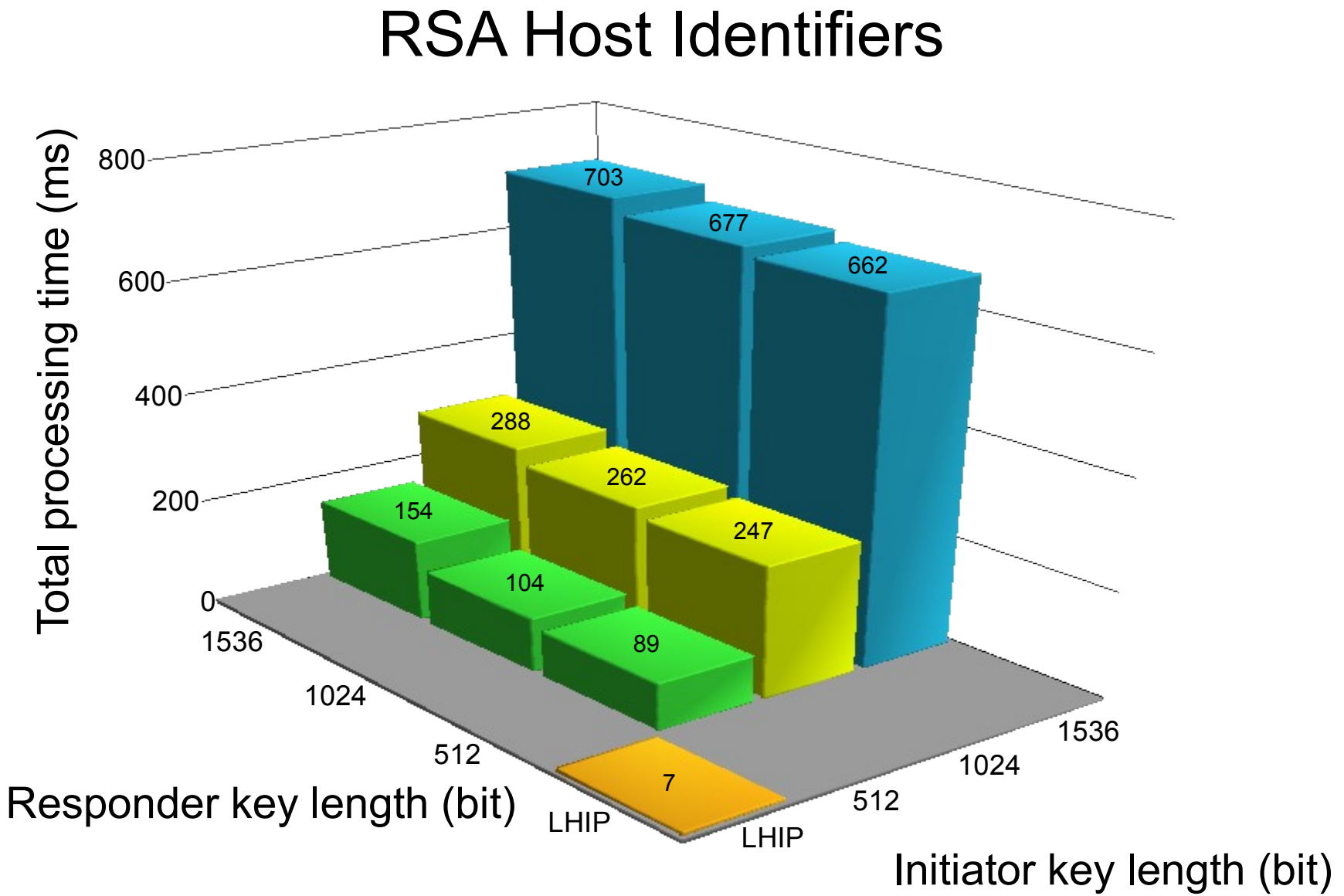
- Currently unprotected
- Use cleartext key as “secret”?
  - Insecure if attacker eavesdrops BEX
  - Maybe secure after mobility
- Use hash chains to protect payload?
  - Many hash chain elements needed
  - Mixture TESLA, IHC based signatures?
- Other options?
- Would LHIP just pretend to be somewhat secure?

LHIP Upgrade

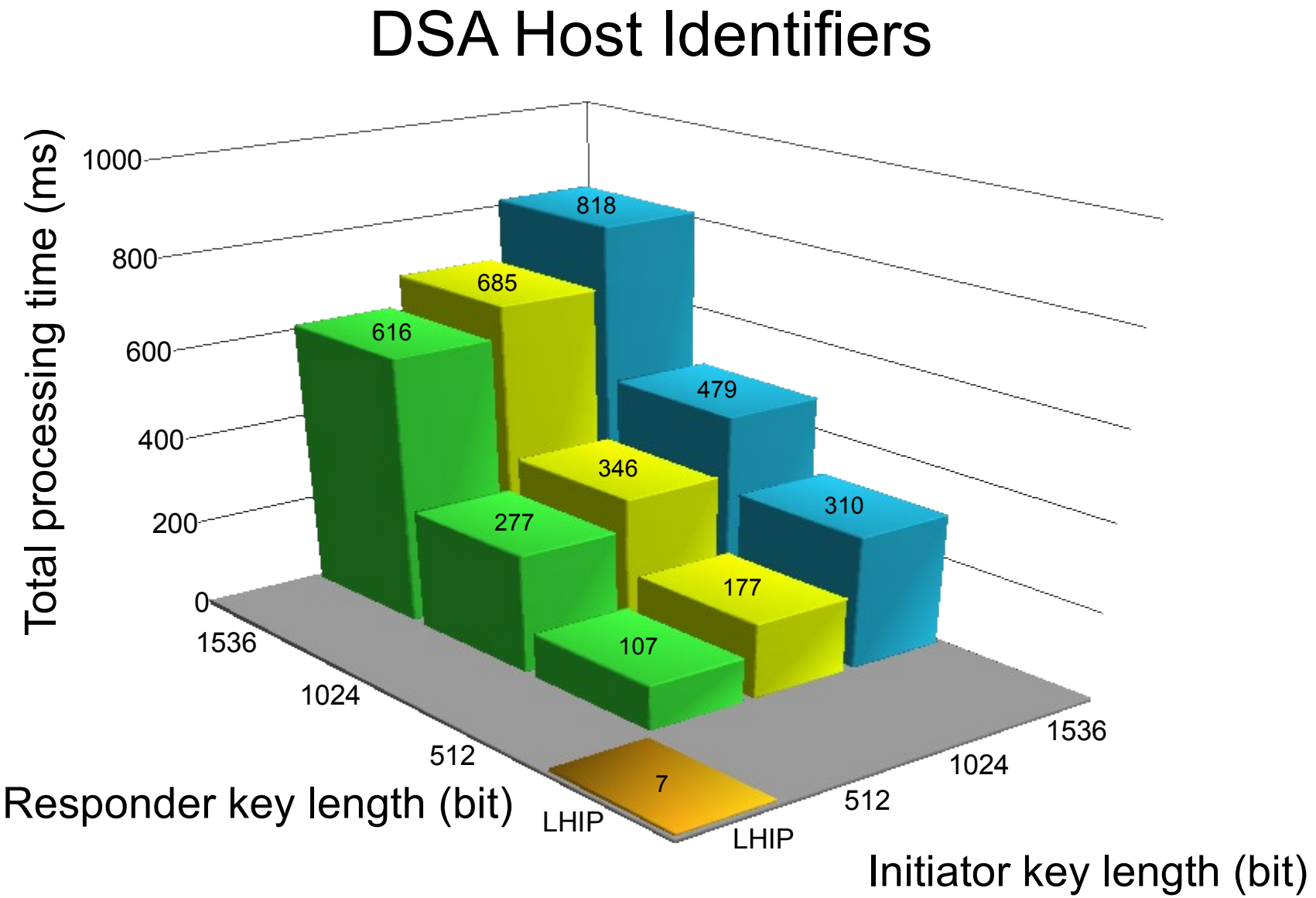
- Triggered by:
  - Application (same socket) - API
  - Request for full HIP assoc. (other socket)



BEX Performance

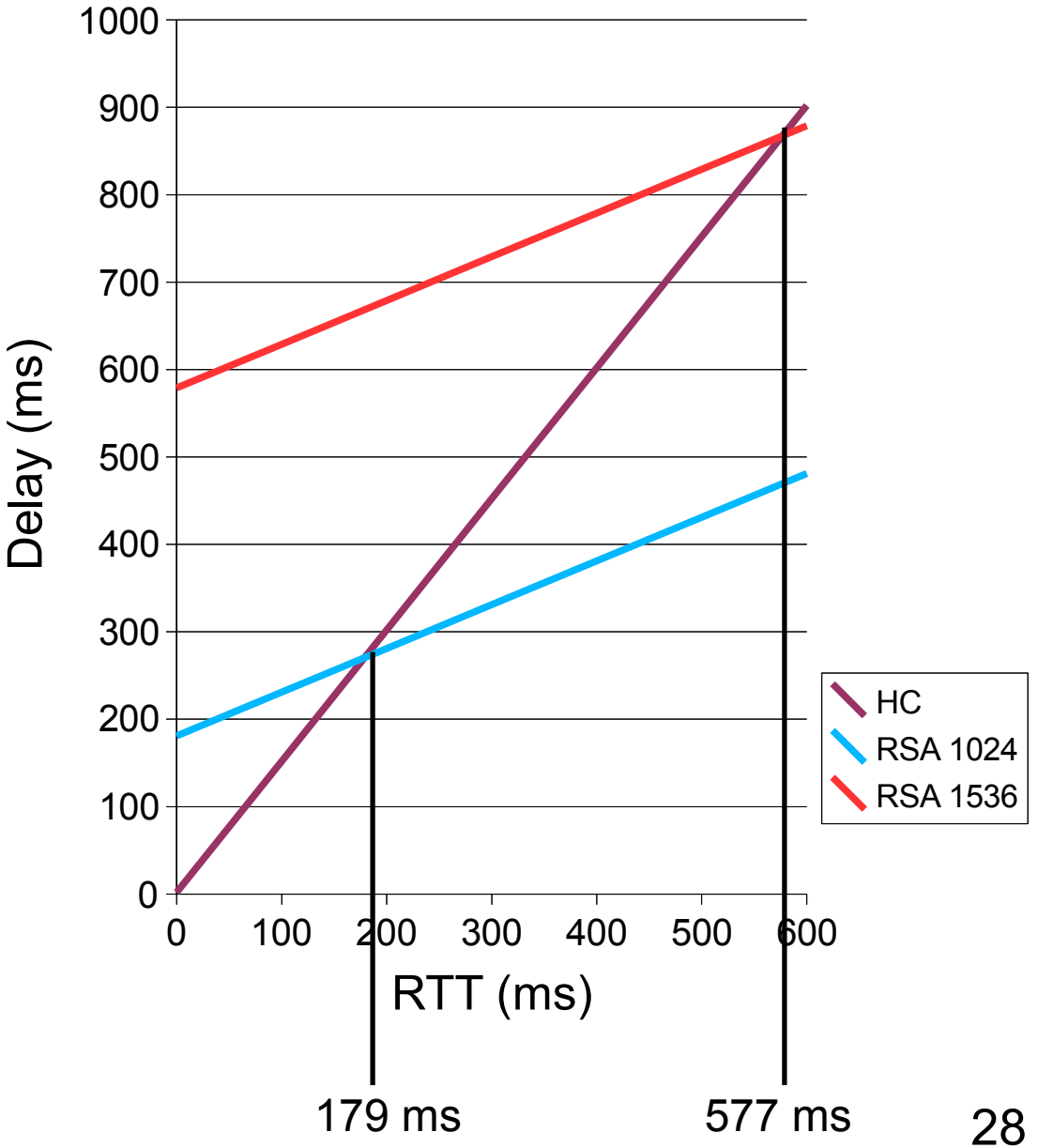


BEX Performance



HC Signature Performance

- HC signatures
  - Sign: 2.3 ms
  - Verify: 3.1 ms
  - Plus 1.5 x RTT
- RSA / DSA
  - Signature
  - Verification
  - Plus 0.5 x RTT



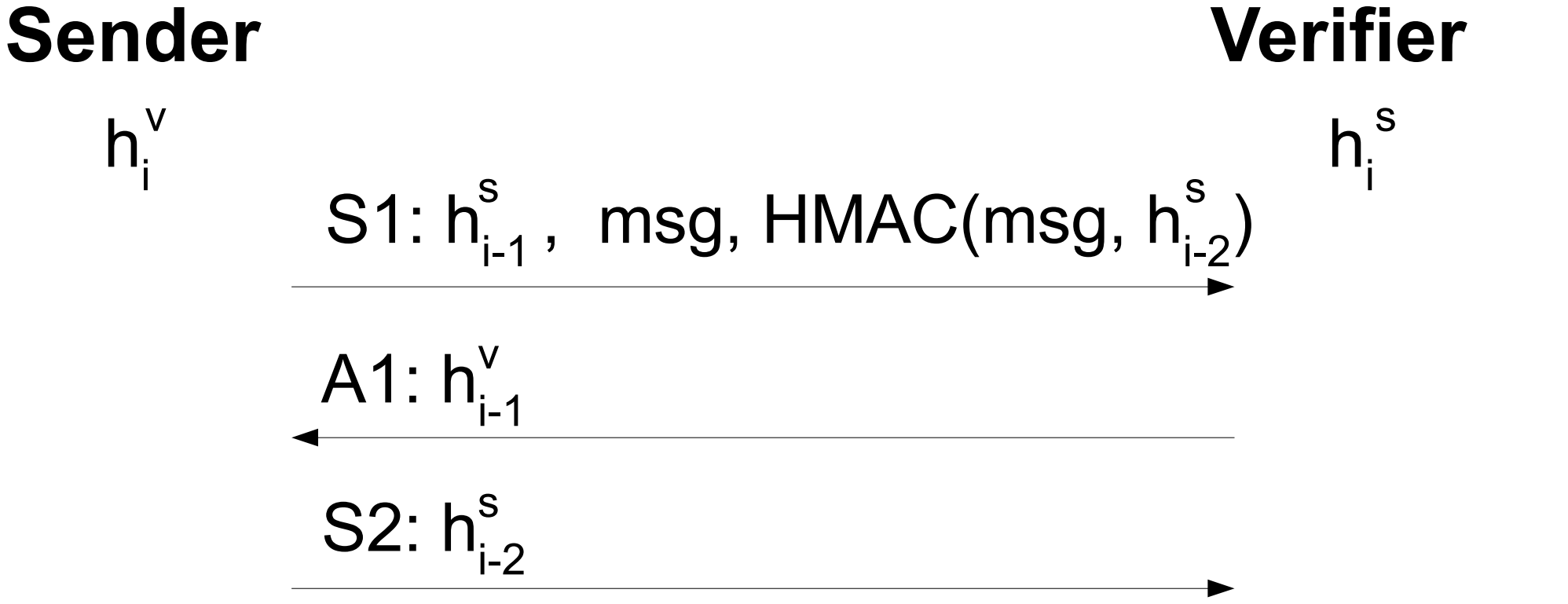
LHIP Summary

- HI namespace reuse
- Performance
  - Less RSA / DSA
  - No DH
- Mobility, multihoming & more
- Middleboxes can verify signatures w/o RSA/DSA
- Extension

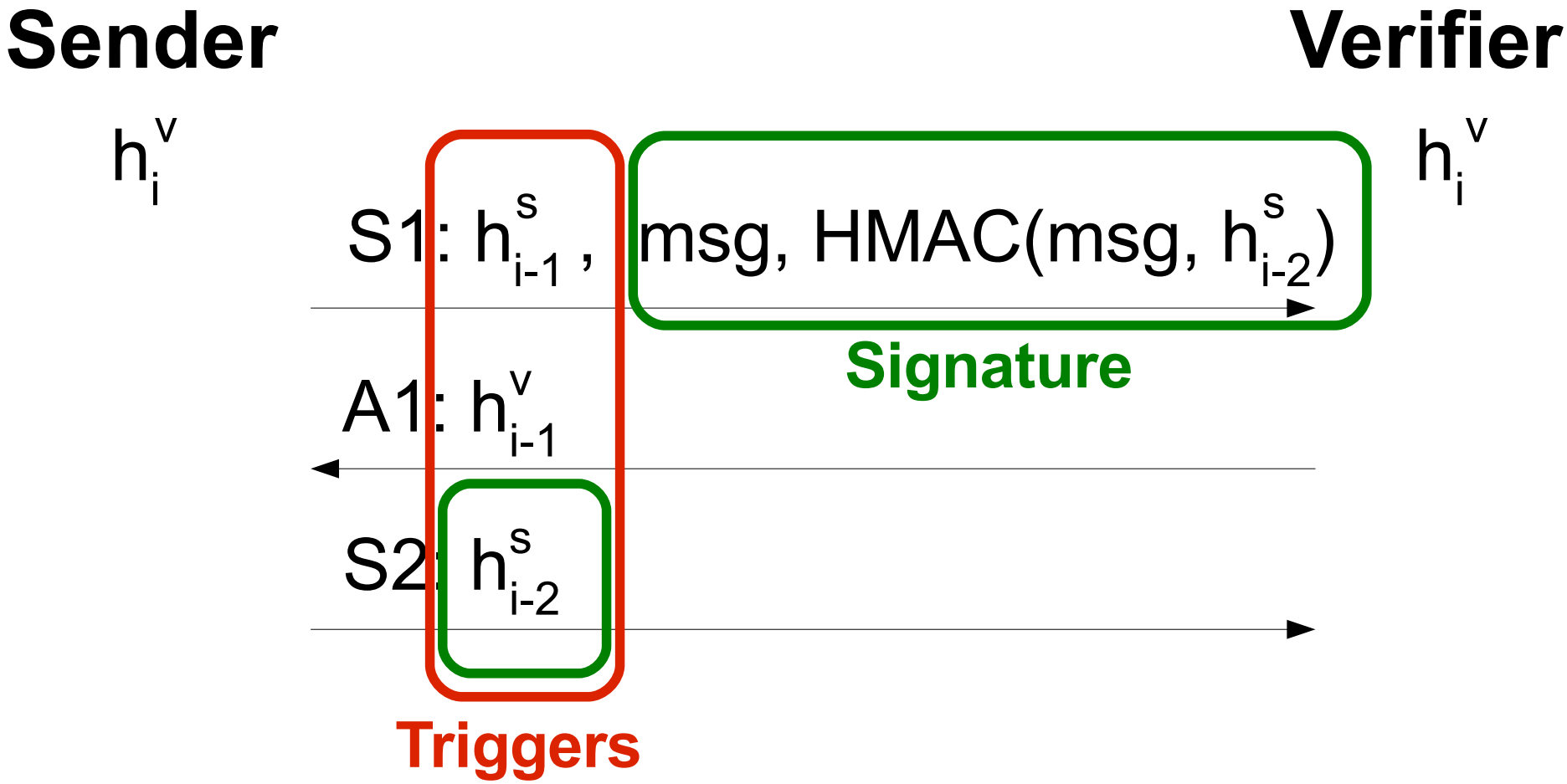
- Just a suggestion
- Could this be useful for the WG or RG?

Appendix I
Interactive Hash Chain Based Signatures

IHC Based Signatures



IHC Based Signatures



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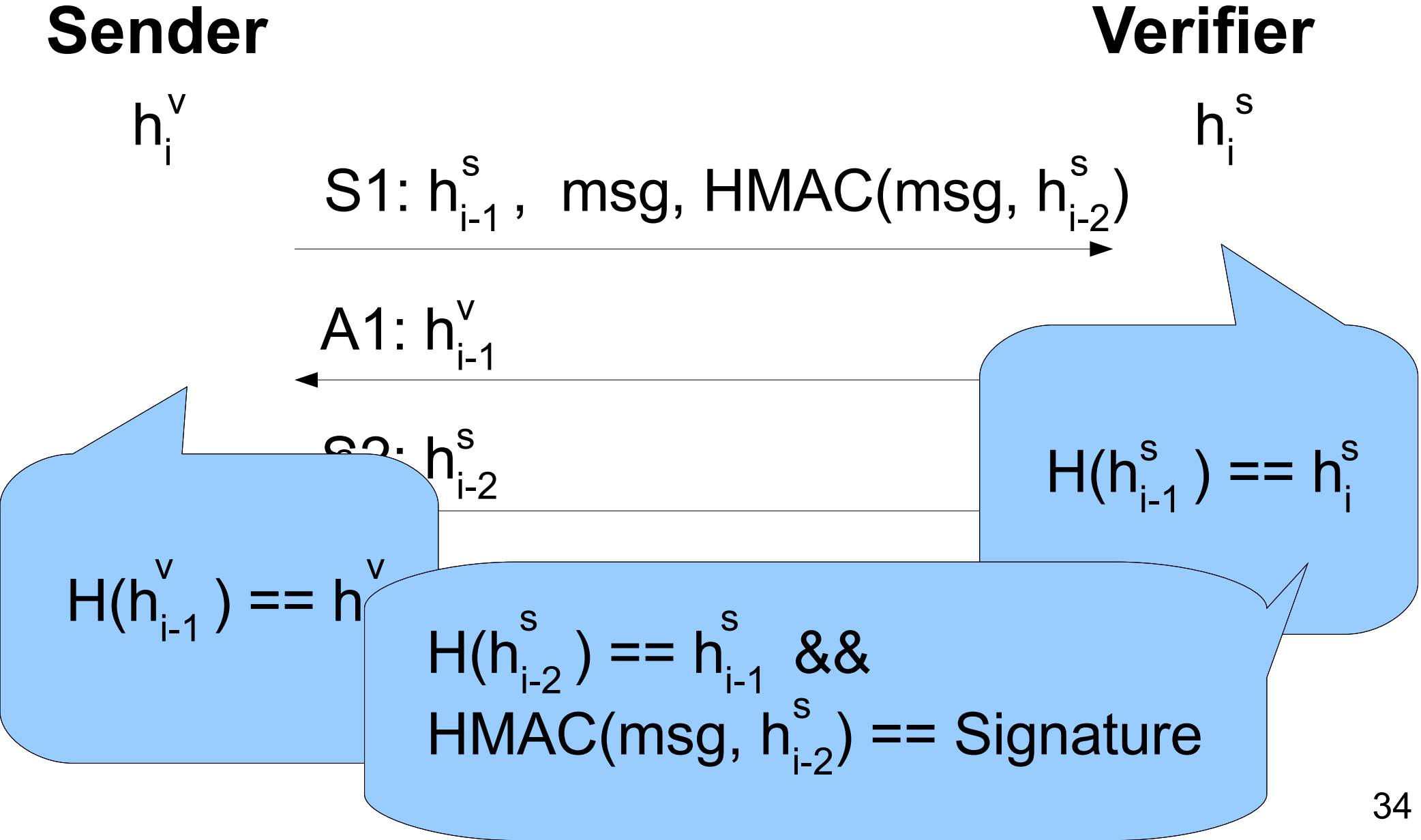

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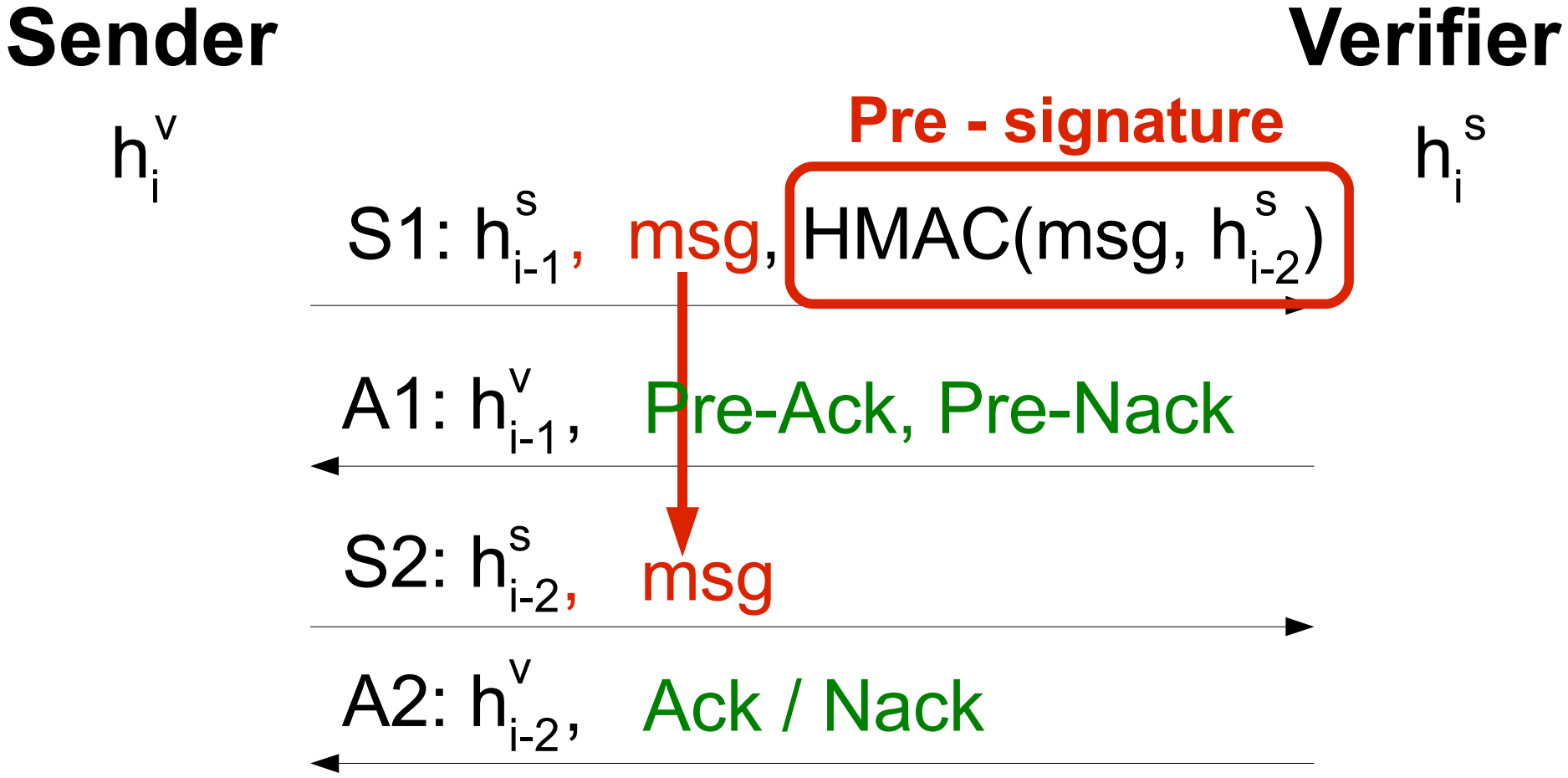

Message Queueing

1) Take control packet from HIP (msg)
2) [Queue msg]
3) Send signed message
4) [Send next msg in Queue]

What do we need PK crypto for?

- Authentication (RSA or DSA)
  - Packet authentication
  - Host authentication

- Shared secret generation (Diffie Hellman)
  - Packet authentication (HMAC)
  - Payload encryption (AES, 3DES, Blowfish)

➔ Minimize the use of RSA and DSA, replace Diffie Hellman!