CNT4406/5412 Network Security

IPsec/IKE

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  - specified in three separate RFCs: 2407, 2408, and 2409
  - complex and ambiguous in implementation details
  - NAT-unfriendly
- The authors hate IKE v1, one of them wrote a RFC for IKE v2

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  - initially published in RFC 4306 with clarifications in RFC 4718
  - more robust and cleaner than IKE v1
- We will cover IKE v2 exclusively
  - we use the term of "IKE" instead of "IKE v2" for clarity

Introduction to IKE v2

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- The requester is responsible to ensure reliability (retransmission)

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- IKE then creates Child SAs for AH/ESP
  - ➠ CREATE_CHILD_SA and INFORMATIONAL exchanges
- IKE and child SAs can be renegotiated during a session (rekeying)
  - ➠ to rekey a SA, create a replacement then delete the old one

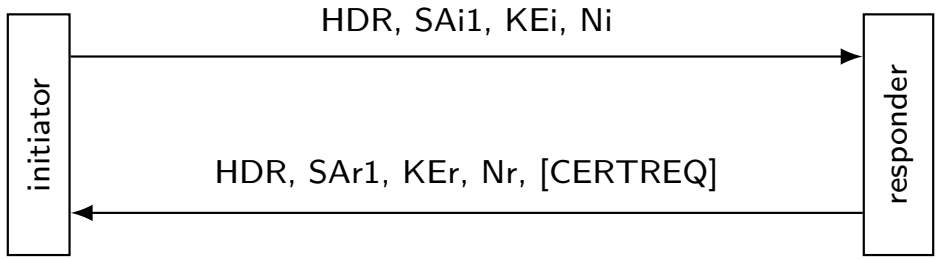
IKE Payload

IKE messages consist of a number of **payloads** linked by "next payload"

Notation	Payload
AUTH	authentication
CERT	certificate
CERTREQ	certificate request
D	delete
HDR	common IKE header (not a payload)
IDi/IDr	identification - initiator/responder
KE	DH key exchange
Ni, Nr	nonce -initiator/responder
N	notify
SA	security association
SK	encrypted and authenticated
TSi/TSr	traffic selector - initiator/ responder

Initial Exchange: IKE_SA_INIT

- This exchange negotiates security parameters for IKE SA



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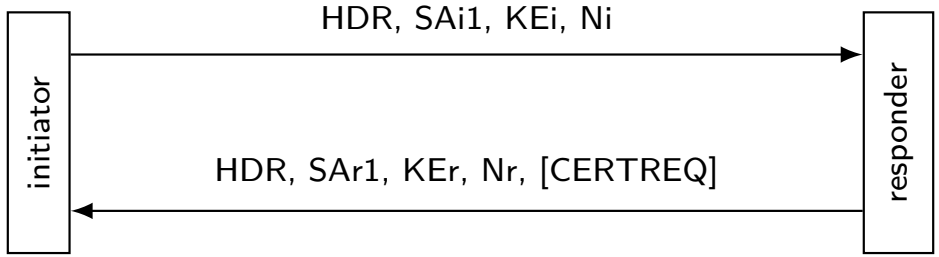

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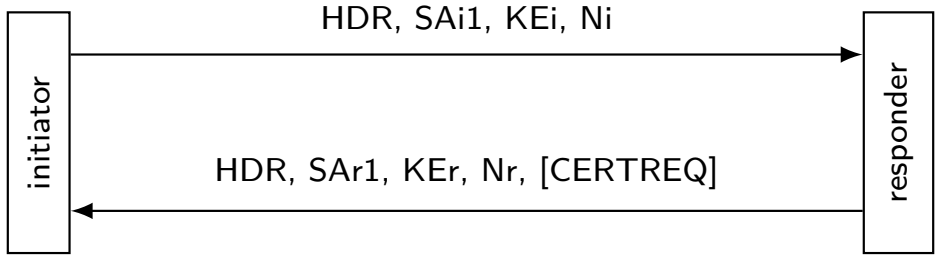

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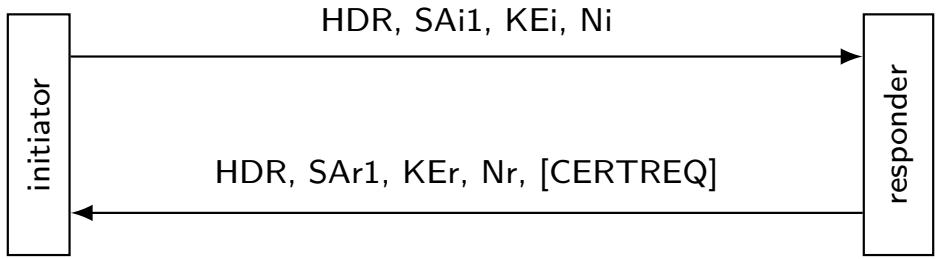

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- SKEYSEED also derives SK_d to be used for Child SAs

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Initial Exchange: IKE_SA_INIT...

Payload details:

Payload	Format
HDR	SPIi|SPIr|Next Payload|Ver|Exchange Type|Flag|Message ID|Length
KE	Next Payload|Payload Length|DH Group|DH Data
N	Next Payload|Length|Nounce Data

- Exchange type: `IKE_SA_INIT`, `IKE_AUTH`, `CREATE_CHILD_SA`, `INFORMATIONAL`
- SA negotiates the algorithms, it has a nested data structure

Initial Exchange: IKE_SA_INIT (ASCII Art)...

```
SA Payload
     |
     +--- Proposal #1 ( Proto ID = ESP(3), SPI size = 4,
     |     |            7 transforms,      SPI = 0x052357bb )
     |     |
     |     +-- Transform ENCR ( Name = ENCR_AES_CBC )
     |     |     +-- Attribute ( Key Length = 128 )
     |     |
     |     +-- Transform ENCR ( Name = ENCR_AES_CBC )
     |     |     +-- Attribute ( Key Length = 192 )
     |     |
     |     +-- Transform ENCR ( Name = ENCR_AES_CBC )
     |     |     +-- Attribute ( Key Length = 256 )
     |     |
     |     +-- Transform INTEG ( Name = AUTH_HMAC_SHA1_96 )
     |     +-- Transform INTEG ( Name = AUTH_AES_XCBC_96 )
     |     +-- Transform ESN ( Name = ESNs )
     |     +-- Transform ESN ( Name = No ESNs )
     |
     +--- Proposal #2 ( Proto ID = ESP(3), SPI size = 4,
           |            4 transforms,      SPI = 0x35a1d6f2 )
           |
           +-- Transform ENCR ( Name = AES-GCM with a 8 octet ICV )
           |     +-- Attribute ( Key Length = 128 )
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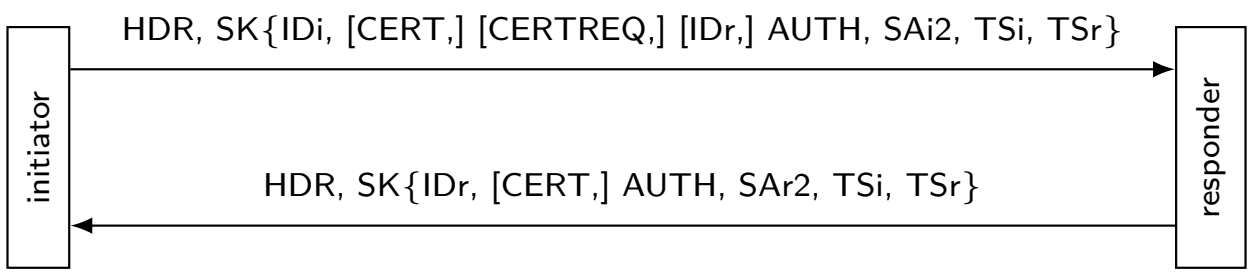

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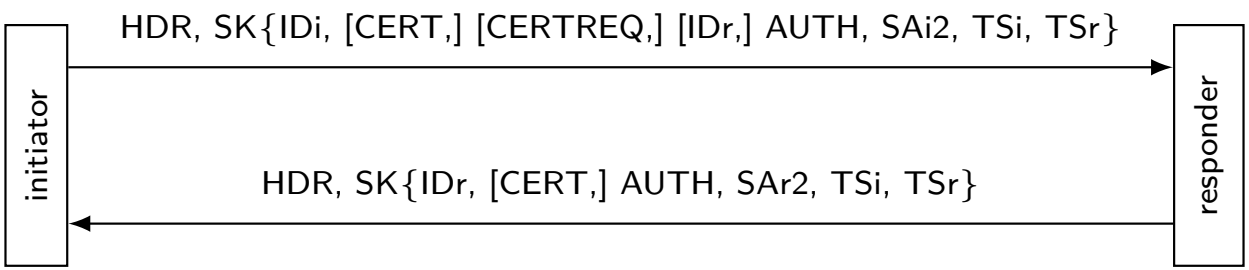

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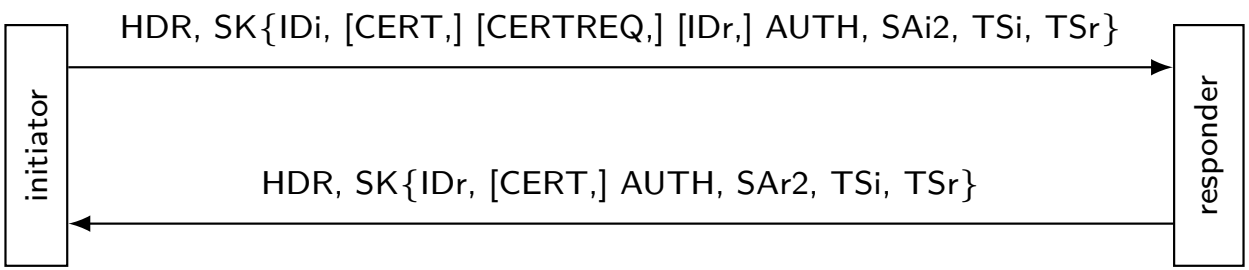

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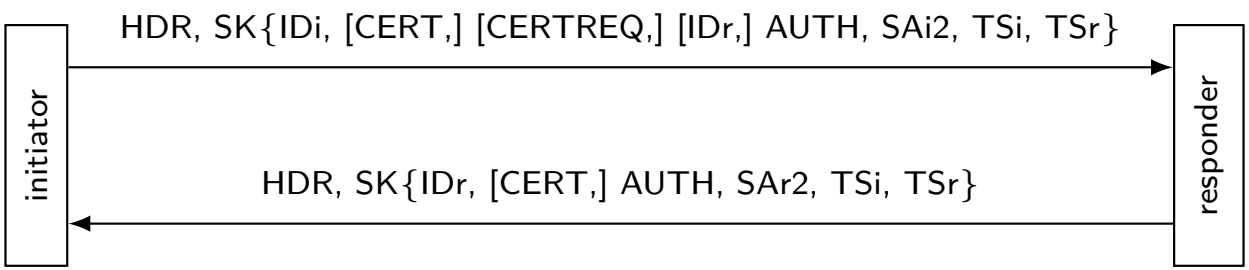

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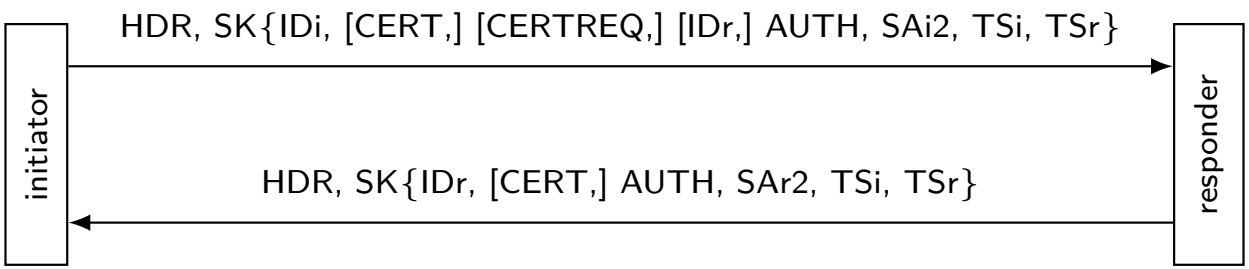

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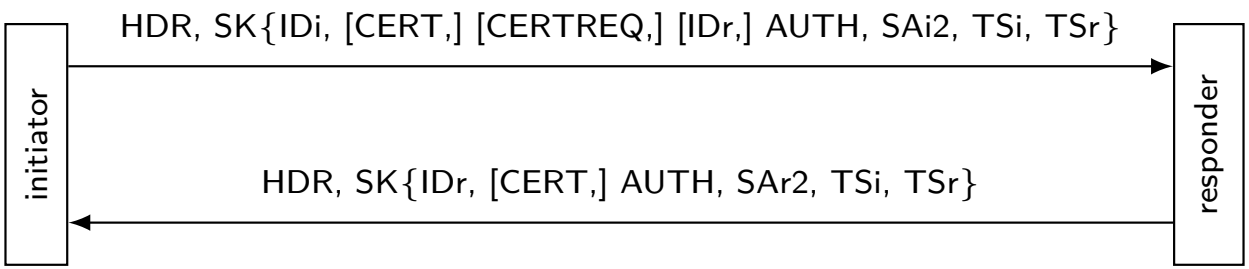

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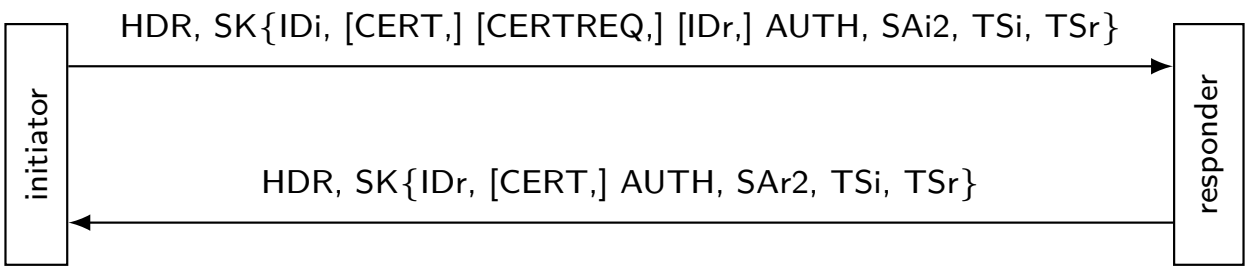

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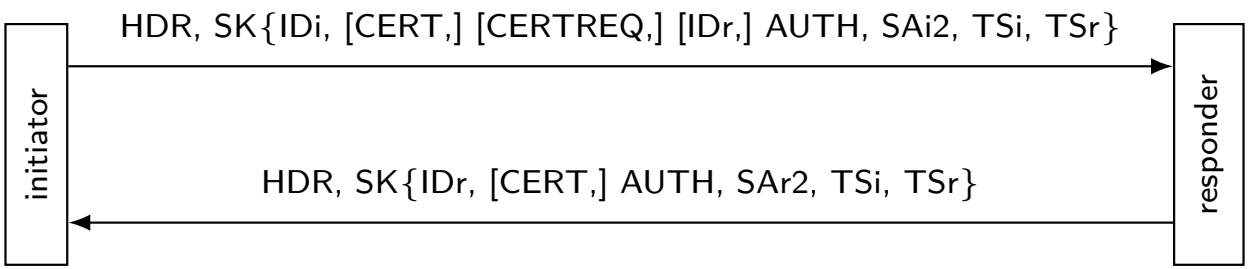
  - SAi2/SAr2 and TSi/TSr are used as key materials for Child SAs
  - failure to negotiate Child SA does not invalid IKE SA



Initial Exchange: IKE_AUTH...

Payload details:

Payload	Format
SK	Next Payload|Payload Length|IV|Encrypted IKE Payloads|MAC
ID	Next Payload|Payload Length|ID Type|ID Data
AUTH	Next Payload|Payload Length|Auth Method|Auth Data
TS	Next Payload|Payload Length|Number of TSs|Selectors

- SK is an encrypted container of other IKE payloads, it must be the last payload in a IKE message
- ID can be IPv4 address, domain name, IPv6 address...
- Traffic selector has src/dst IP rangers, IP protocol, and a port range

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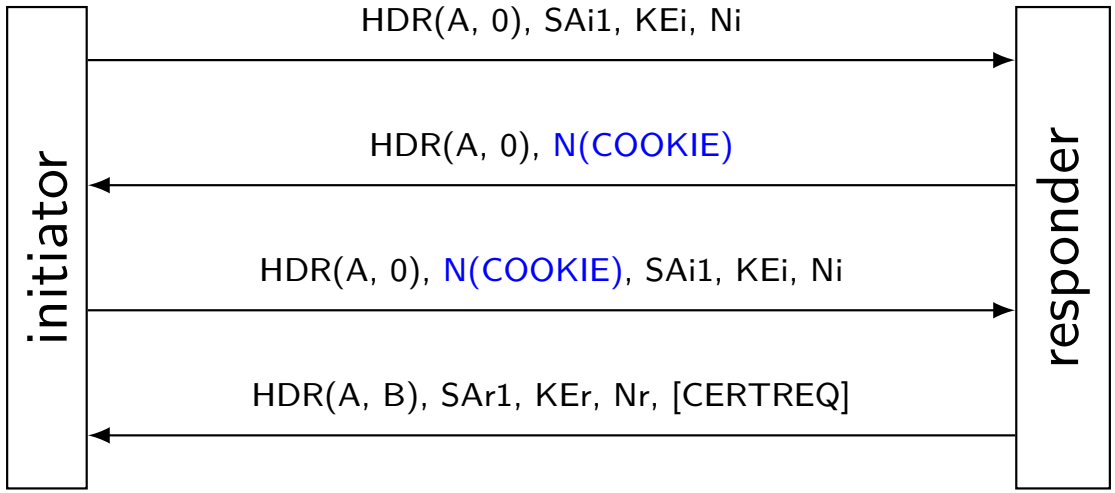

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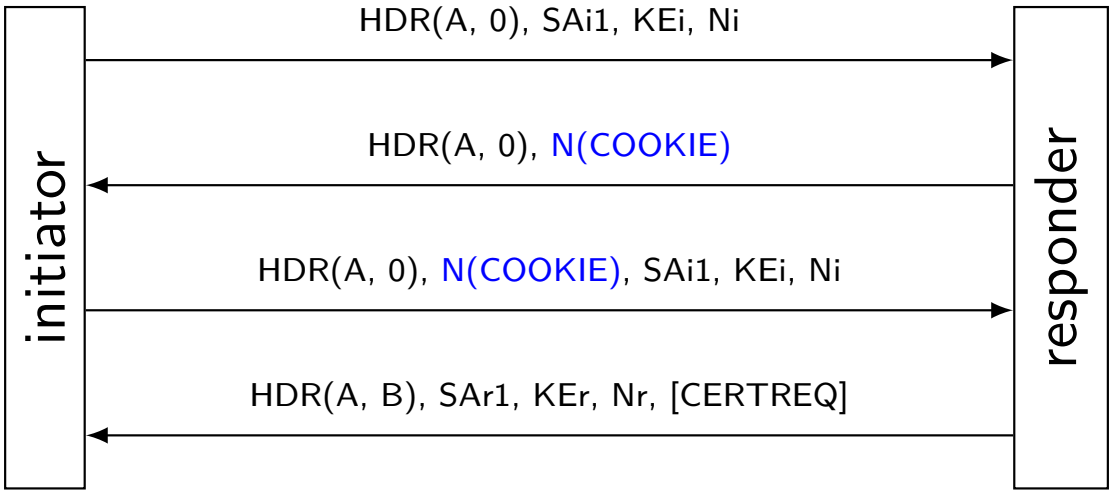

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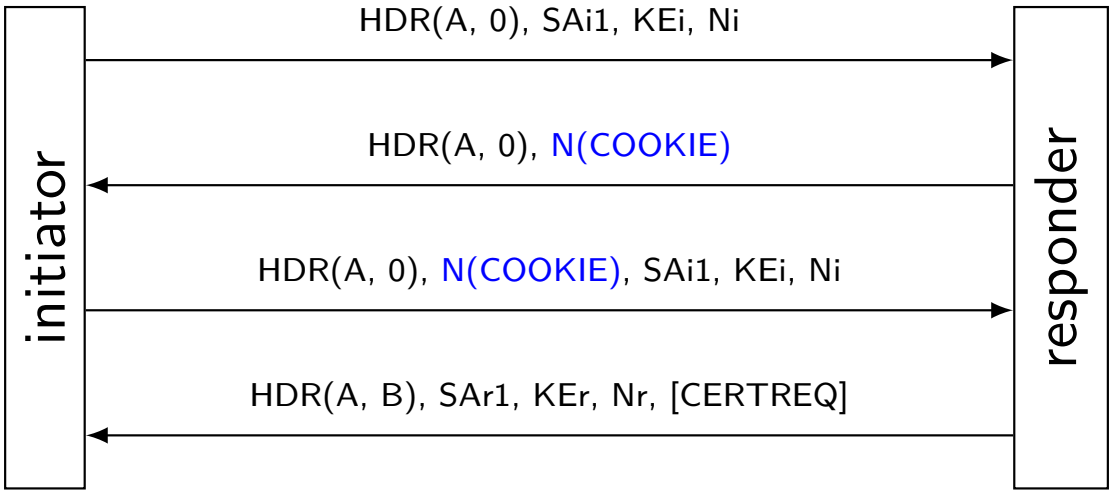

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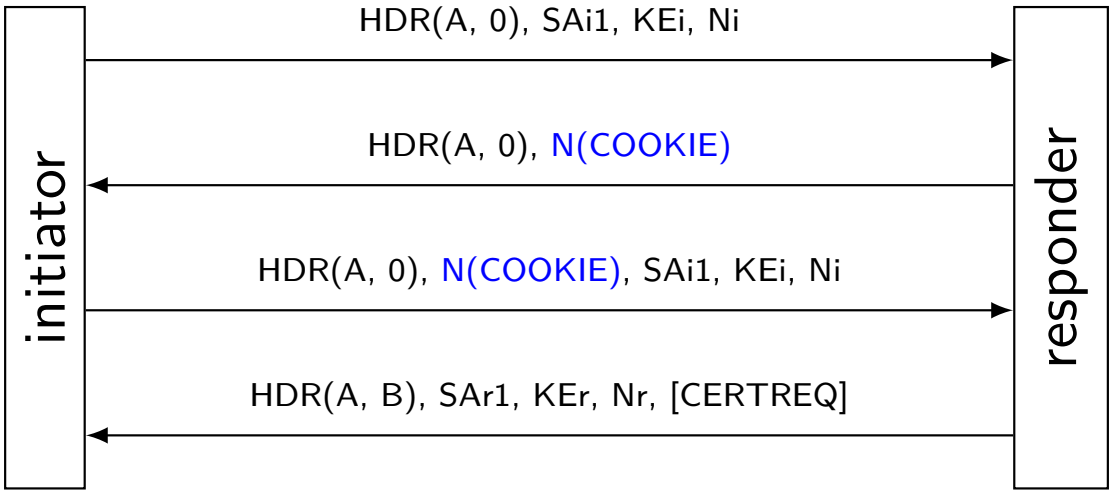
  - the secret for DoS protection is changed periodically, why?



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CREATE_CHILD_SA Exchange

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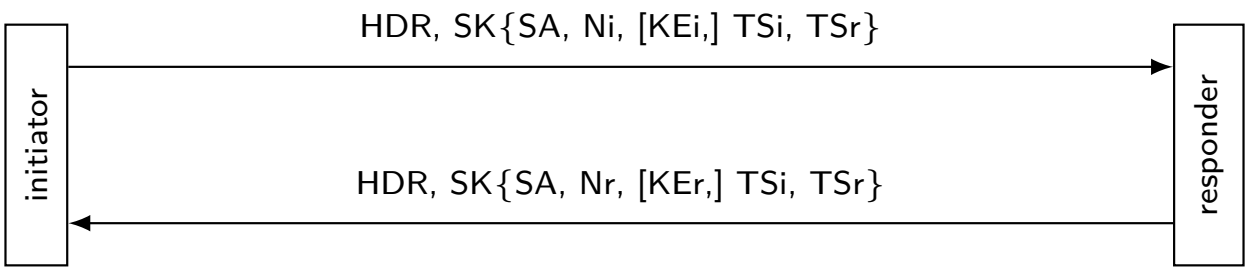

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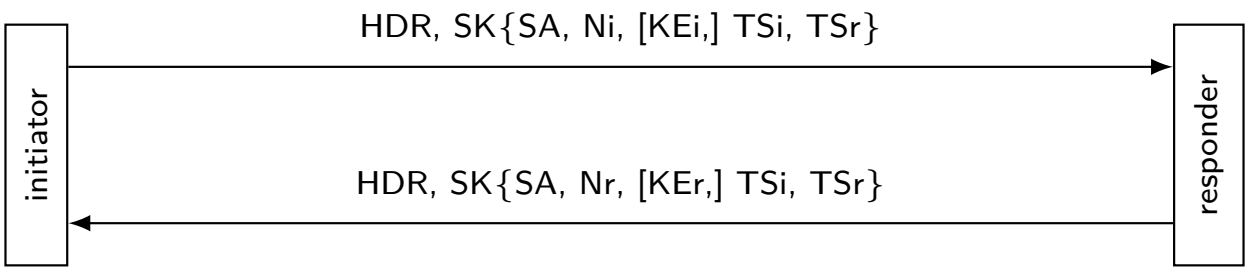

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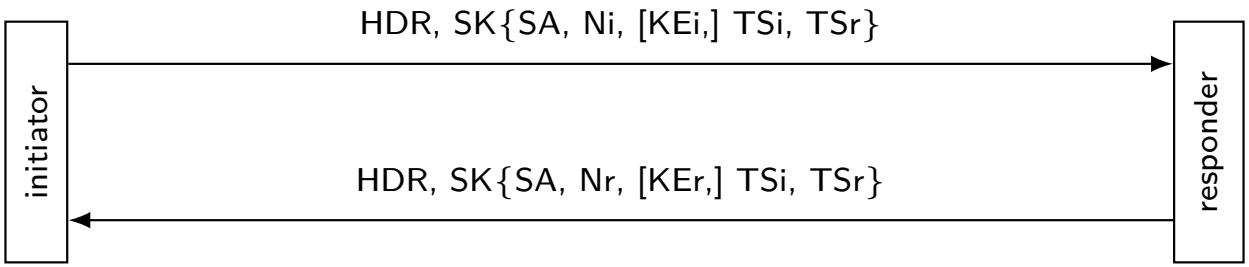

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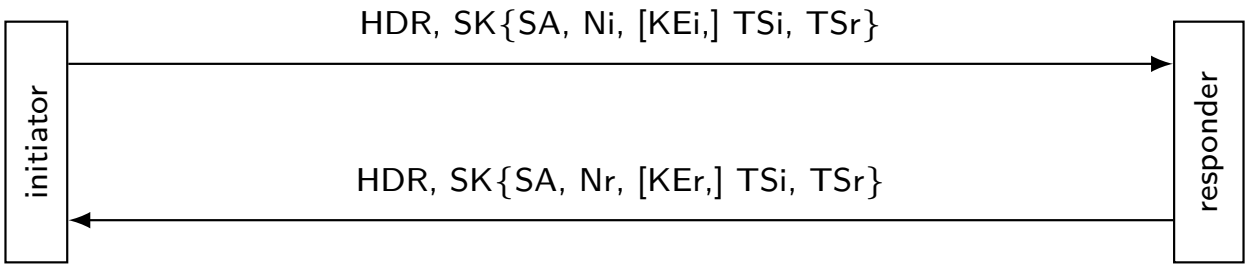

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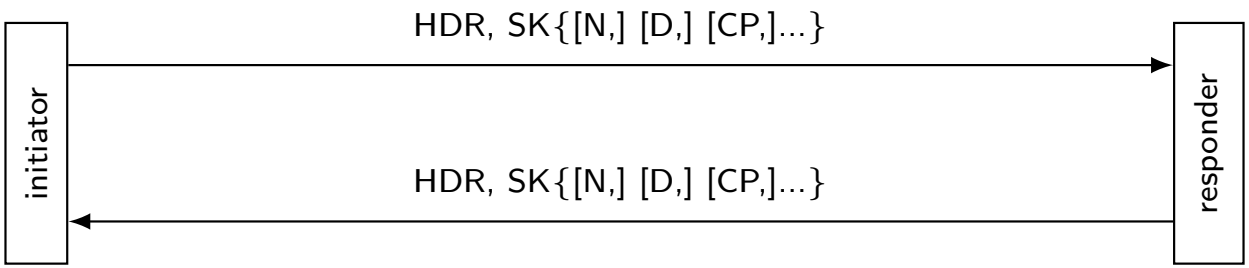

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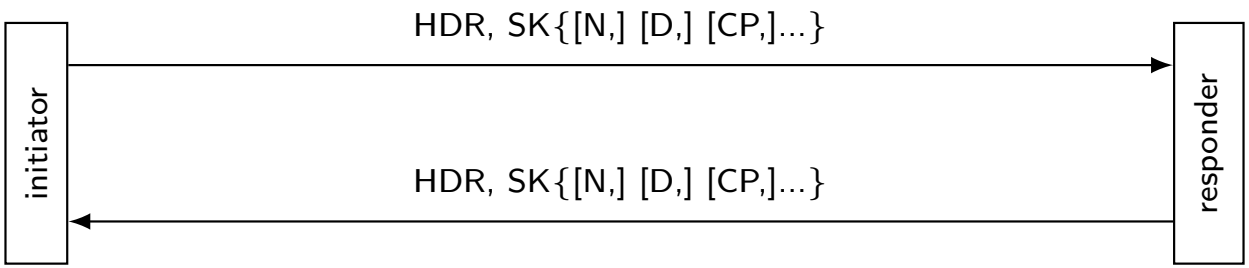

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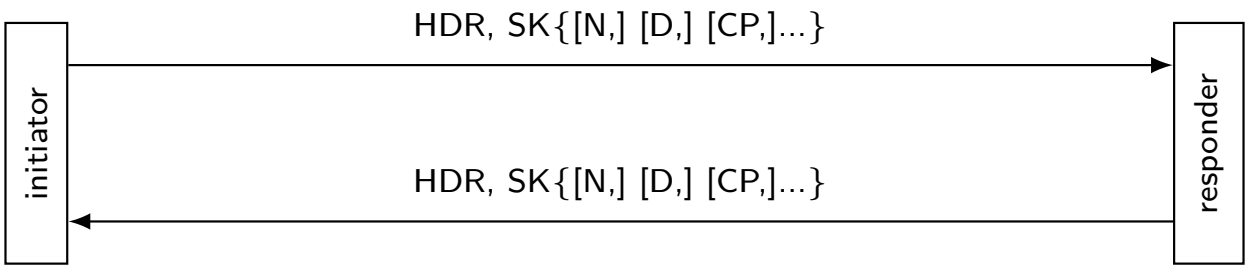

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  ➠ e.g., src IP address is protected by AH, and included in the TCP/UDP checksum (encrypted in ESP)
- Solution: encapsulating IKE/ESP in a UDP packet (port 4500)

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- ESP will also be encapsulated in UDP port 4500 when NAT exists
  - ➠ IP addresses for TCP/UDP checksum come from traffic selector
  - ➠ IKE messages are prepended by four octets of zero to distinguish it from ESP messages (how?)

Summary

- IKE History
- IKE Payloads
- IKE Exchanges
- DoS Protection and NAT Traversal

- Next lecture: SSL/TLS