Group Domain of Interpretation

<draft-ietf-msec-gdoi-00.txt>

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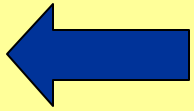
Thomas Hardjono (Nortel)
Hugh Harney (SPARTA)
Brian Weis (Cisco)

Group DOI

GDOI Design Criteria



Overview of related protocols

GDOI Protocol Overview

Current Status

Future Plans

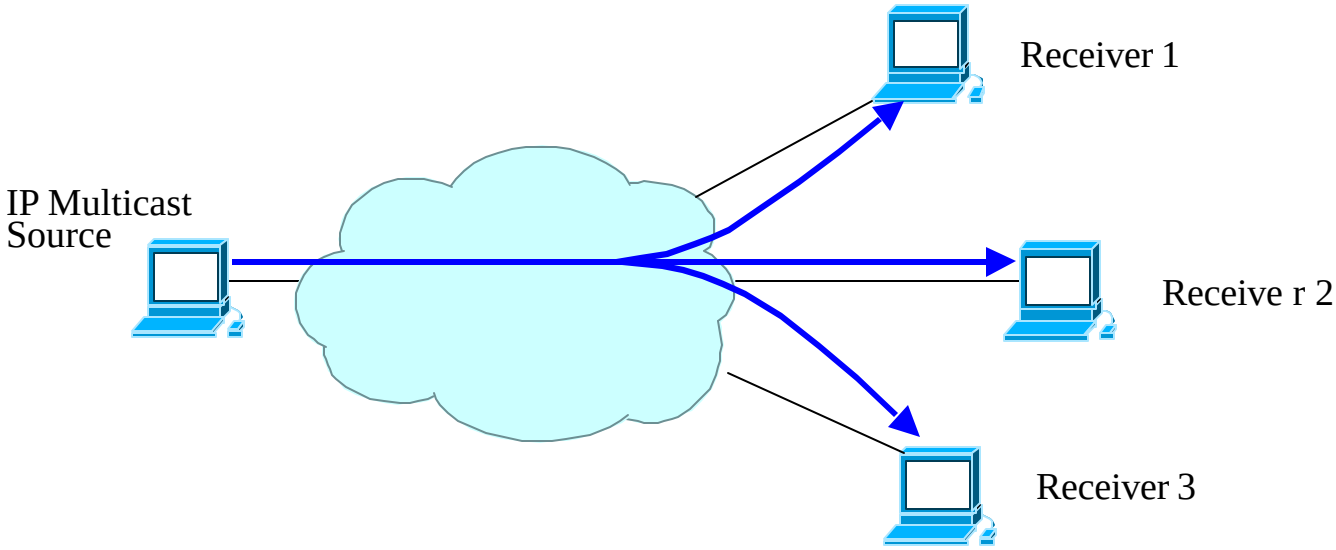
Design criteria for GDOI

- General enough for keying many applications
- Co-existence with unicast key management
- Make use of existing key management protocol definitions when possible.

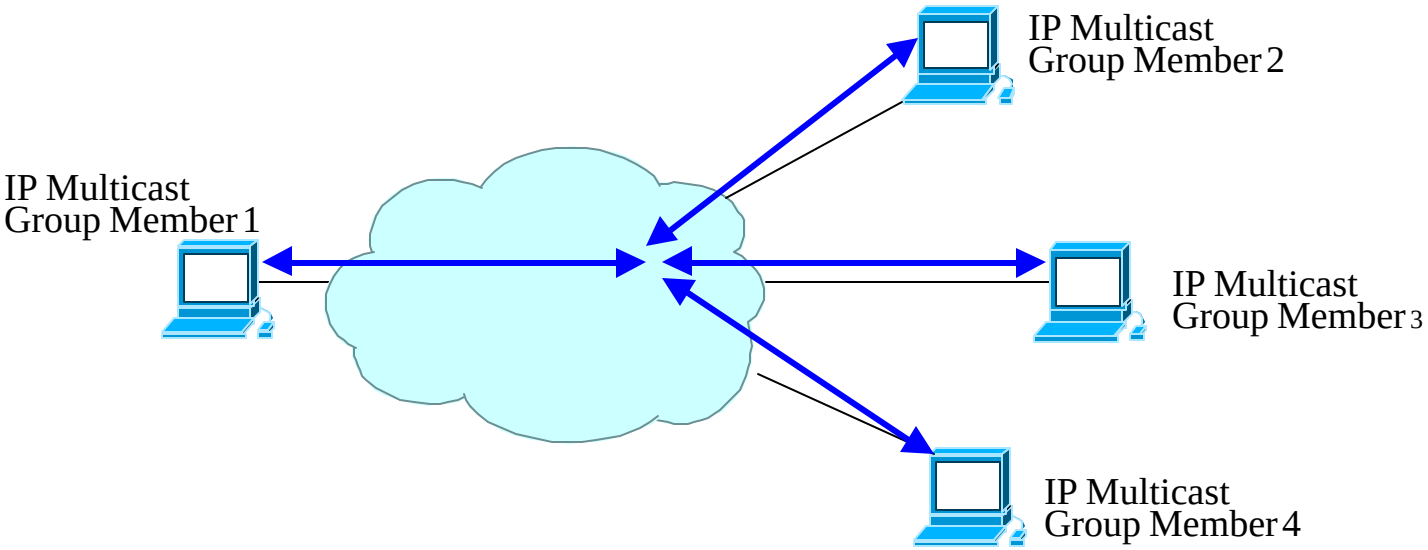
Applications

- GDOI is designed to handle many application scenarios
- Each of the applications has unique characteristics for key management

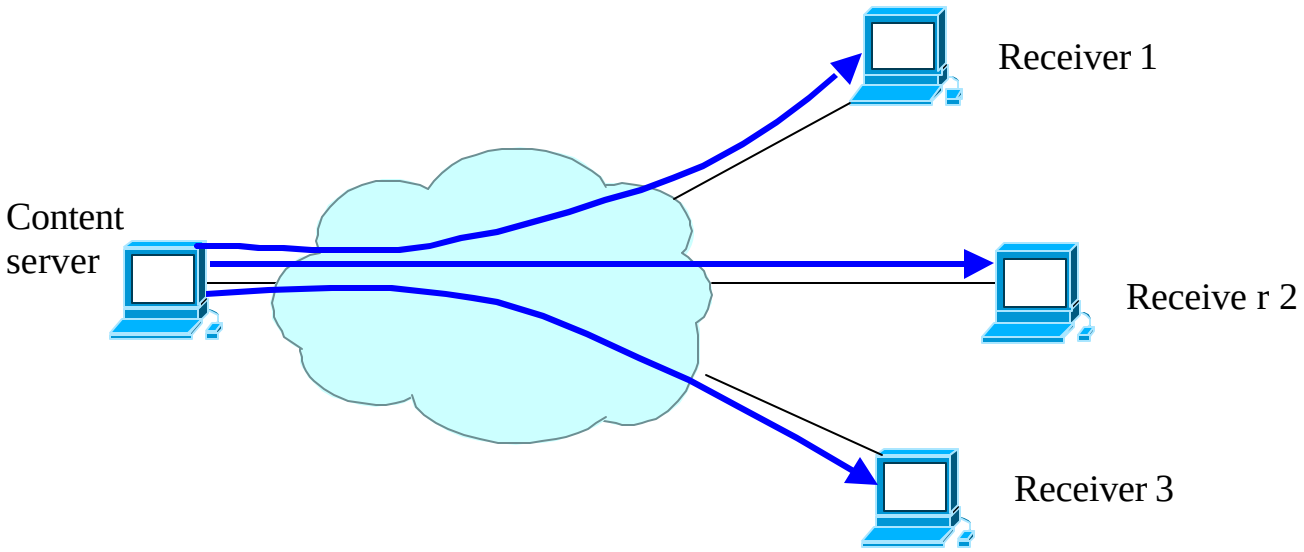
Single-source multicast



Multiple-source multicast



On-demand content distribution



Co-existence with unicast key management

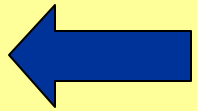
- There will be a need for systems to protect both group and unicast traffic.
- Having two independent key mgmt frameworks on one system is unnecessarily complex.
  - Two independent key mgmt frameworks for IPSEC (one unicast, one multicast) is unnecessary.

Co-existence with IKE

- Many systems have implemented ISAKMP and IKE for unicast key mgmt.
  - PCs and Workstations
  - Firewalls, Gateways, VPN boxes
- We believe that these devices can be used for group key mgmt.

Group DOI

GDOI Design Criteria

Overview of related protocols 

GDOI Protocol Overview

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ISAKMP

- ISAKMP [RFC 2408] specifies a general framework for key management
  - It defines payloads for authentication, policy negotiation, and key generation.
  - It defines basic key management exchanges.

Domains of Interpretation

- ISAKMP provides for multiple domains of interpretation (DOIs)
- One DOI is defined for IPSEC
- Other recently proposed ISAKMP DOIs:
  - `draft-tsenevir-smpls-doi-00.txt`
  - `draft-arkko-map-doi-01.txt`
  - `draft-lordello-ipsec-vpn-doi-00.txt`

IPSEC DOI & IKE

- IPSEC DOI [RFC 2407] defines IPSEC-specific payloads and policy definitions
- IKE [RFC 2409] defines exchanges in two phases:
  - IKE Phase 1 sets up a “secure channel” between IKE peers.
  - IKE Phase 2 negotiates specific IPSEC policy.

IKE Phase 1

- Authenticates the encryption peer.
- Negotiates “secure channel” policy for the key management session.

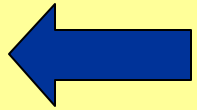
IKE Phase 1 services

- IKE Phase 1 provides the following security services for subsequent exchanges:
  - *Confidentiality* -- encryption of exchange payloads
  - *Integrity* -- HASH payload provides an HMAC
  - *Replay protection* -- NONCE payload provides liveliness proof

Group DOI

GDOI Design Criteria

Overview of related protocols

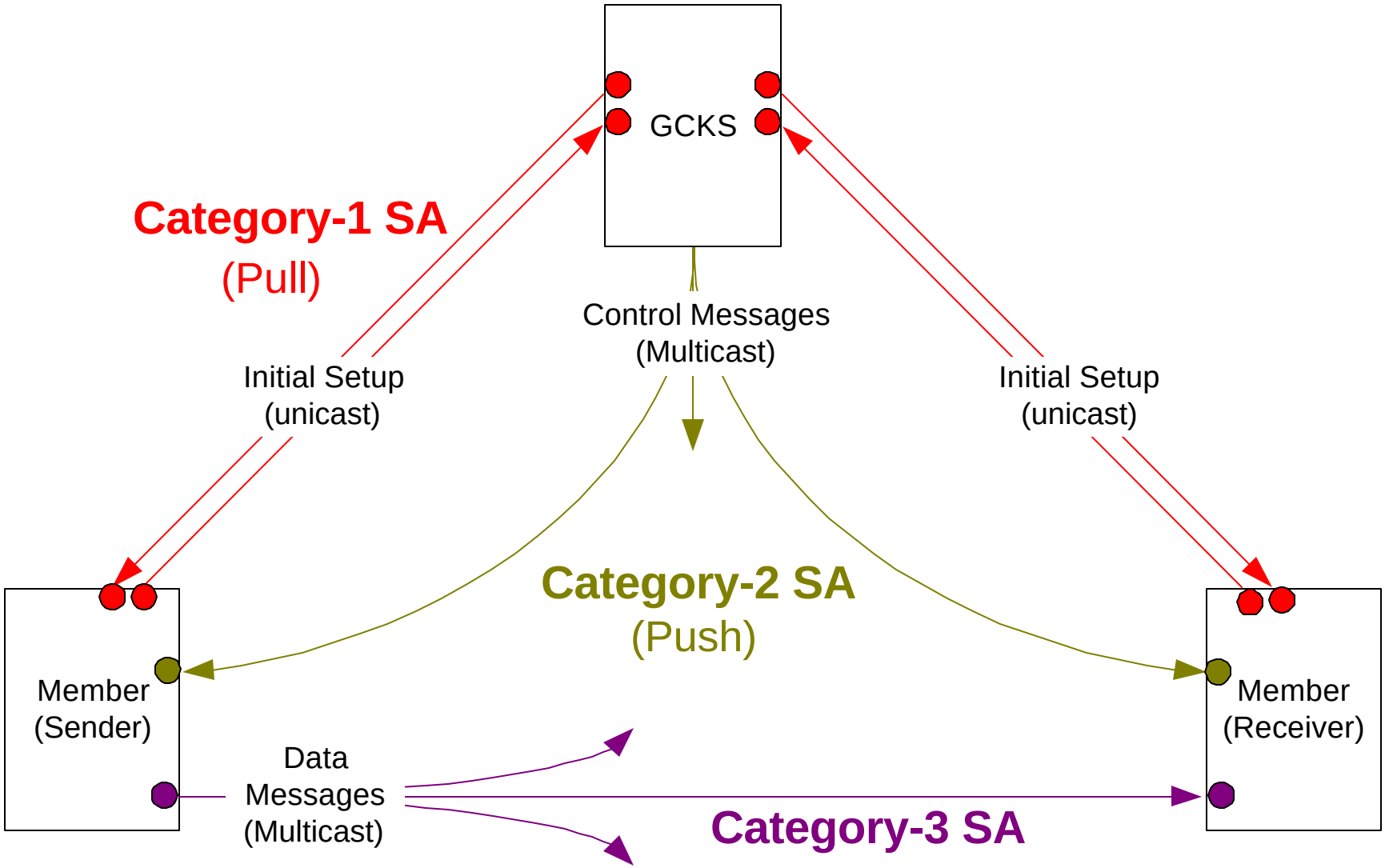
GDOI Protocol Overview 

Current Status

Future Plans

Group DOI Overview

- Proposes that a new DOI number be assigned for GDOI.
- Defines a new Category-1 SA (“Pull”) exchange for initial group key mgmt.
- Defines a Category-2 SA (“Push”) exchange for subsequent key updates. This exchange can be multicasted for efficiency.


GCKS
Category-1 SA
(Pull)
Control Messages
(Multicast)
Initial Setup
(unicast)
Initial Setup
(unicast)
Category-2 SA
(Push)
Member
(Sender)
Member
(Receiver)
Data
Messages
(Multicast)
Category-3 SA

“Pull Protocol”

- Group member “pulls” keys over the IKE Phase 1 “secure channel”.
- Four message exchange between group member and GCKS.
- When complete the group member has all keys necessary to decrypt and authenticate:
  - data packets
  - “push” key management messages

Message 1: Request

```
Initiator (Member)                  Responder (GCKS)
------------------                  ----------------
HDR*, HASH(1), Ni, ID      -->

* Protected by IKE Phase 1 SA Hashes, encryption occurs after HDR
```

```
  HASH(1) = prf(SKEYID_a, M-ID | Ni | ID)
```

- HASH provides message authentication
- NONCE is used for replay protection
- ID indicates the desired group to join

Message 2: Policy Push

```
Initiator (Member)                    Responder (GCKS)
------------------                    ----------------
                            <--       HDR*, HASH(2), Nr, SA
```

```
  HASH(2) = prf(SKEYID_a, M-ID | Ni_b | Nr | SA)
```

- SA contains specific policy for the Category-2 and Category-3 SAs. E.g., which crypto algorithms to use.

Message 3: Ack

```
Initiator (Member)                  Responder (GCKS)
------------------                  ----------------
HDR*, HASH(3) [, KE_I]     -->

          [,CERT] [,POP_I]
```

```
  HASH(3) = prf(SKEYID_a, M-ID | Ni_b | Nr_b [ | KE_I ] [| POP_I])
```

- KE_I obtains perfect forward secrecy (if desired)
- CERT send a public key used for authorization (if needed for POP_I)
- POP_I provides evidence that the client has possession of a private or secret key

Message 4: Key Download

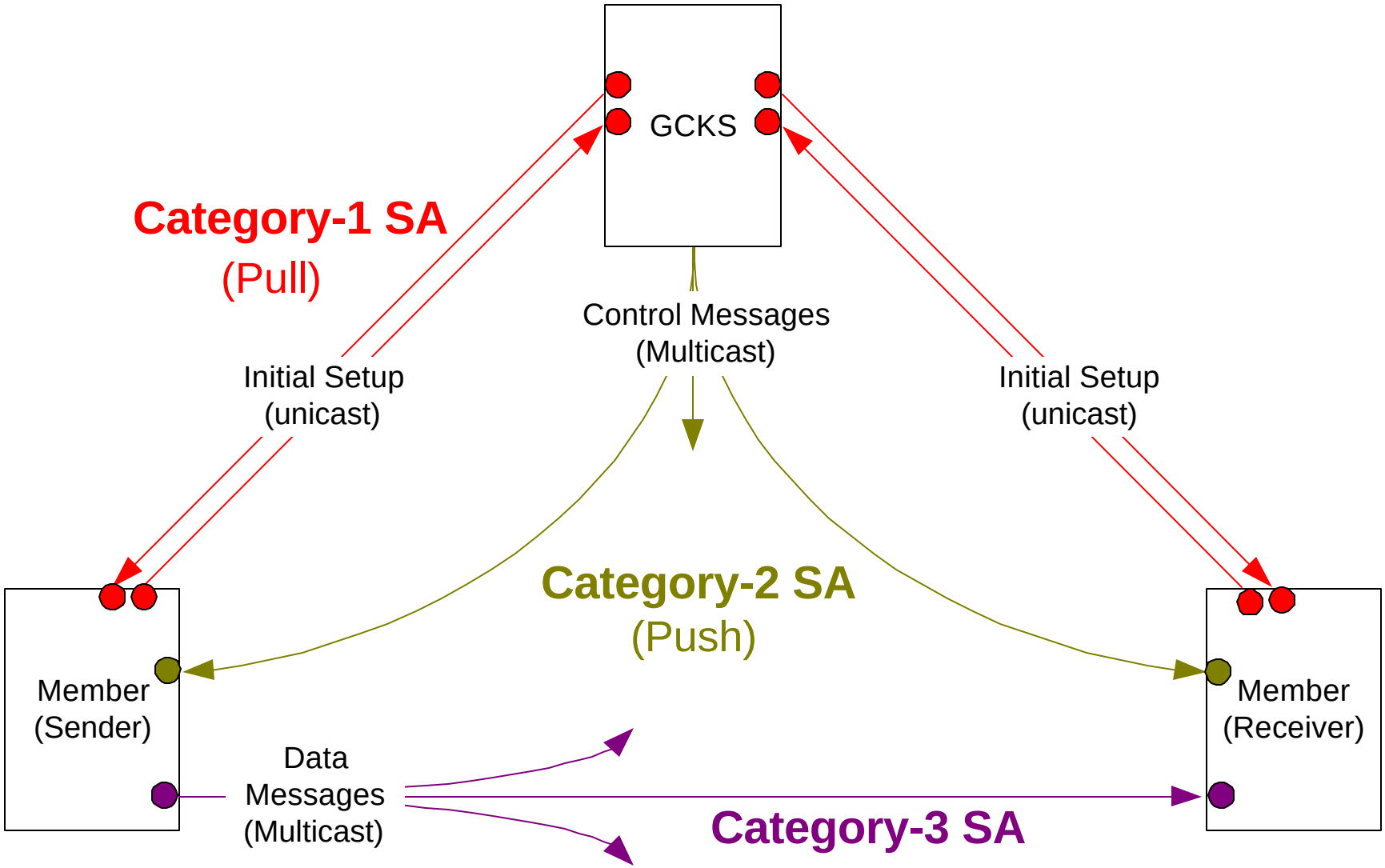
```
Initiator (Member)                    Responder (GCKS)
------------------                    ----------------
                          <--          HDR*, HASH(4), [KE_R,] SEQ, KD
                                                        [,CERT] [,POP_R]
```

```
  HASH(4) = prf(SKEYID_a, M-ID | Ni_b | Nr_b [ | KE_R ] | SEQ | KD [| POP_R])
```

- SEQ provides the sequence number which will be used for the next “push” message.
- KD provides the keys for the policy delivered in the SA payload

Entire “Pull” Protocol

```
Initiator (Member)                    Responder (GCKS)
-----------------                     ----------------

HDR*, HASH(1), Ni, ID       -->

                            <--       HDR*, HASH(2), Nr, SA

HDR*, HASH(3) [, KE_I]      -->
          [,CERT] [,POP_I]

                            <--       HDR*, HASH(4), [KE_R,] SEQ, KD
                                                    [,CERT] [,POP_R]

* Protected by IKE Phase 1 SA Hashes, encryption occurs after HDR
```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(Push)
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(Sender)
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Data
Messages
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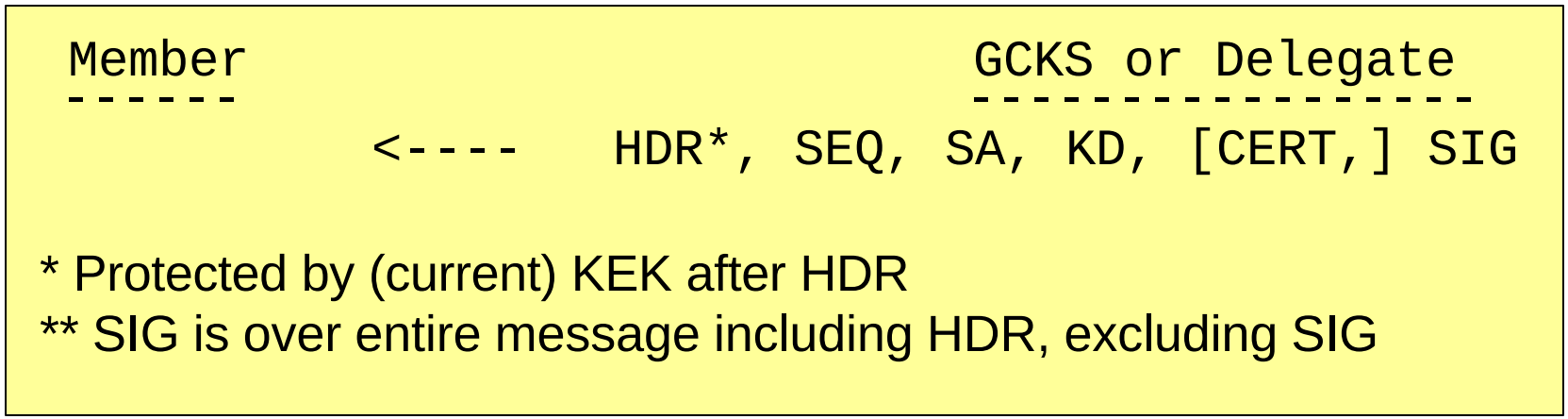
Category-3 SA

“Push” Message



- The “cookie pair” in the ISAKMP HDR acts as a SPI which identifies the group.
- SEQ contains a counter used for replay protection
- SIG contains a digital signature of the packet for authentication

Payloads

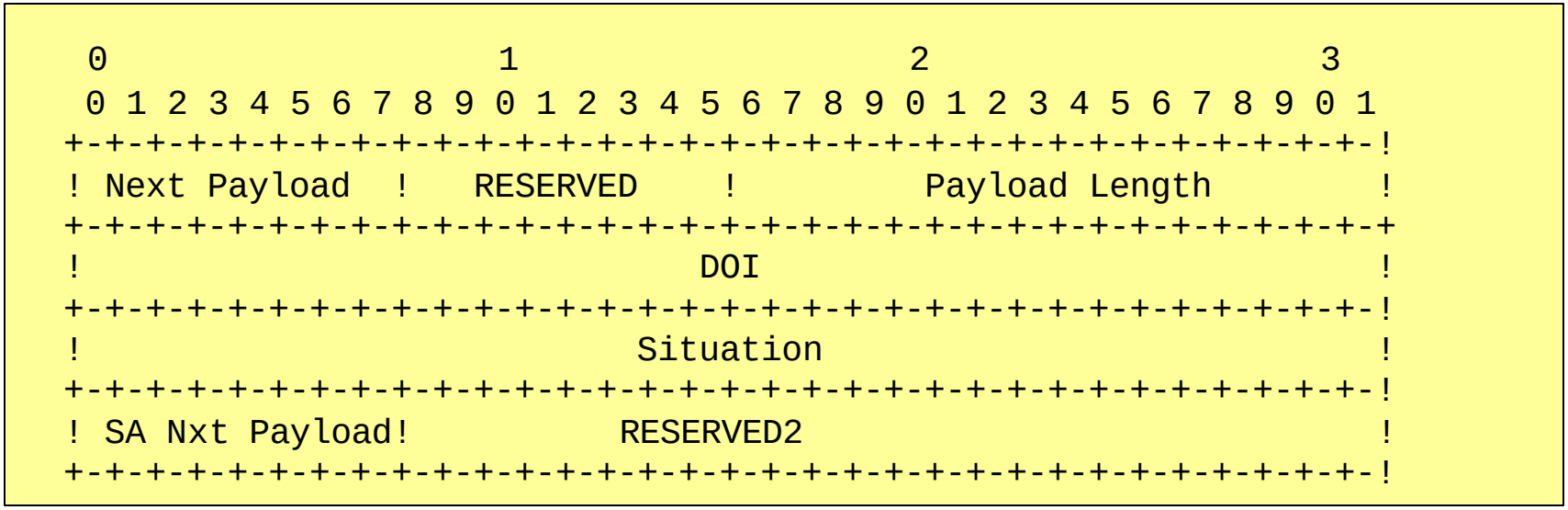
Modified Payload:

- SA (further specified for GDOI DOI)

New Payloads:

- POP payload is defined
- SEQ payload is defined
- KD payload is defined

SA Payload



- DOI: Need an IANA assigned value
- Situation: must be zero in this version

SA Payloads

SA_KEK provides policy for the Category-2 SA

– There may be 0 or 1 present

- SA_TEK provides policy for the Category-3 SA

–There may be 0 - n present

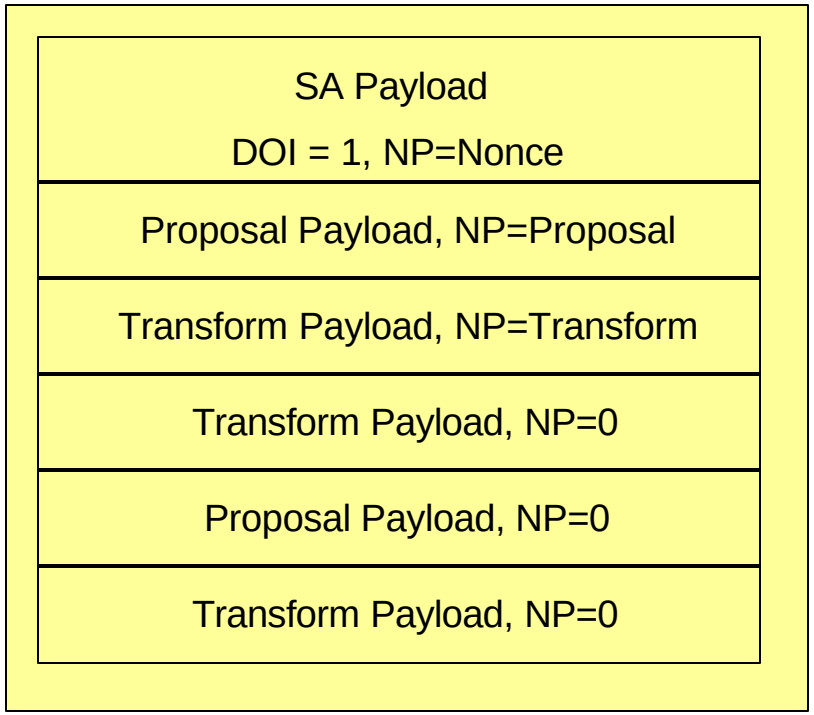
At least one payload must be present!

SA Payload Usage Examples

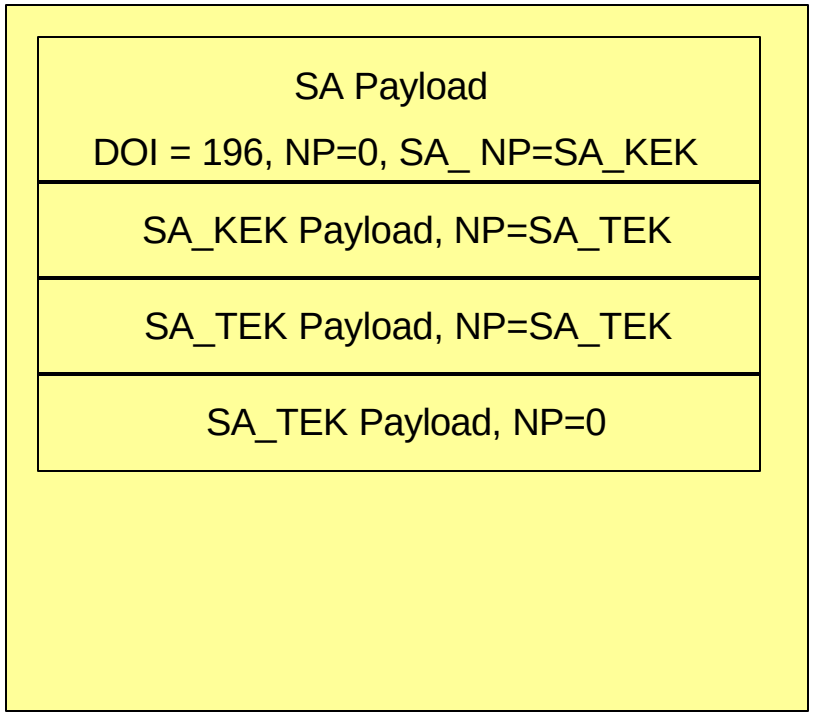
- A multicast application could include SA_KEK and SA_TEKs in the pull and push messages.
- An on-demand content distribution application could include an SA_KEK in the pull message, and send only SA_TEKs in the push message.

SA Payload linking

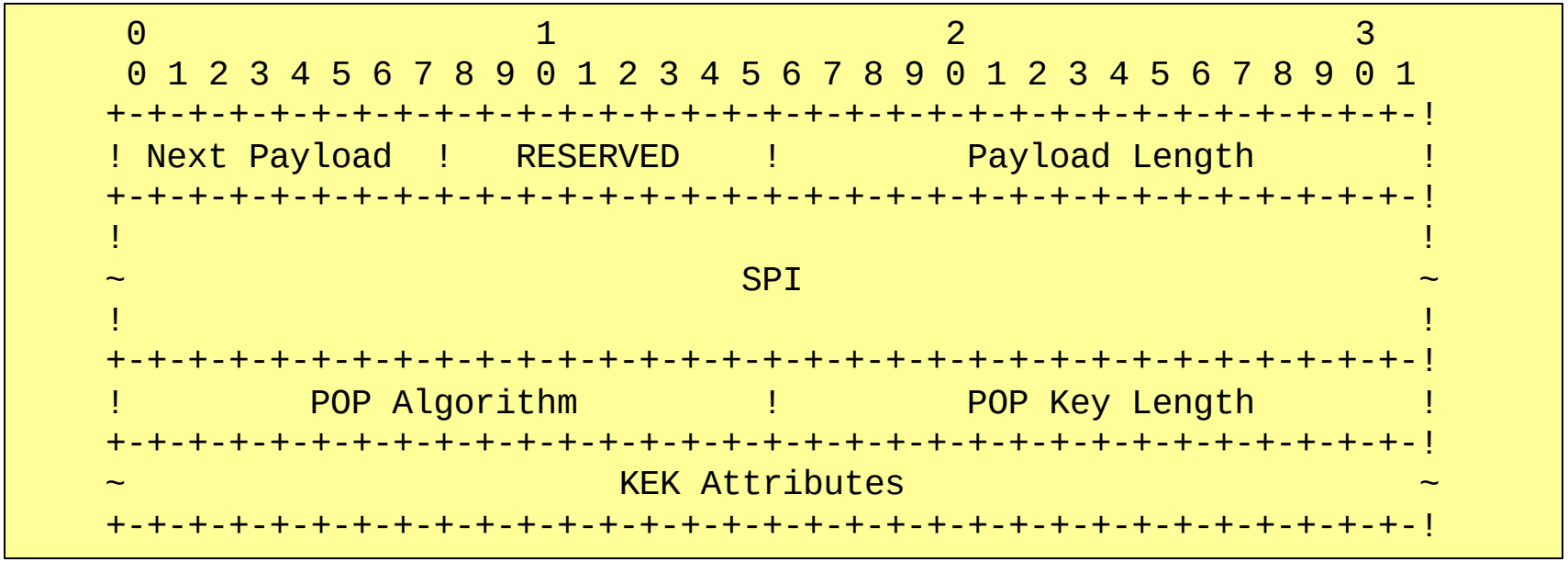
IPSec SA Payload example



GDOI SA Payload example

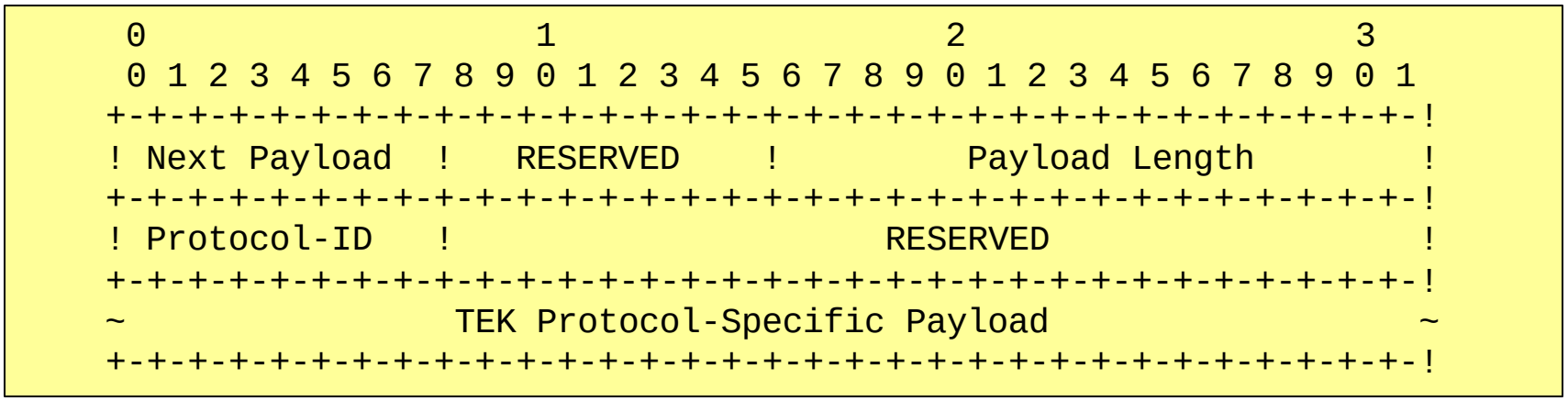


SA_KEK Payload



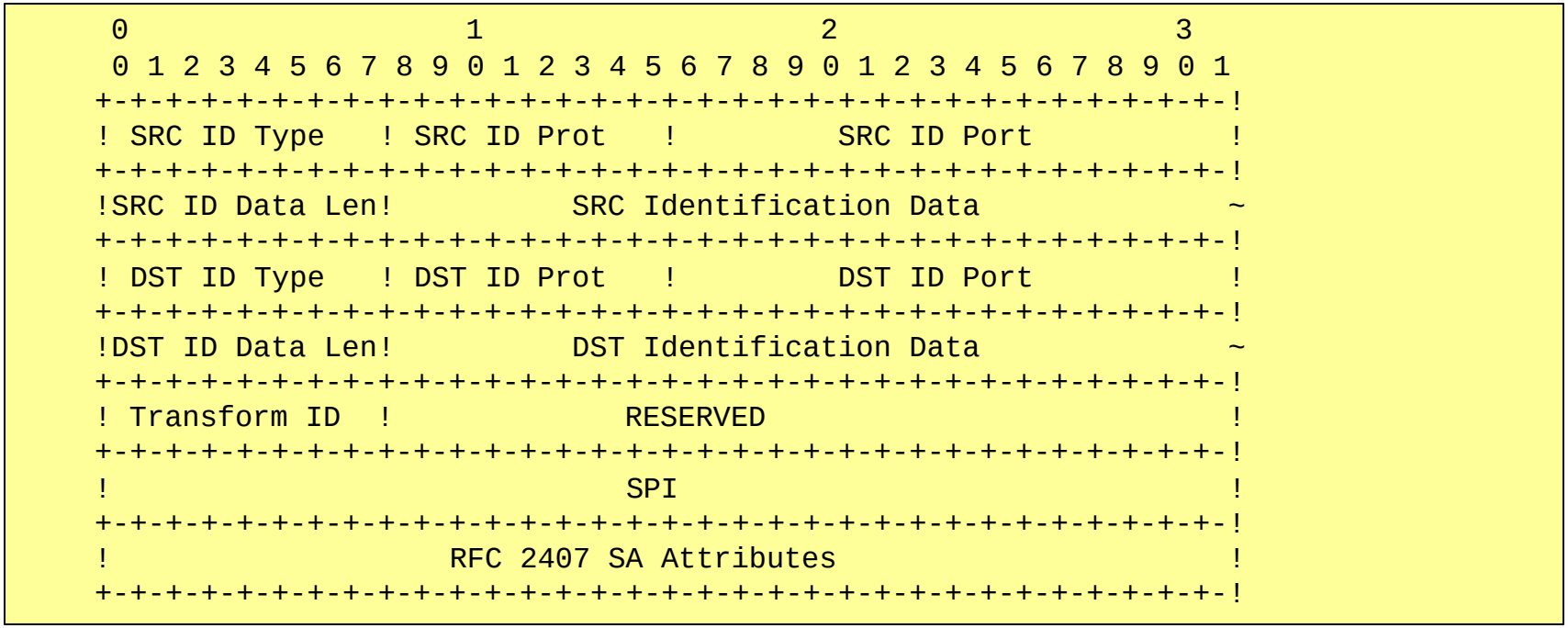
- SPI: ISAKMP initiator/responder cookies for push msg
- POP Algorithm: Proof of Possession algorithm type
- KEK Attributes: algorithm and keying policy for push msg

SA_TEK Payload



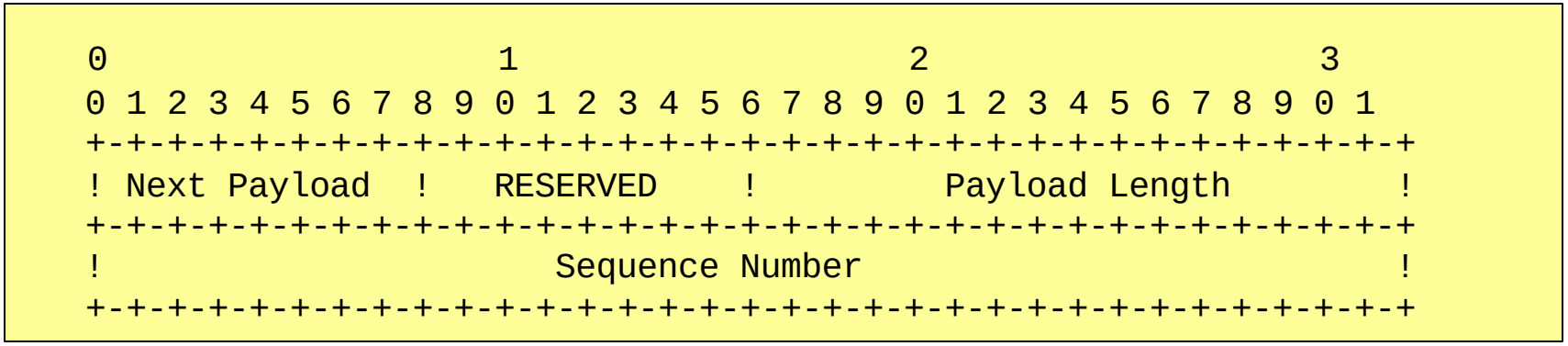
- Protocol-ID: TEK-specific payload type
  - ESP
  - MESP
  - AMESP

ESP SA_TEK Payload



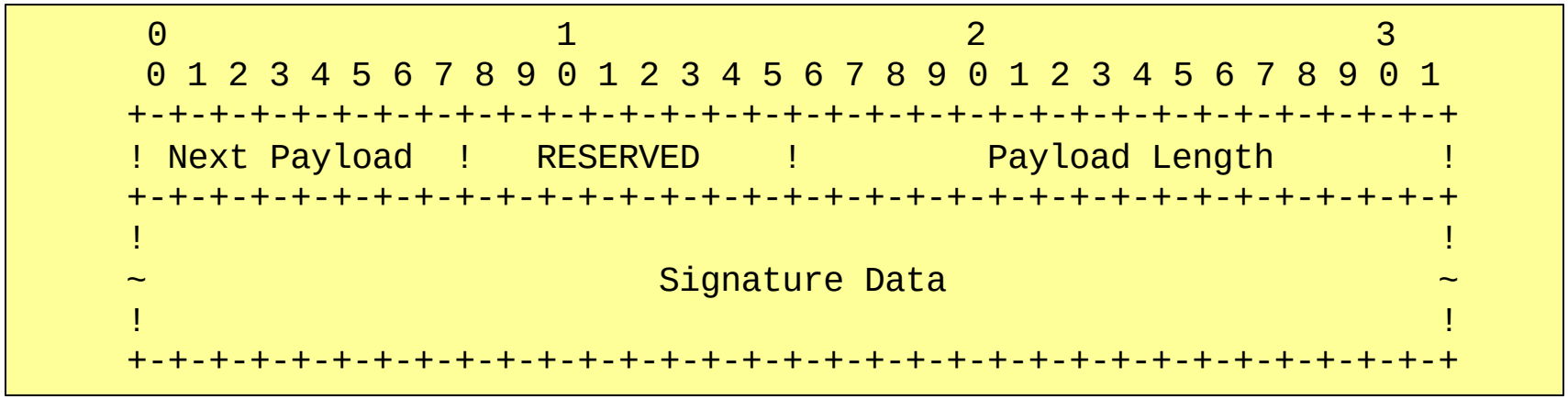
- SRC ID/DST ID: Similar to IPSEC ID payloads
- Transform ID: Defines crypto transform (e.g., ESP 3DES)
- SPI: ESP SPI

SEQ Payload



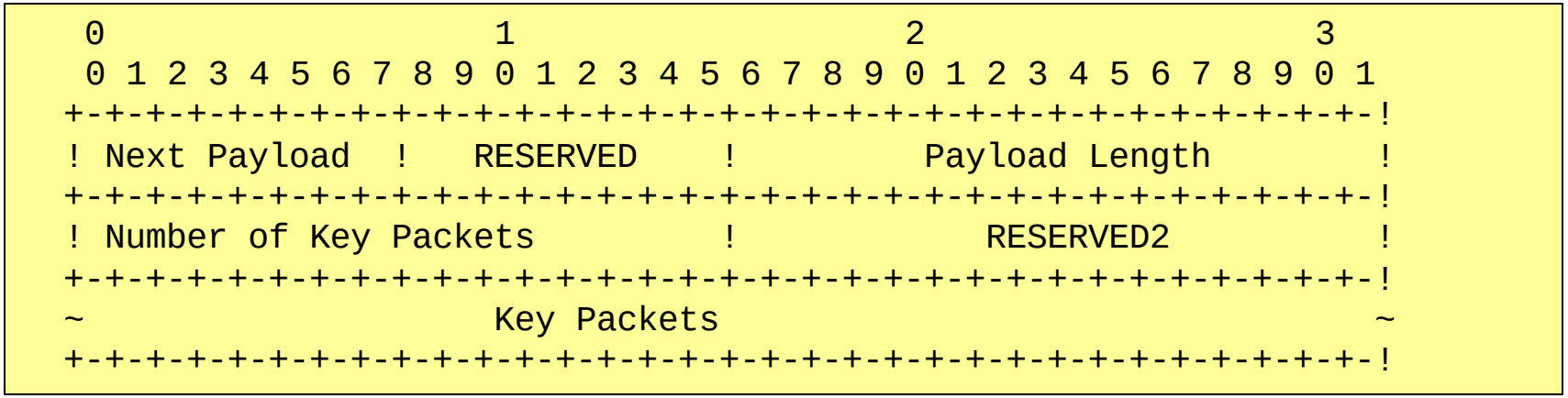
- Contains a sequence number used for replay protection
- Initializes the group members replay window when included in a “pull” message.
- Acts as a replay protection when included in a “push” message.

POP Payload



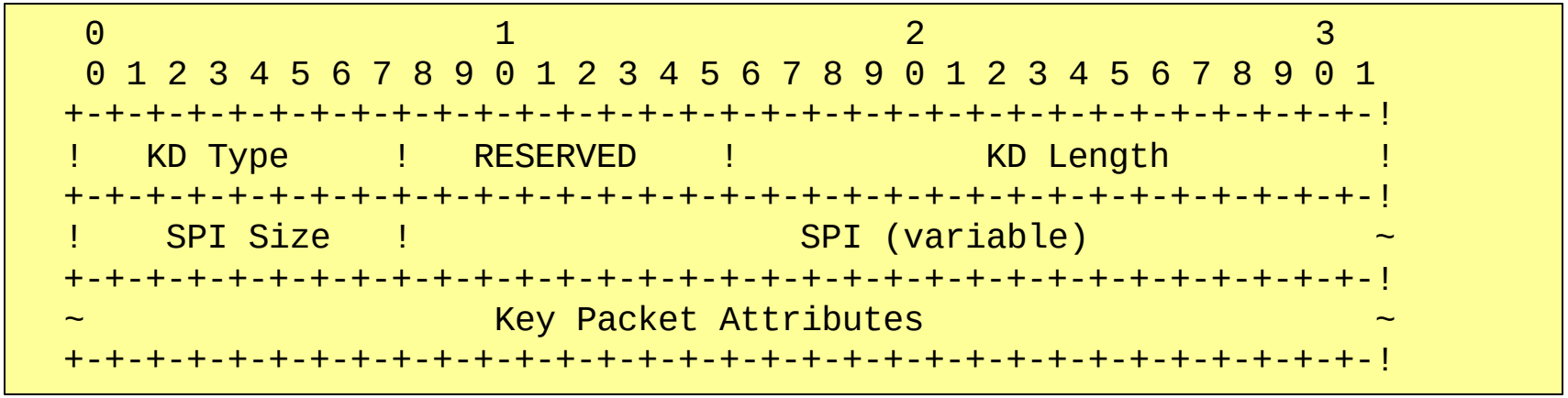
- Identical to a SIG payload, but uniquely named for clarification
- Signature in the POP payload provides evidence that group member is in possession of the private key
- Signature is over entire payload, excluding SIG

KD Payload



- KD is a header to the actual key packets.

Key Download Packet



- KD Type: TEK, KEK (single key), LKH (key array)
- SPI: Matches a SPI sent in an SA_KEK or SA_TEK payload
- Attributes: Encryption keys

Group DOI

GDOI Design Criteria

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GDOI Protocol Overview

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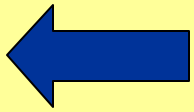

Future Plans

Proof of Concept

- We started with the assertion that it would be reasonable to add GDOI to an IKE implementation.
- A proof of concept test was done using the freely available *isakmpd* package to test the assertion.
- Result:It was easy to add with few changes to the original code

Current status

- Latest draft:

  http://www.ietf.org/internet-drafts/draft-ietf-msec-gdoi-00.txt
- Two independent implementations underway (Cisco and Nortel). Interoperability testing not yet begun.
- Group DOI protocol specification under evaluation by Catherine Meadows, NRL.

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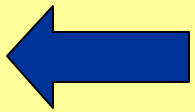

Future Plans

- Revise the draft as necessary.
  - Fix inconsistencies
  - Investigate features necessary to support large groups.
  - Investigate using a different port number than IKE
- Complete the reference implementations and test with multicast applications.