Diet-ESP: A flexible and compressed format for IPsec/ESP

draft-mglt-ipsecme-diet-esp-01.txt

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Securing IoT communications

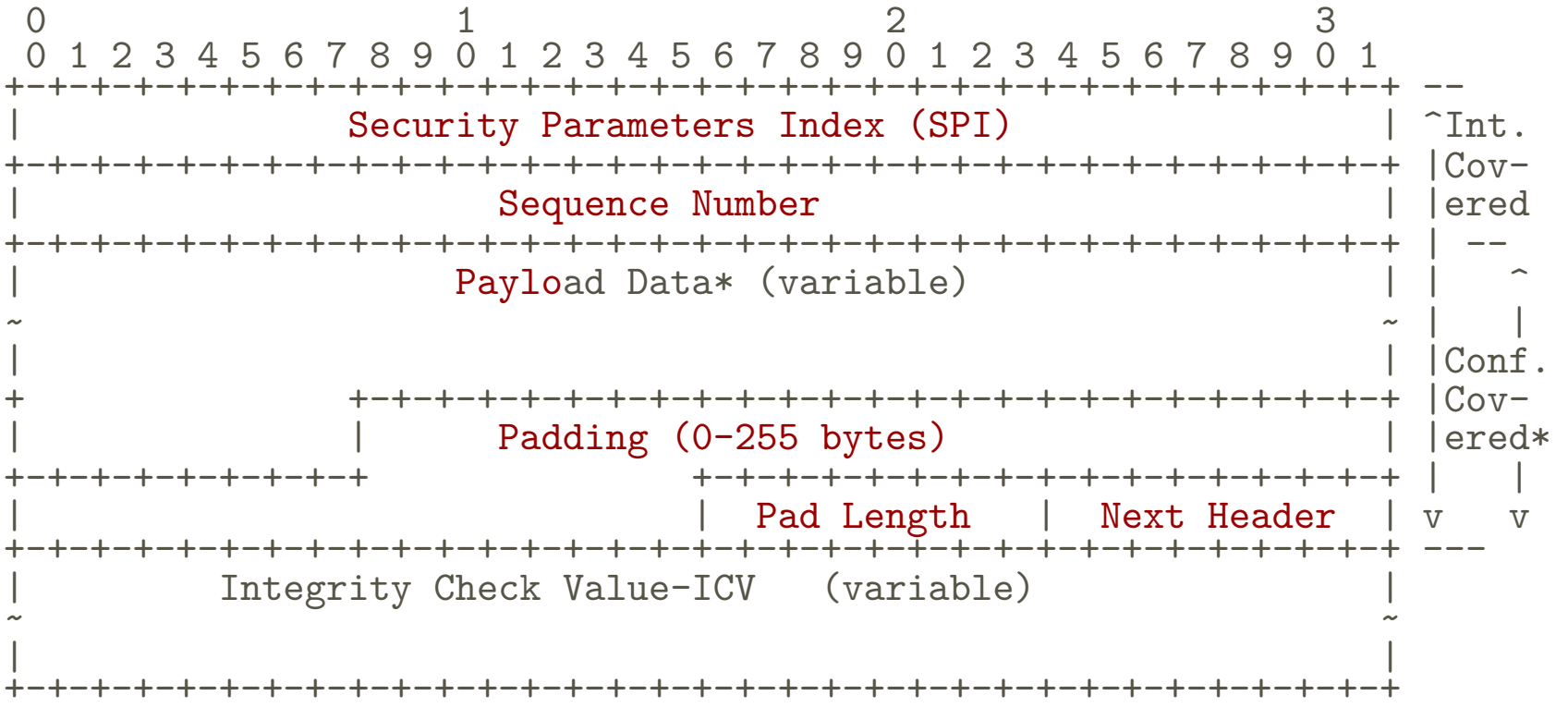
The IoT context:

- Sending data is very expensive (10-100 times higher than computation)
- Highly specialized device (OS + application)
- Developer specifies (or knows) the system
- Small Data usually fits in on IP frame
- IPsec can be used like a tiny Firewall, providing a secure environment for all applications

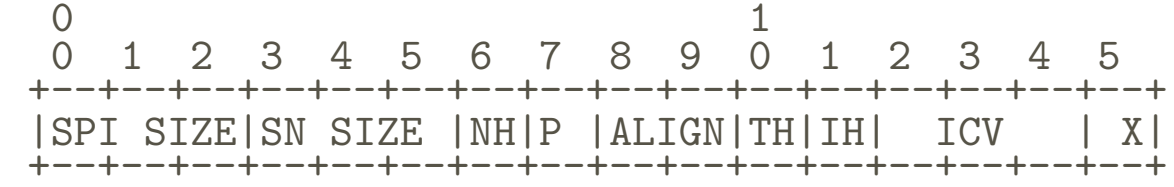
Overhead for X byte data with UDP (Security-Header + 8 bytes UDP header)

	IPsec/ESP	DTLS	Diet-ESP	6LoWPAN DTLS	6LoWPAN DTLS+UDP
Packet Overhead	10 + 8 bytes	13 + 8 bytes	0 + 0 bytes	8 + 8 bytes	8 + 3 bytes

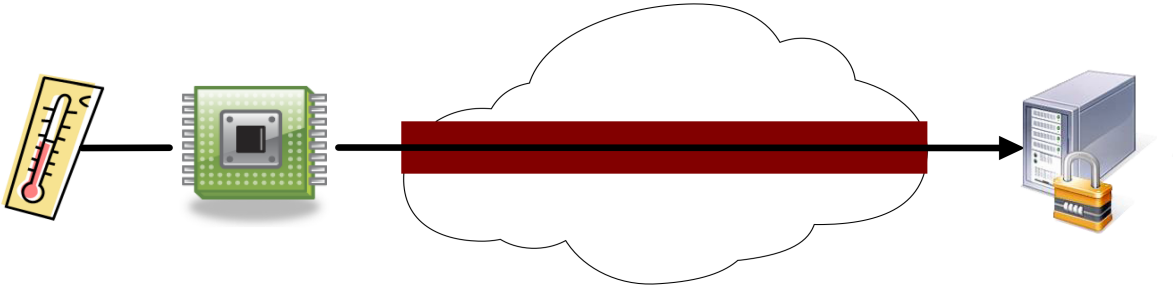
IPsec / ESP



The Diet-ESP context for compression definition:

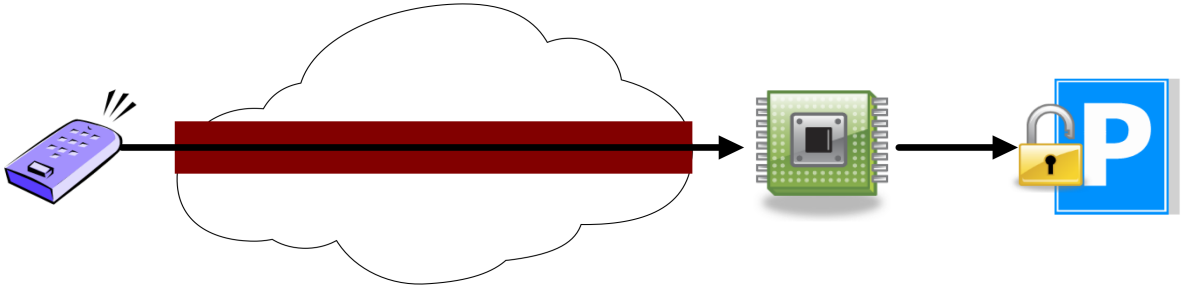


Sending X byte of data every Y time.



- 1 application (fixed ports, specified in Traffic Selector)
  - no Next Header / no UDP-Header
- 8 bit alignment or aligned application data
  - no Padding / no Pad Length
- 1 IP connection
  - no SPI
- 1 packet per minute, no replay risk
  - no SN

Receiving X byte of data



- 1 application (fixed ports, specified in Traffic Selector)
  - no Next Header / no UDP-Header
- 8 bit alignment or aligned application data
  - no Padding / no Pad Length
- multiple Senders with different IPs
  - no SPI
- some packets per day, replay risk
  - 1-2 byte SN

Diet-ESP vs. ESP

Impact on ESP

- ESP-header (compressed / removed fields)
- Encrypted ESP-payload (removed fields)
- ESP-ICV (compressed field)

Impact on IPsec (eventually):

- SAD Lookup (variable SPI, no SPI)

How can we make this an ESP extension?

- Diet-ESP Context is negotiated during IKE_AUTH exchange
- Modifications applies to the negotiated SA.

Security Considerations

Reducing/Removing the SPI

- Regular SAD-Lookup
  - Limiting number of possible connection on the gateway.
- Modified the SAD-Lookup
  - higher effort to identify SA
  - DoS-vulnerability

Reducing/Removing the SN

- Prevents/Downgrade anti-replay-protection
- Can we use ESN mechanism without sending the all lower 32 bit on the wire?

Reducing the ICV

- Reducing level of Security, provided by the MAC algorithm.

Accomplished Work / Next Steps

Accomplished Work:

- Development Demonstration in Python (ca. 400 lines of code)
- Rudimentarily Contiki implementation
  - based on the ESP implementation of Vilhelm Jutvik
  - less than 100 lines of code patches
- Start performance measurements

Next Step:

- Deployment on Excelyo
- Alternate Algorithm (Encryption / Authentication)
- IV reduction

Thank you for your attention

Looking for a PhD
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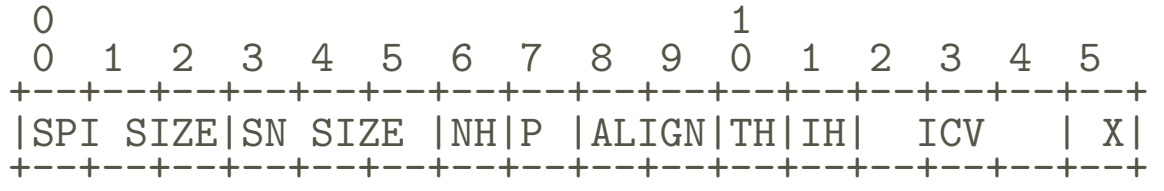
Diet-ESP context

The Diet-ESP context for compression definition:



- SPI SIZE: Size of the SPI in the Diet-ESP-Header.
- SN SIZE: Size of the SN in the Diet-ESP-Header.
- NH: Next Header in the Diet-ESP-Trailer.
- P: Padding Length and Padding in the Diet-ESP-Trailer.
- ALIGN: necessary packet alignment (1, 2, 4 byte).
- TH: Transport Header in the Diet-ESP-payload.
- IH: IP Header in the Diet-ESP-payload (for TUNNEL).
- ICV: Size of the Diet-ESP-ICV.

Compression

Possible compression:

- ESP-header: 8 byte –> 0 byte
- ESP-trailer: 2 (+ PADDING) byte –> 0 byte
- ESP-payload:
  - Transport Mode UDP: 8 byte –> 0 byte
  - Tunnel Mode IPv4: 20 byte –> 0 byte
  - Tunnel Mode IPv6: 40 byte –> 0 byte
  - Tunnel Mode 6LoWPAN: 2-42 byte –> 1 byte

Compression

How is that possible?

- Most informations are already stored in the Traffic Selectors:
  - IPsec mode
  - IP addresses
  - Transport protocol
  - Transport protocol ports (cannot be a range)
- only the mapping is difficult:
  - reduced interoperability

    –> but in general, sensors have exactly ONE function
  - Application Developer knows the intended use

    –> he can specify the possible compression

Negotiation with IKEv2

```
   Initiator                        Responder
  -----------                      -----------
1) HDR, SAi1, KEi, Ni     -->

                          <--   HDR, SAr1, KEr, Nr

2) HDR, SK { IDi, [CERT,] AUTH,
             SAi2, TSi, TSr,
             N(DIET_ESP_SUPPORTED [CTX_1, CTX_2, CTX_3, ANY])}
                          -->

                          <--   HDR, SK { IDr, [CERT,] AUTH,
                                           SAr2, TSi, TSr,
                                           N(DIET_ESP_SUPPORTED [CTX_2])}
```

SAD Lookup

The SPI size is unknown for incoming packets.

–>The lookup for incoming ESP packets, has to be changed:

Naive implementation:

one lookup for each supported SPI_SIZE (in general 5)

- perform 5 lookups based on IP_D, IP_S, SPI
- if more than one SA fits:
  - authenticate with all found keys
  - use the SA with the fitting key

–> DoS vulnerability

SAD Lookup

Solution:

- Forbid overlapping SPIs for one IP_D – IP_S – combiniation
- Impossible for Mobile IP

  2 possibilities:

  - code the SPI size in the SPI field (1-4 byte)
    - has to be included to the SA negotiation
    - impossible for 0 SPI
    - reduces SPI range
  - IP address based lookup

IP address based lookup