The new Internet Protocol security IPsec testing with TTCN-3

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30/05/2007

Suite of security protocols

	Authentication Header (AH)	Encapsulating Security Payload (ESP)
Connectionless Integrity	√	√

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Connectionless Integrity	✓	✓
Data Origin Authentication	✓	✓
Access Control	✓	✓
Confidentiality	✗	✓

Set of cryptographic algorithms

Encryption algorithm

- 3DES-CBC

Authentication algorithm

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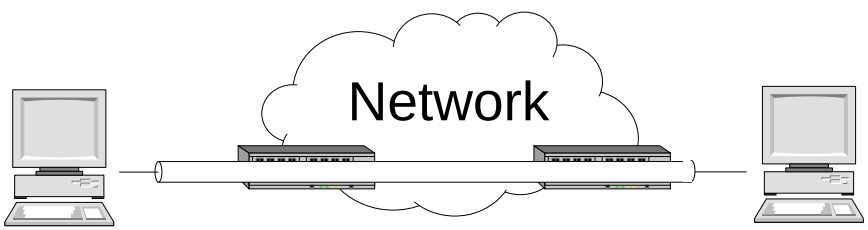
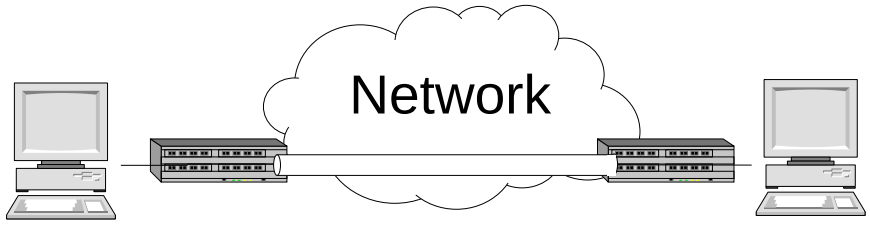
- AES-XCBX-MAC-96

IPsec modes



Transport mode



Tunnel mode

SPD and SA

Security Policy Database

- control IPsec traffic

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- one SA for each traffic direction

v6RL test suite coverage

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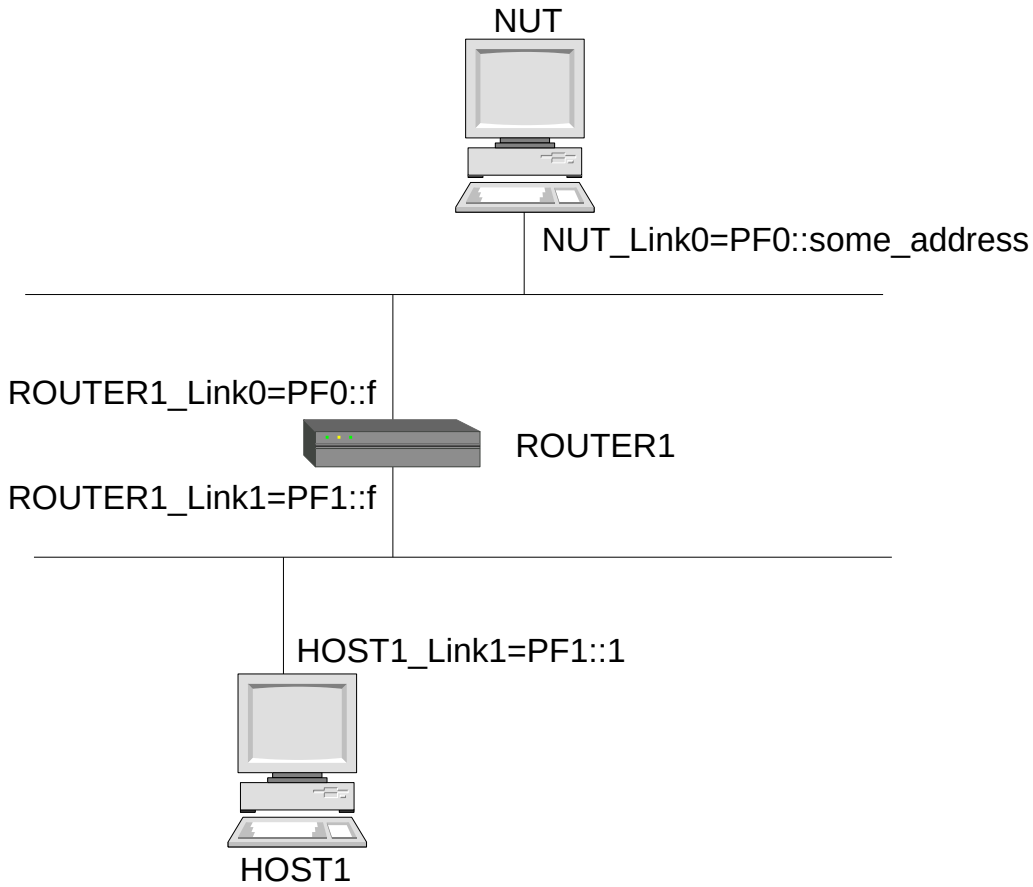
- ICMPv6 messages exchange

Test case 5.2.3

- Transport mode tested
- 3DES-CBC encryption algorithm
- NULL authentication algorithm



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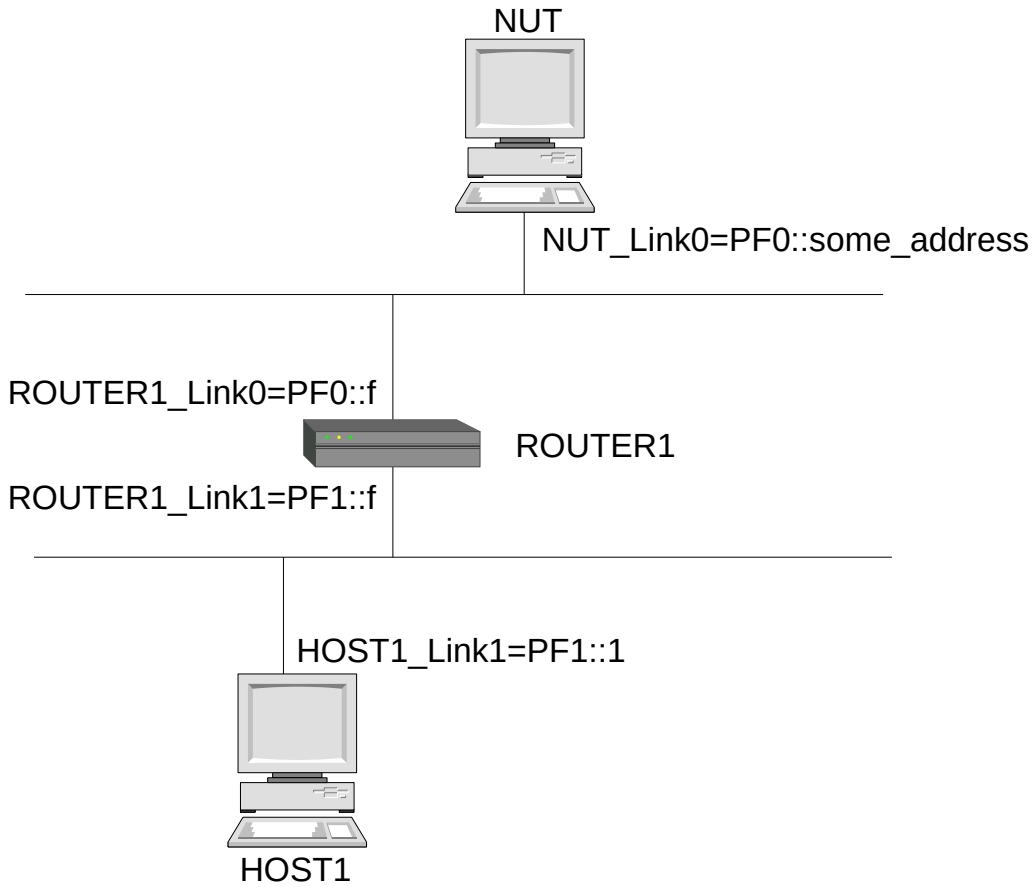

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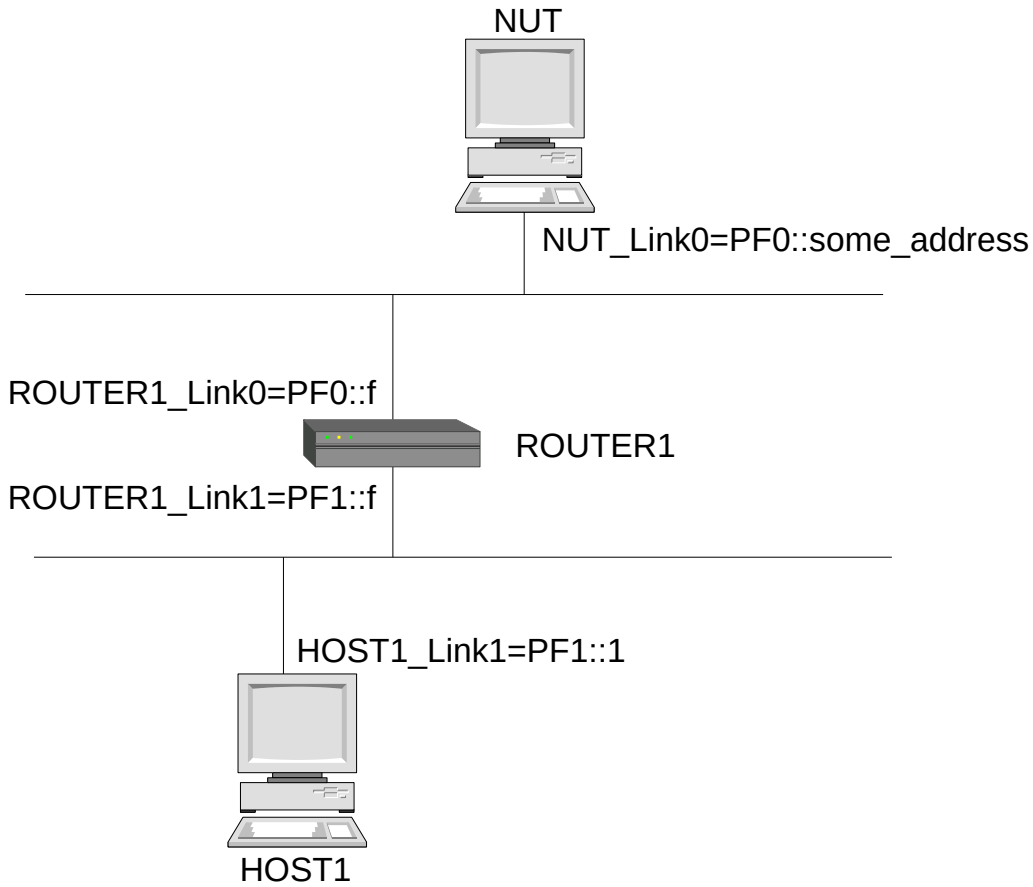

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Test case engineering

- Just an ICMPv6 Echo Request and Echo Reply exchanged
- Simple message sequence
- Messages use 3DES-CBC encryption with PSK
- Complex assembly and disassembly
- Where to perform cryptographic operations?

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  - CoDec
  - External Functions

CoDec only Transmission

- ESP message modeled in TTCN-3
- Checksum and padding fields calculated in the CoDec
- Payload encrypted in the CoDec

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Link1.send(ICMPv6WithESP_EchoRequest_AuthNULL(SPI_SA1, ''O));
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CoDec only Reception

```
alt
  //Receive the correct answer
  [] Link1.receive(ICMPv6WithESP_EchoReply_AuthNULL
                                        (SPI_SA2, ''O))
       { setverdict(pass);
         replyTimer.stop; }
  //Receive incorrect answer
  [] Link1.receive
       { setverdict(fail);
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  [] replyTimer.timeout
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CoDec+Ext Transmission

```
template ESPMessage ICMPv6ESPMessage (IPv6AddressType src,
                    IPv6AddressType dst, octetstring m_spi,
                    octetstring m_data, UInt16 checksum) := {

          SPI:= m_spi,
          SeqNum := 1,
          Payload := EncryptPayload(src, dst, EchoRequestType,
                                    m_data, checksum),
          ICV :=omit
 }
```

CoDec+Ext Reception

```
alt{
        //Receive correct answer, unverified encrypted payload
        [] Link1.receive(ICMPv6ESPMessage_Answer_AuthNULL
                        (PF0_1, PF1_1, SPI_SA2, DATA, checksum)) -> value Myvar {
              var bitstring encpayload := Myvar.Payload;
              var UInt8 payloadLength := lengthof(encpayload)/8;
              var EncPayload payload := DecriptPayload(encpayload, payloadLength);
              if (match(payload, ICMPv6EncPayload_Answer(PF0_1, PF1_1, DATA))) {
                     setverdict(pass);
              } else {
                     setverdict(fail);
              }
              replyTimer.stop;
        }
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            var bitstring encpayload := Myvar.Payload;
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Message transmission & reception

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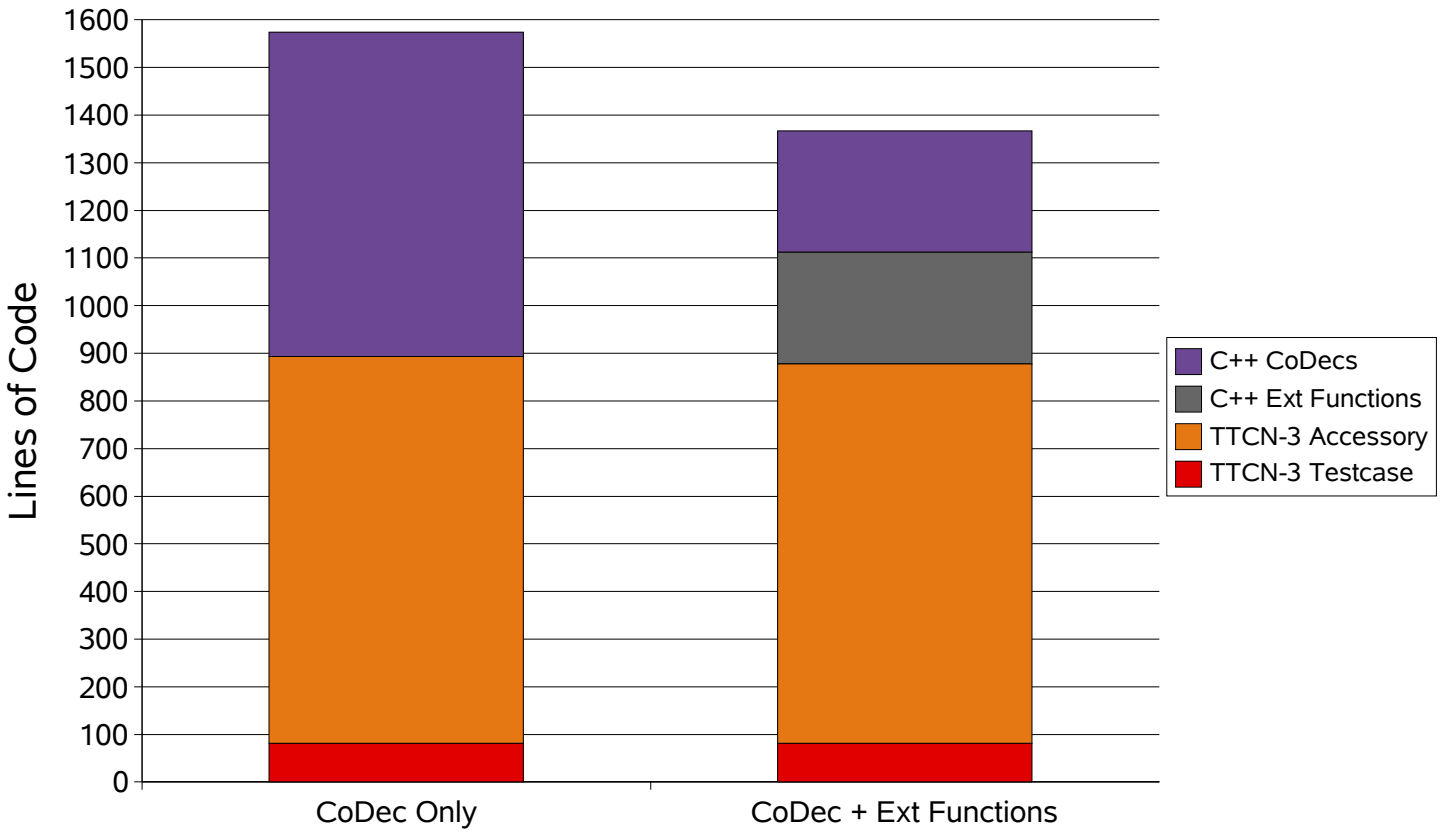
External Functions

- More control from ATS
- CoDec just encode and decode
- Software engineering techniques applicable

loc based metrics



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- External functions based approach requires 4 external function invocations.
- Not relevant in conformance or interoperability testing, but might be critical for other test paradigms.

Final remarks

- Ongoing research for more thorough analysis
- Both methodologies are valid and applicable, with consistent results
- Excessively complex CoDec development diverges from TTCN-3 philosophy
- When performance degradation is allowed, external functions provide better code properties and a cleaner solution

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Thank you for your time

Questions?

http://www.irisa.fr/tipi/publi/t3uc2007paper.pdf