Computer and Network Security

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Network Security Protocols

Network Security Protocols
OSI, GSSAPI, IPSO, SSL

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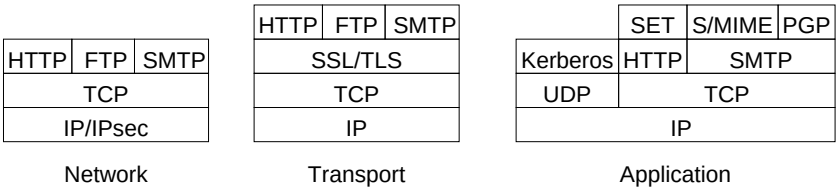
Security Protocol Locations



OSI Reference Architecture Layers

7 − Application	− underlying OS security − interoperation − multiple applications
6− Presentation	− compression, encryption, common coding
5 − Session	− managing multiple related streams
4 − Transport	− end−to−end
3 − Network	− host identification only − per−packet OH if datagram service − higher level entities are treated same
2 − Link 1 − Physical	− only useful for immediate neighbors

OSI Security Services − Classes

1. Peer entity authentication service − no replay
   Data origin authentication service − no modification/duplication prot.

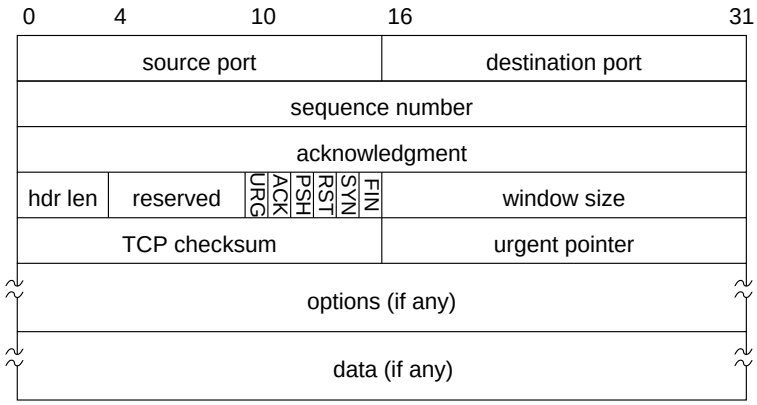
2. Access control service

3. Connection confidentiality service
   Connectionless confidentiality service
   Selected field confidentiality service
   Traffic flow confidentiality service

4. Connection integrity service with recovery
   Connection integrity service without recovery
   Selected field connection integrity service
   Connectionless integrity service
   Selected field connectionless integrity service

5. Non−repudiation with proof of origin
   Non−repudiation with proof of delivery

TCP Packet Format



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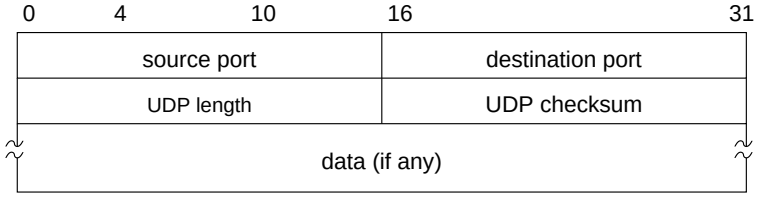
UDP Packet Format



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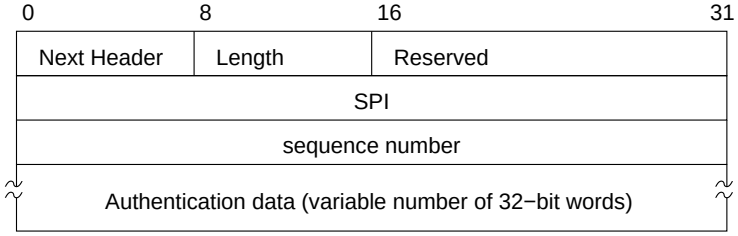
IPSO − IP Security Option

RFC 1825 − Overview of IP Security Architecture
RFC 1826 − Packet Authentication Extension to IP
RFC 1827 − Packet Encryption Extension to IP
RFC 1828 − A Specific Authentication Mechanism (MD5)
RFC 1829 − A Specific Encryption Algorithm

IPv4 − optional
IPv6 − support is mandatory
Both − features implemented in extension headers following main IP header
- − authentication: Authentication Header (AH)
- − privacy: Encapsulating Security Payload (ESP) header (optional authentication)

Security Association:
- − one−way relationship between sender and receiver (if two−way desired, then two SA's needed)
- − SA uniquely identified by IP address and SPI (Security Parameter Index)
- − More than one sender can share same SA with receiver
- − Either ESP or AH, but not both

IPSO − Authentication Header



IPv4 − immediately follows IPv4 header
IPv6 − after fragmentation and end−to−end headers, before ESP and transport level headers

Next Header = Type of following header
Length = number of 32−bit words in this header
SPI = Security Parameter Index − identifies SA − 0 = none exists
1−255 = reserved
Authentication data = depends on authentication algorithm
- − must not use crypto−weak checksum like CRC
- − calculated on entire IP packet, excluding dynamic fields (TTL,...)
- − performed before fragmentation/after assembly
- − if intermediate authentication desired => MTU discovery needed

see RFC 1828 − MD5−based authentication − <p,Ksa>MD5

IPSO − Security Association

Defining Parameters:

Authentication algorithm and algorithm mode in AH (req)
Key(s) used with authentication algorithm (req)
Encryption algorithm, mode and transform in ESP (req)
Key(s) for ESP (req)
Flag and size of crypto synch or IV for ESP (req)
Authentication algorithm and mode for ESP (rec)
Authentication keys for ESP (rec)
Key lifetime (rec)
SA lifetime (rec)
Source address(es) of SA (wildcard if >1 source) (rec)
Sensitivity level of protected data (req. for MLS, rec o/w)
(see RFC 1108 − DoD Security Options − labels
and whose rules are to be used for protection)

IPSO − Key Management

Manual − sysadmin configures keys

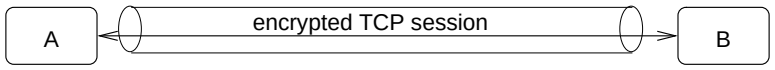
Automated − on−demand key creations for SAs, support of large systems

ISAKMP/Oakley − default automated key management protocol

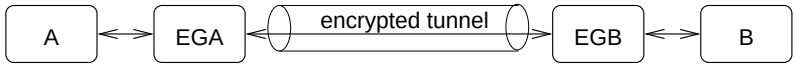
Oakley − Key determination protocol − based on Diffie−Hellman

ISAKMP − Internet Security Association and Key Management Protocol
framework for key management
provides specfic formats, negotiation protocols

IPSO − Encapsulating Security Payload

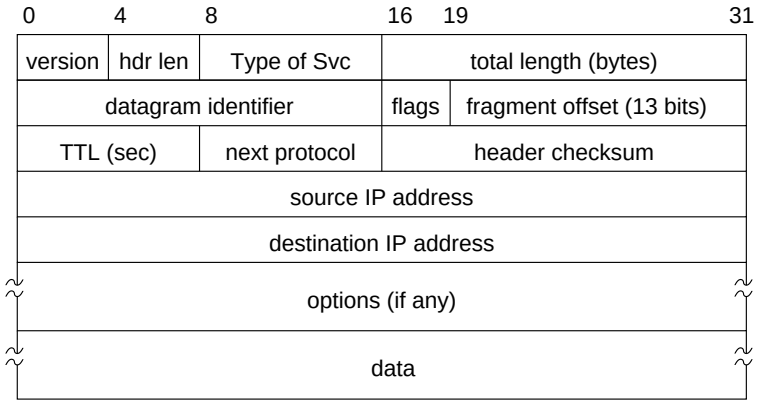


Transport Mode

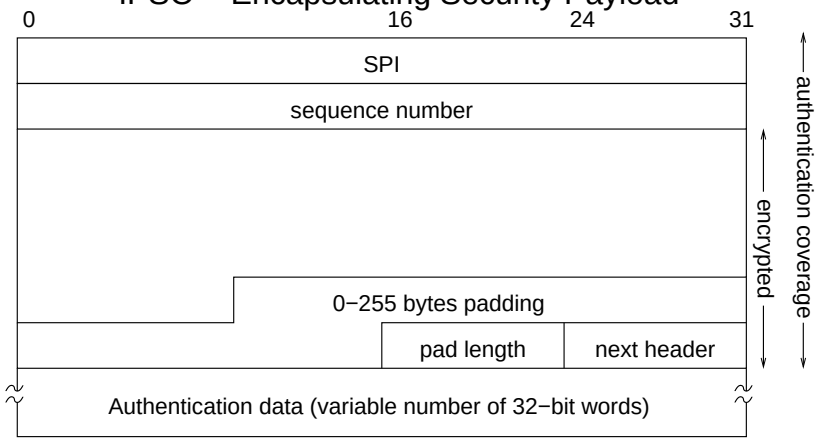


Tunnel Mode

IP Packet Format

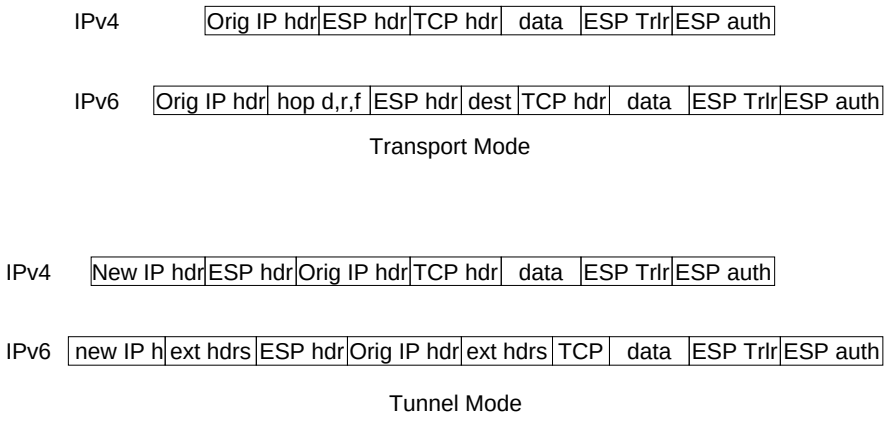


IPSO − Encapsulating Security Payload



SPI = security parameters index
data = transport level segment (transport mode) or IP packet (tunnel mode)
Must support DES in CBC mode
IDs for 3−key 3DES, RC5, IDEA, 3−key 3IDEA, CAST, Blowfish
MAC default length 96 bits, must support HMAC−MD5−96 and
HMAC−SHA−1−96

IPSO − ESP Modes in IPv4 and IPv6



IPSO − ISAKMP

Establish, negotiate, modify, delete IPSO SAs

Defines payloads for key generation and authentication data independent of particular key exchange protocol, encryption algorithm, or authentication protocol

Five default exchanges −

- Base exchange (4) − key and authentication data sent together − gives Id
- ID protection (6) − protects IDs by establishing SA first, then key, then auth
- Authentication only (3) − establish AH SA
- Aggressive (3) − authentication and key exchange, reveals IDs
- Informational (1) − one−way transmission of info for SA management

IPSO − ISAKMP Payload Types

- SA payload − begin establishment of SA − DOI − situation (reqts)
- Proposal payload − SA negotiation − ESP/AH − SPI − # transforms
- Transform payload − Transform # − Transform ID − parameters defines specific transform, e.g., 3DES, HMAC−MD5−96
- Key Exchange payload − KE data − depends on key exchange algorithm
- Identification payload − ID data − usually IPv4 or IPv6 address
- Certificate payload − transfers public key certificate (e.g., PGP, X.509,...)
- Certificate Request payload − acceptable types, CAs
- Hash payload − for integrity, authentication
- Signature payload − digital signature data − integrity, nonrepudiation
- Nonce payload − for liveness, replay prevention
- Notification payload − error or status information
- Delete payload − one or more SAs that are no longer valid

IPSO − Oakley Key Determination Protocol

Based on Diffie−Hellman

Uses cookies to defeat Denial of Service attacks

- start by sending cookies before DH exponentiation work
- can only force target to send ACKs on spoofed sessions
- cookies depend on source, dest IP/port and secret values

Supports groups (preset g, n for DH exchange)

Uses nonces to prevent replays

Enables DH public key value exhange

Authenticates DH key determination to prevent bucket−brigade attack

- digital signatures
- public key encryption
- symmetric key encryption

Supports various sequences for key exchange (e.g., aggressive, 3−msg)

Generic Security Service API (GSS−API)

RFC−1508: GSS−API RFC−1509: GSS−API bindings for C

− Provide interoperability for systems with different sets of security mechanisms

− Be independent of communication protocol, protocol association constructs

GSS_{Acquire|Release|Inquire}_cred() − credential management

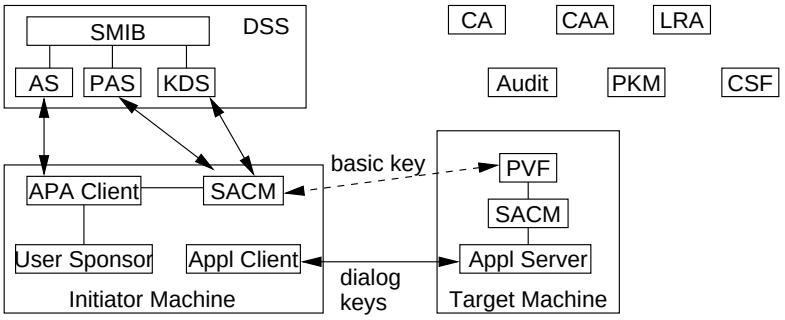
GSS_{Init|Accept|Delete}_sec_context()
GSS_Process_context_token() − context management
GSS_Context_time()

GSS_{Sign|Verify|Seal|Unseal}() − per−message calls

GSS_Display_status() − support calls
GSS_Indicate_mechs()
GSS_{Compare|Display|Import|Release}_name()
GSS_Release_{buffer|oid_set}()

GSS−API caller accepts (uninterpreted) tokens provided by local GSS−API implementation, sends these to remote peer, who passes them to its impl. Calls return a "more" or "done" status to indicate if further processing needed.

SESAME Application View



CSF = Cryptographic Support Facility

SACM = Secure Association Context Manager

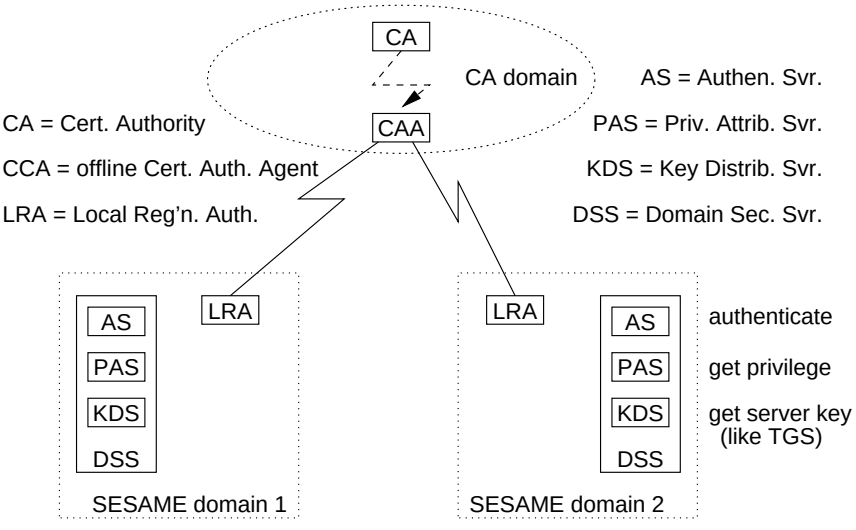
PKM = Public Key Management

SMIB = Security Management Information Base

PVF = PAC Validation Facility

APA = Authentication and Privilege Attribute

SESAME



CA = Cert. Authority

CCA = offline Cert. Auth. Agent

LRA = Local Reg'n. Auth.

AS = Authen. Svr.

PAS = Priv. Attrib. Svr.

KDS = Key Distrib. Svr.

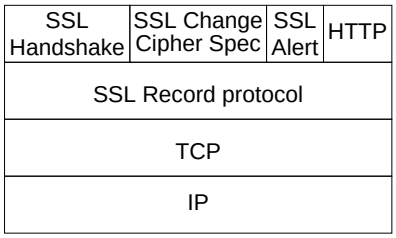
DSS = Domain Sec. Svr.

authenticate

get privilege

get server key
(like TGS)

Secure Socket Layer Protocol Stack



Connection − OSI transport; peer−to−peer, transient relationship

Each connection associated with one session

Session − client−server association created by Handshake Protocol

Set of cryptographic security parameters to be used over many connections

SSL Connection State

Client and Server Random − random bytes chosen for each connection

Server write MAC secret − secret key used by server in MACs

Client write MAC secret − secret key used by client in MACs

Server write key − symmetric key used by server to encrypt data

Client write key − symmetric key used by client to encrypt data

Initialization vectors − IV for each key used with CBC mode

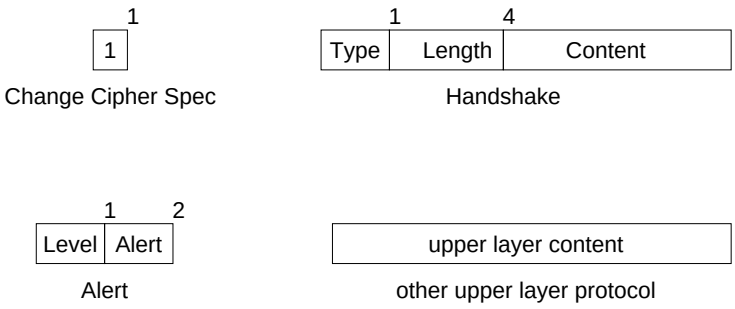
Initialized by Handshake Protocol, then last ciphertext block from each record used as IV for next record

Sequence numbers − each party has its own 64−bit sequence numbers

Change cipher spec messages (sent or received) reset these to 0

Sequence numbers may not wrap around

SSL Record Protocol Payload Formats



SSL Record Protocol

Provides −

- Confidentiality (SSL Handshake Protocol defines symmetric keys)
- Message Integrity (Handshake Protocol defines MAC secrets)

Steps −

- Fragment − into 16384−byte (max) chunks
- Compress − lossless, no expansion more than 1024 bytes (default null)
- Add MAC − H(MWS | pad−2 | H(MWS | pad−1| seq # | SSL−comp−type | SSL−comp−length | SSL−compressed−fragment))
- Encrypt − may not increase length by more than 1024 bytes
- Prepend header − Content type (8), Major version (8), Minor version (8), Compressed length (16 bits)
  - Content type is change_cipher_spec, alert, handshake, or application_data

SSL Session State

Session ID − for server to identify active or resumable state info

Peer certificate − X.509.v3 certificate of peer (may be null)

Compression method − for pre−encryption compression

Cipher spec − bulk encryption algorithm, hash algorithm, other parameters (e.g., hash length)

Master Secret − 48−byte secret shared between client and server

Is−resumable Flag − indicates whether the session may be used to initiate new connections

SSL Handshake Protocol