ELECTRONIC MAIL SECURITY

- PGP is an open-source, freely available software package for e-mail security. It provides authentication through the use of digital signature, confidentiality through the use of symmetric block encryption, compression using the ZIP algorithm, and e-mail compatibility using the radix-64 encoding scheme.
- PGP incorporates tools for developing a public-key trust model and public-key certificate management.
- S/MIME is an Internet standard approach to e-mail security that incorporates the same functionality as PGP.
- DKIM is a specification used by e-mail providers for cryptographically signing e-mail messages on behalf of the source domain.

PRETTY GOOD PRIVACY

- 1. It is available free worldwide in versions that run on a variety of platforms, including Windows, UNIX, Macintosh, and many more. In addition, the commercial version satisfies users who want a product that comes with vendor support.
- 2. It is based on algorithms that have survived extensive public review and are considered extremely secure. Specifically, the package includes RSA, DSS, and Diffie-Hellman for public-key encryption; CAST-128, IDEA, and 3DES for symmetric encryption; and SHA-1 for hash coding.
- 3. It has a wide range of applicability, from corporations that wish to select and enforce a standardized scheme for encrypting files and messages to individuals who wish to communicate securely with others worldwide over the Internet and other networks.
- 4. It was not developed by, nor is it controlled by, any governmental or standards organization. For those with an instinctive distrust of "the establishment," this makes PGP attractive

NOTATION

K_s = session key used in symmetric encryption scheme
PR_a = private key of user A, used in public-key encryption scheme
PU_a = public key of user A, used in public-key encryption scheme
EP = public-key encryption
DP = public-key decryption
EC = symmetric encryption
DC = symmetric decryption

H = hash function
|| = concatenation
Z = compression using ZIP algorithm
R64 = conversion to radix 64 ASCII format[1]

SUMMARY OF PGP SERVICES

Function	Algorithms Used	Description
Digital signature	DSS/SHA or RSA/SHA	A hash code of a message is created using SHA-1. This message digest is encrypted using DSS or RSA with the sender's private key and included with the message.
Message encryption	CAST or IDEA or Three-key Triple DES with Diffie-Hellman or RSA	A message is encrypted using CAST-128 or IDEA or 3DES with a one-time session key generated by the sender. The session key is encrypted using Diffie-Hellman or RSA with the recipient's public key and included with the message.
Compression	ZIP	A message may be compressed for storage or transmission using ZIP.
E-mail compatibility	Radix-64 conversion	To provide transparency for e-mail applications, an encrypted message may be converted to an ASCII string using radix-64 conversion.

Reference :William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006

OPERATIONAL DESCRIPTION

- The actual operation of PGP, as opposed to the management of keys, consists of four services: authentication, confidentiality, compression, and e-mail compatibility

AUTHENTICATION

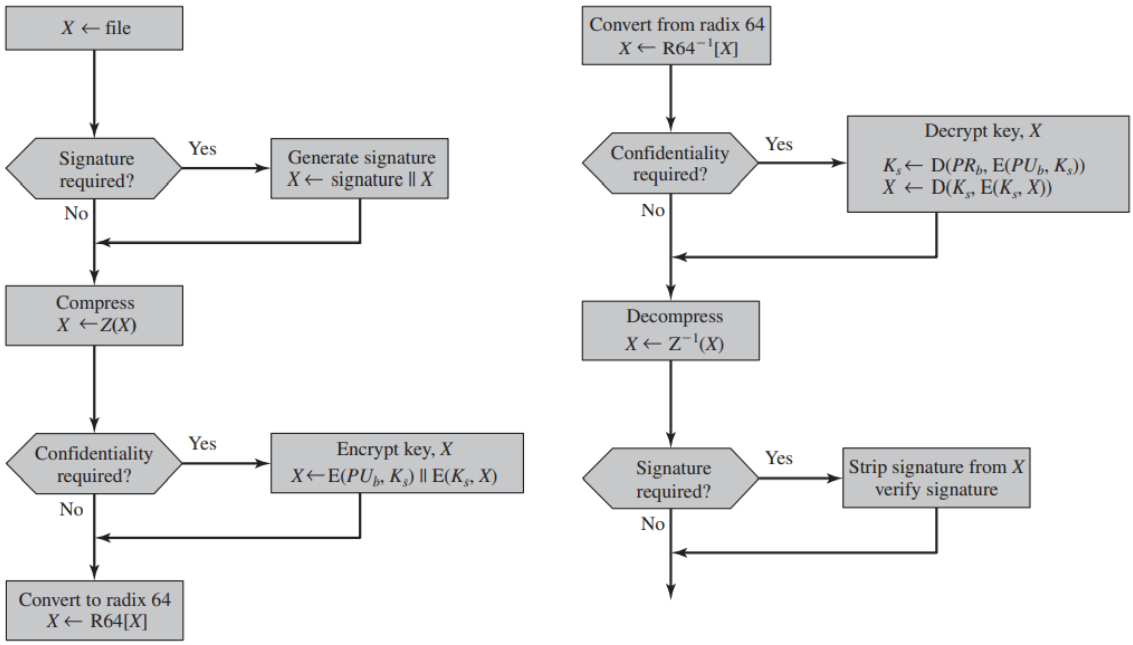
- 1. The sender creates a message.
- 2. SHA-1 is used to generate a 160-bit hash code of the message.
- 3. The hash code is encrypted with RSA using the sender's private key, and the result is prepended to the message.
- 4. The receiver uses RSA with the sender's public key to decrypt and recover the hash code.
- 5. The receiver generates a new hash code for the message and compares it with the decrypted hash code. If the two match, the message is accepted as authentic

CONFIDENTIALITY

- 1. The sender generates a message and a random 128-bit number to be used as a session key for this message only.
- 2. The message is encrypted using CAST-128 (or IDEA or 3DES) with the session key.

- 3. The session key is encrypted with RSA using the recipient's public key and is prepended to the message.
- 4. The receiver uses RSA with its private key to decrypt and recover the session key.
- 5. The session key is used to decrypt the message.

TRANSMISSION AND RECEPTION OF PGP MESSAGES



(a) Generic transmission diagram (from A)

(b) Generic reception diagram (to B)

Reference :William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006

S/MIME

- Secure/Multipurpose Internet Mail Extension (S/MIME) is a security enhancement to the MIME Internet e-mail format standard based on technology from RSA Data Security.
- Although both PGP and S/MIME are on an IETF standards track, it appears likely that S/MIME will emerge as the industry standard for commercial and organizational use, while PGP will remain the choice for personal e-mail security for many users.
- S/MIME is defined in a number of documents—most importantly RFCs 3370, 3850, 3851, and 3852.

RFC 5322

- RFC 5322 defines a format for text messages that are sent using electronic mail.

- It has been the standard for Internet-based text mail messages and remains in common use. In the RFC 5322 context, messages are viewed as having an envelope and contents.
- The envelope contains whatever information is needed to accomplish transmission and delivery. The contents compose the object to be delivered to the recipient.
- The RFC 5322 standard applies only to the contents. However, the content standard includes a set of header fields that may be used by the mail system to create the envelope, and the standard is intended to facilitate the acquisition of such information by programs.
- The overall structure of a message that conforms to RFC 5322 is very simple. A message consists of some number of header lines (the header) followed by unrestricted text (the body).
- The header is separated from the body by a blank line. Put differently, a message is ASCII text, and all lines up to the first blank line are assumed to be header lines used by the user agent part of the mail system
- A header line usually consists of a keyword, followed by a colon, followed by the keyword's arguments; the format allows a long line to be broken up into several lines.
- The most frequently used keywords are From,To, Subject, and Date. Here is an example message:

```
Date: October 8, 2009 2:15:49 PM EDT
From: "William Stallings" <ws@shore.net>
Subject: The Syntax in RFC 5322
To: Smith@Other-host.com
Cc: Jones@Yet-Another-Host.com

Hello. This section begins the actual
message body, which is delimited from the
message heading by a blank line.
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Reference :William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006

MULTIPURPOSE INTERNET MAIL EXTENSIONS

- Multipurpose Internet Mail Extension (MIME) is an extension to the RFC 5322 framework that is intended to address some of the problems and limitations of the use of Simple Mail Transfer Protocol (SMTP), defined in RFC 821, or some other mail transfer protocol and RFC 5322 for electronic mail.
- Limitations of the SMTP/5322 scheme.
- 1. SMTP cannot transmit executable files or other binary objects. A number of schemes are in use for converting binary files into a text form that can be used by SMTP mail systems, including the popular UNIX UUencode/UUdecode scheme. However, none of these is a standard or even a de facto standard.

- 2. SMTP cannot transmit text data that includes national language characters, because these are represented by 8-bit codes with values of 128 decimal or higher, and SMTP is limited to 7-bit ASCII.
- 3. SMTP servers may reject mail message over a certain size.
- 4. SMTP gateways that translate between ASCII and the character code EBCDIC do not use a consistent set of mappings, resulting in translation problems.
- 5. SMTP gateways to X.400 electronic mail networks cannot handle nontextual data included in X.400 messages.
- 6. Some SMTP implementations do not adhere completely to the SMTP standards defined in RFC 821. Common problems include:
- Deletion, addition, or reordering of carriage return and linefeed
- Truncating or wrapping lines longer than 76 characters
- Removal of trailing white space (tab and space characters)
- Padding of lines in a message to the same length
- Conversion of tab characters into multiple space characters

OVERVIEW

- The MIME specification includes the following elements.
- 1. Five new message header fields are defined, which may be included in an RFC 5322 header. These fields provide information about the body of the message.
- 2. A number of content formats are defined, thus standardizing representations that support multimedia electronic mail.
- 3. Transfer encodings are defined that enable the conversion of any content format into a form that is protected from alteration by the mail system.

HEADER FIELDS

- The five header fields defined in MIME are
- MIME-Version: Must have the parameter value 1.0. This field indicates that the message conforms to RFCs 2045 and 2046.
- Content-Type: Describes the data contained in the body with sufficient detail that the receiving user agent can pick an appropriate agent or mechanism to represent the data to the user or otherwise deal with the data in an appropriate manner.
- Content-Transfer-Encoding: Indicates the type of transformation that has been used to represent the body of the message in a way that is acceptable for mail transport.

- Content-ID: Used to identify MIME entities uniquely in multiple contexts.
- Content-Description: A text description of the object with the body; this is useful when the object is not readable (e.g., audio data).

MIME CONTENT TYPES

Type	Subtype	Description
Text	Plain	Unformatted text; may be ASCII or ISO 8859.
	Enriched	Provides greater format flexibility.
Multipart	Mixed	The different parts are independent but are to be transmitted together. They should be presented to the receiver in the order that they appear in the mail message.
	Parallel	Differs from Mixed only in that no order is defined for delivering the parts to the receiver.
	Alternative	The different parts are alternative versions of the same information. They are ordered in increasing faithfulness to the original, and the recipient's mail system should display the "best" version to the user.
	Digest	Similar to Mixed, but the default type/subtype of each part is message/rfc822.
Message	rfc822	The body is itself an encapsulated message that conforms to RFC 822.
	Partial	Used to allow fragmentation of large mail items, in a way that is transparent to the recipient.
	External-body	Contains a pointer to an object that exists elsewhere.
Image	jpeg	The image is in JPEG format, JFIF encoding.
	gif	The image is in GIF format.
Video	mpeg	MPEG format.
Audio	Basic	Single-channel 8-bit ISDN mu-law encoding at a sample rate of 8 kHz.
Application	PostScript	Adobe Postscript format.
	octet-stream	General binary data consisting of 8-bit bytes.

Reference :William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006

S/MIME FUNCTIONALITY

- In terms of general functionality, S/MIME is very similar to PGP. Both offer the ability to sign and/or encrypt messages

FUNCTIONS

- Enveloped data: This consists of encrypted content of any type and encrypted content encryption keys for one or more recipients.
- Signed data: A digital signature is formed by taking the message digest of the content to be signed and then encrypting that with the private key of the signer. The content plus

signature are then encoded using base64 encoding. A signed data message can only be viewed by a recipient with S/MIME capability.

- Clear-signed data: As with signed data, a digital signature of the content is formed. However, in this case, only the digital signature is encoded using base64.As a result, recipients without S/MIME capability can view the message content, although they cannot verify the signature.
- Signed and enveloped data: Signed-only and encrypted-only entities may be nested, so that encrypted data may be signed and signed data or clear-signed data may be encrypted