6 : Email Security and Domain Name System Security

IT6406 - Network Security and Audit

Level III - Semester 6

Overview

6.1. Email Security

- 6.1.1. Internet Mail Architecture
- 6.1.2. Email Formats
- 6.1.3. Email Threats and Comprehensive Email Security
- 6.1.4. S/MIME
- 6.1.5. Pretty Good Privacy (PGP)

6.2. Domain Name System Security

- 6.2.1. DNSSEC
- 6.2.2. DNS-Based Authentication of Named Entities
- 6.2.3. Sender Policy Framework
- 6.2.4. DomainKeys Identified Mail
- 6.2.5. Domain-Based Message Authentication, Reporting, and Conformance

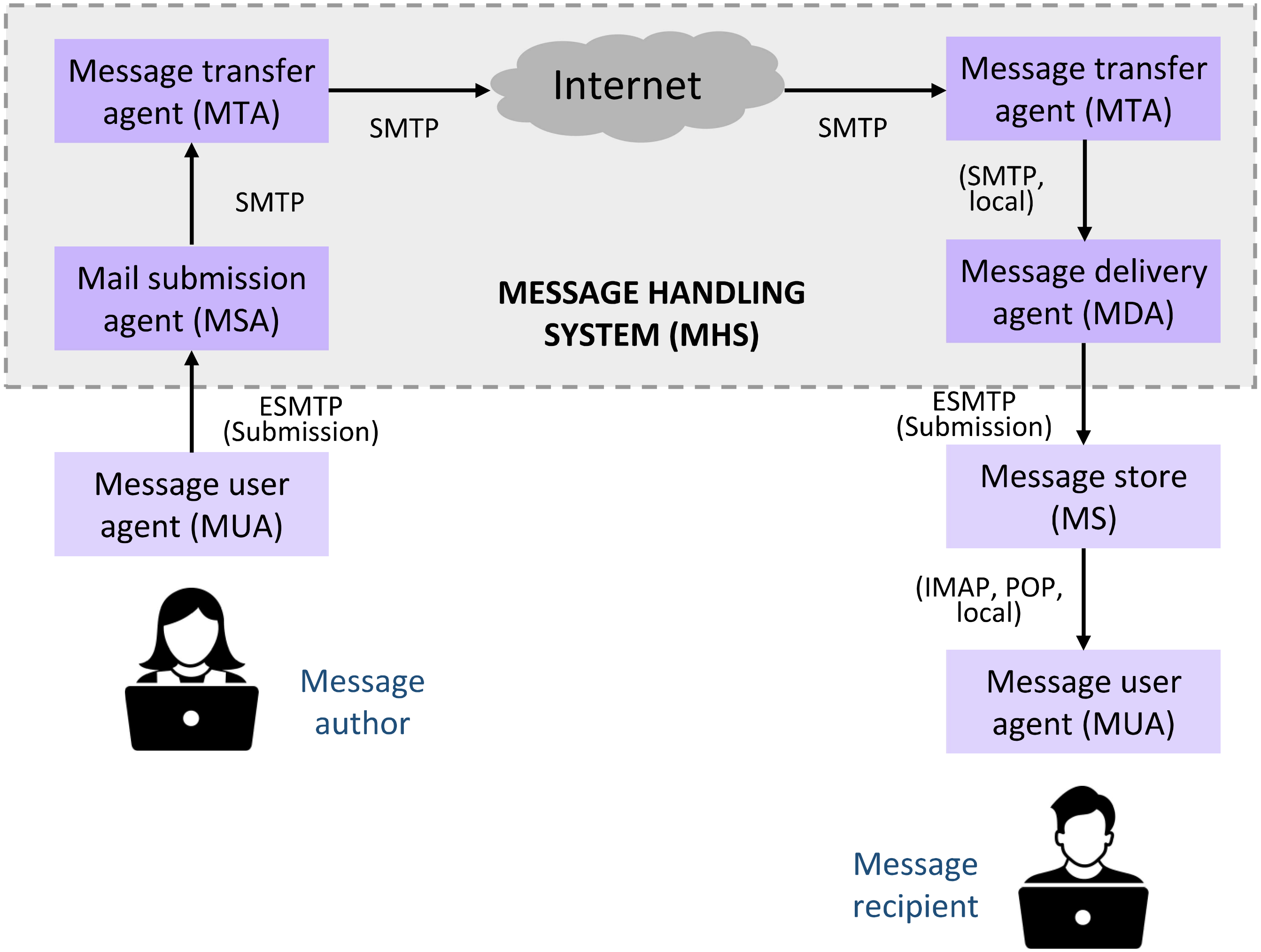
6.1.1. Internet Mail Architecture

- Email components
  - Message User Agent (MUA)
  - Mail Submission Agent (MSA)
  - Message Transfer Agent (MTA)
  - Mail Delivery Agent (MDA)
  - Message Store (MS)

Read more: Ref 1: Pg. (614-615)

6.1.1. Internet Mail Architecture…(2)

- Email components



Read more: Ref 1: Pg. (614-615)

Email Protocols

- Simple Mail Transfer Protocol (SMTP)
  - SMTP encapsulates an email message in an envelope and is used to relay the encapsulated messages from source to destination through multiple MTAs.
- Mail Access Protocols (POP, ICMP)
  - Post Office Protocol (POP3) allows an email client (user agent) to download an email from an email server (MTA).
  - IMAP is more complex than POP3.
  - IMAP provides stronger authentication than POP3.

Read more: Ref 1: Pg. (615-617)

6.1.2. Email Formats

- The structure of message described in RFC 5322 is very simple.
  - It consist of number of header lines and text (body) separated by blank line.
  - Header has some keywords like *From*, *To*, *Subject*, and *Date*.
- Multipurpose Internet Mail Extension (MIME)
  - An extension to the RFC 5322, to solve some problems and limitations in Simple Mail Transfer Protocol (SMTP).

Read more: Ref 1: Pg. (617-624)

6.1.2. Email Formats…(2)

- Header fields defined in MIME
  - MIME-Version
  - Content-Type
  - Content-Transfer-Encoding
  - Content-ID
  - Content-Description

Read more: Ref 1: Pg. (617-624)

6.1.3. Email Threats and Comprehensive Email Security

- Email security threats can be classified as,
  - Authenticity-related threat
  - Integrity-related threats
  - Confidentiality-related threat
  - Availability-related threats

Read more: Ref 1: Pg. (625-626)

6.1.3. Email Threats and Comprehensive Email Security…(2)

- Some standardised protocols designed as solutions for the threats
  - STARTTLS
  - S/MIME
  - DNS Security Extensions (DNSSEC)
  - DNS-based Authentication of Named Entities (DANE)
  - Sender Policy Framework (SPF)
  - DomainKeys Identified Mail (DKIM)
  - Domain-based Message Authentication, Reporting, and Conformance (DMARC)

Read more: Ref 1: Pg. (625-626)

6.1.4. S/MIME

- Secure/Multipurpose Internet Mail Extension (S/MIME)
- Security enhancement to the MIME Internet email format standard.
- It is based on technology from RSA.
- S/MIME provides
  - Authentication
  - Confidentiality
  - Compression
  - Email compatibility

Read more: Ref 1: Pg. (627-638)

6.1.4. S/MIME...(2)

- Authentication
  - Provides by digital signature. Most commonly RSA with SHA-256.
- Confidentiality
  - Provides confidentiality by encrypting messages. Use AES-128 with CBC
- Compression
  - Compress a messages to save the space in transmission and storage.
- Email compatibility
  - Many electronic mail systems only permit the use of blocks consisting of ASCII text. S/MIME provides the service of converting the raw 8-bit binary stream to a stream of printable ASCII characters.

Read more: Ref 1: Pg. (627-638)

6.1.4. S/MIME...(3)

- S/MIME Message Content Types
  - Data
  - SignedData
  - EnvelopedData
  - CompressedData

Read more: Ref 1: Pg. (627-638)

6.1.5.Pretty Good Privacy (PGP)

- Email security protocol
- Has the same functionality as S/MIME
- OpenPGP was developed as a new standard protocol based on PGP version 5.x.

- Differences between S/MIME and OpenPGP
  - Key Certification
    - S/MIME uses X.509 certificates that are issued by Certificate Authorities.
    - In OpenPGP, users generate their public key and private keys. OpenPGP public key is trusted if it is signed by another OpenPGP public key that is trusted by the recipient (Web-of-Trust).
  - Key Distribution
    - OpenPGP does not include the sender's public key with each message.

Read more: Ref 1: Pg. (638-639)

6.2.1. DNSSEC

- Domain Name System (DNS) is a service which provide a mapping between Domain names and the IP addresses.
- DNS Security Extensions (DNSSEC) secure the data exchange in DNS.
- It protect DNS clients from accepting forged or altered DNS resource records by using digital signatures.
- DNSSEC provides,
  - Data origin authentication
  - Data integrity verification

Read more: Ref 1: Pg. (639-642)

6.2.2. DNS-Based Authentication of Named Entities

- DNS-Based Authentication of Named Entities (DANE)
- If a CA in the internet compromised, the attacker can use the private key of CA and issue false certificates.
- The purpose of DANE is to replace reliance on the security of the CA system with reliance on the security provided by DNSSEC.
- DANE defines a new DNS record type, TLSA, that can be used for a secure method of authenticating SSL/TLS certificates.
- DANE can be used in conjunction with SMTP over TLS to more fully secure email delivery.

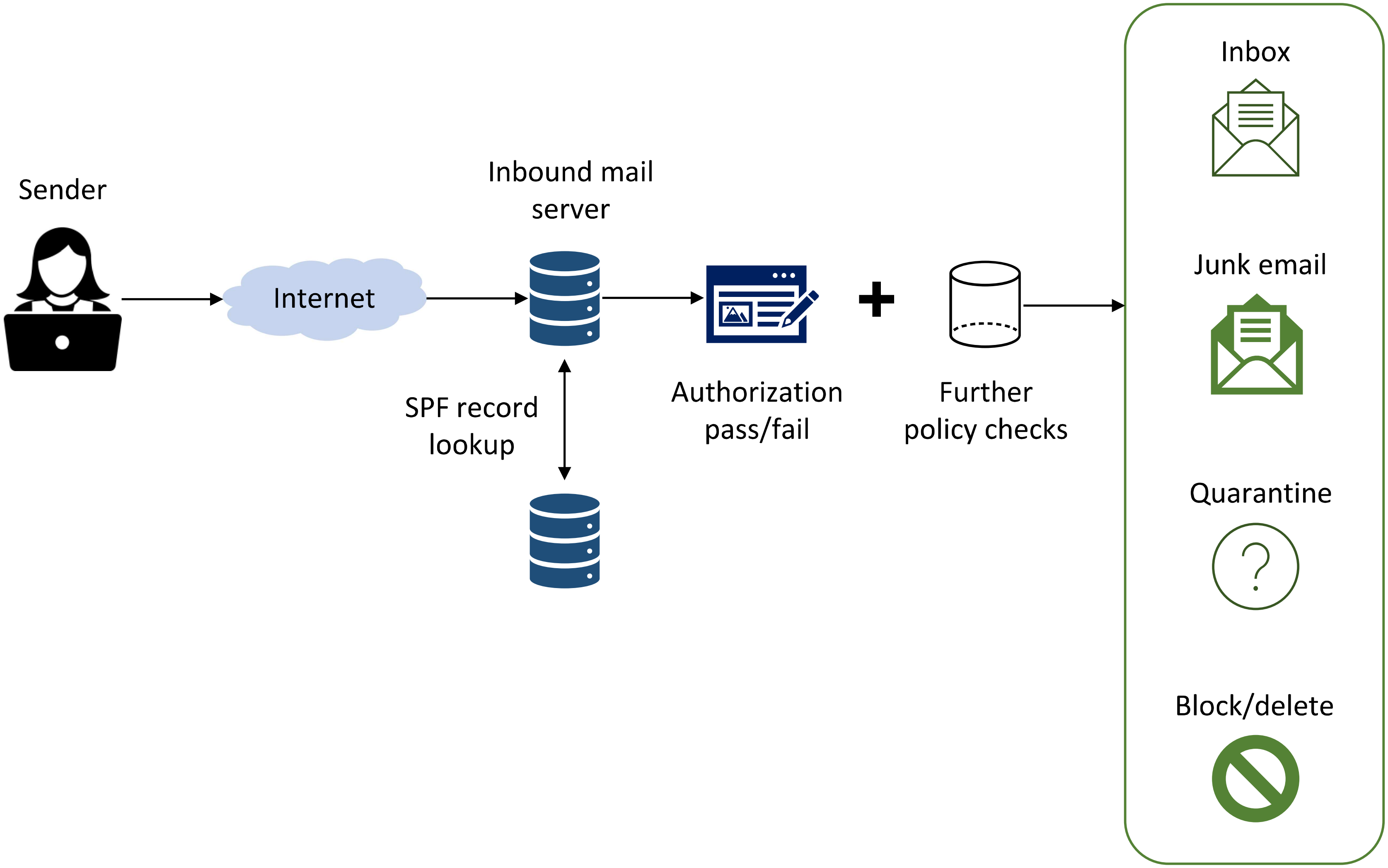
Read more: Ref 1: Pg. (643-644)

6.2.3. Sender Policy Framework

- SPF is the standardised way for a sending domain to identify and assert the mail senders for a given domain.
    - With the current email infrastructure, any host can use any domain name for each of the various identifiers in the mail header.
- SPF provides a protocol by which Administrative Management Domain (ADMD) can authorise hosts to use their domain names in the “MAIL FROM” or “HELO” identities.
- With SPF, it is difficult for the sender to alter the domain of the sender email.

Read more: Ref 1: Pg. (645-647)

6.2.3. Sender Policy Framework...(2)



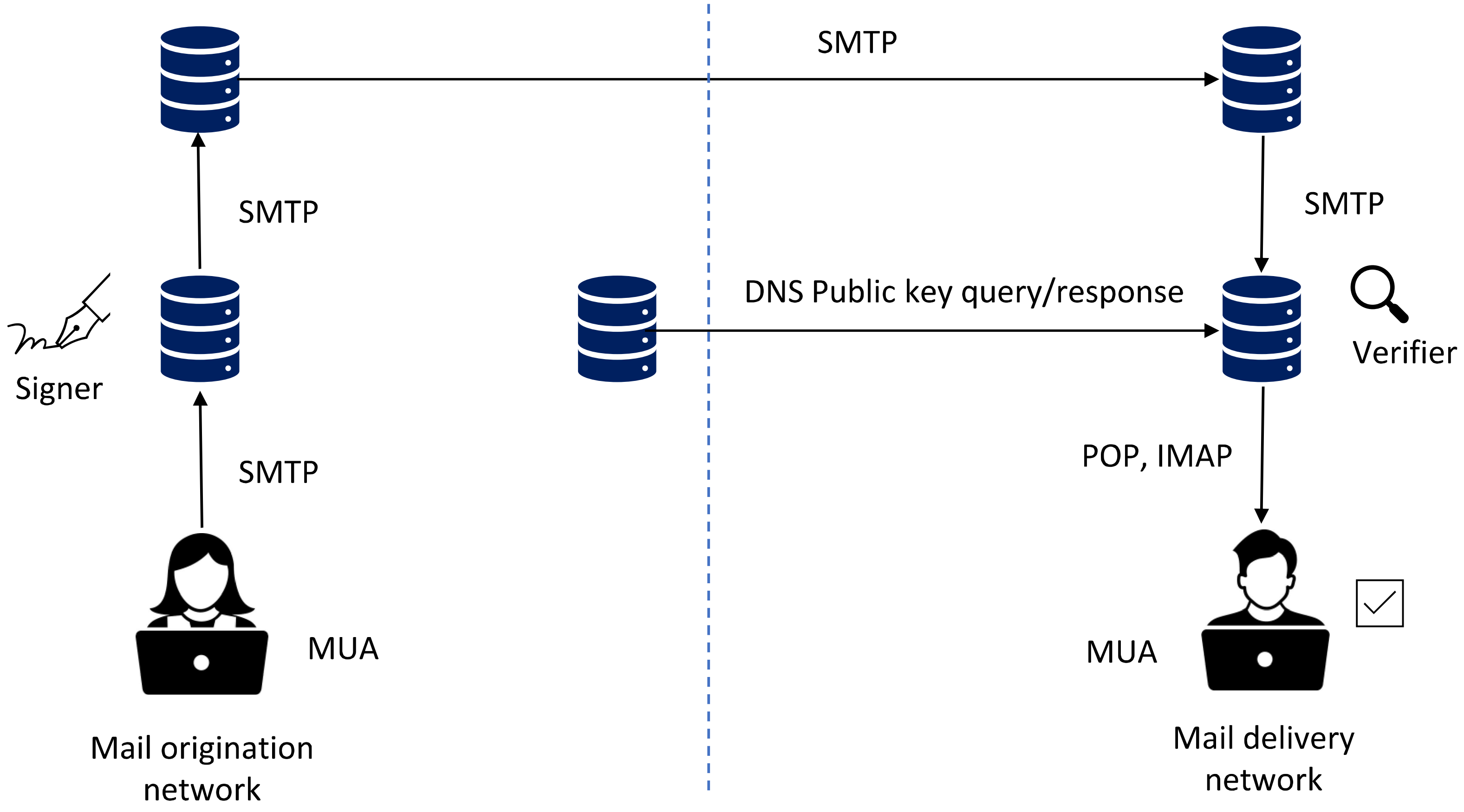
Read more: Ref 1: Pg. (645-647)

6.2.4.DomainKeys Identified Mail

- DomainKeys Identified Mail (DKIM) is a specification for cryptographically signing email messages, permitting a signing domain to claim responsibility for a message in the mail stream.
- DKIM authentication is transparent to the end user.
- User’s email message is signed by a private key of the administrative domain from which the email originates.
- At the receiving end, the Mail Delivery Agent (MDA) can access the corresponding public key via a DNS and verify the signature.

Read more: Ref 1: Pg. (648-653)

6.2.4.DomainKeys Identified Mail...(2)



DNS = Domain Name System
MDA = Mail Delivery Agent
MSA = Mail Submission Agent
MTA = Message Transfer Agent
MUA = Message User Agent

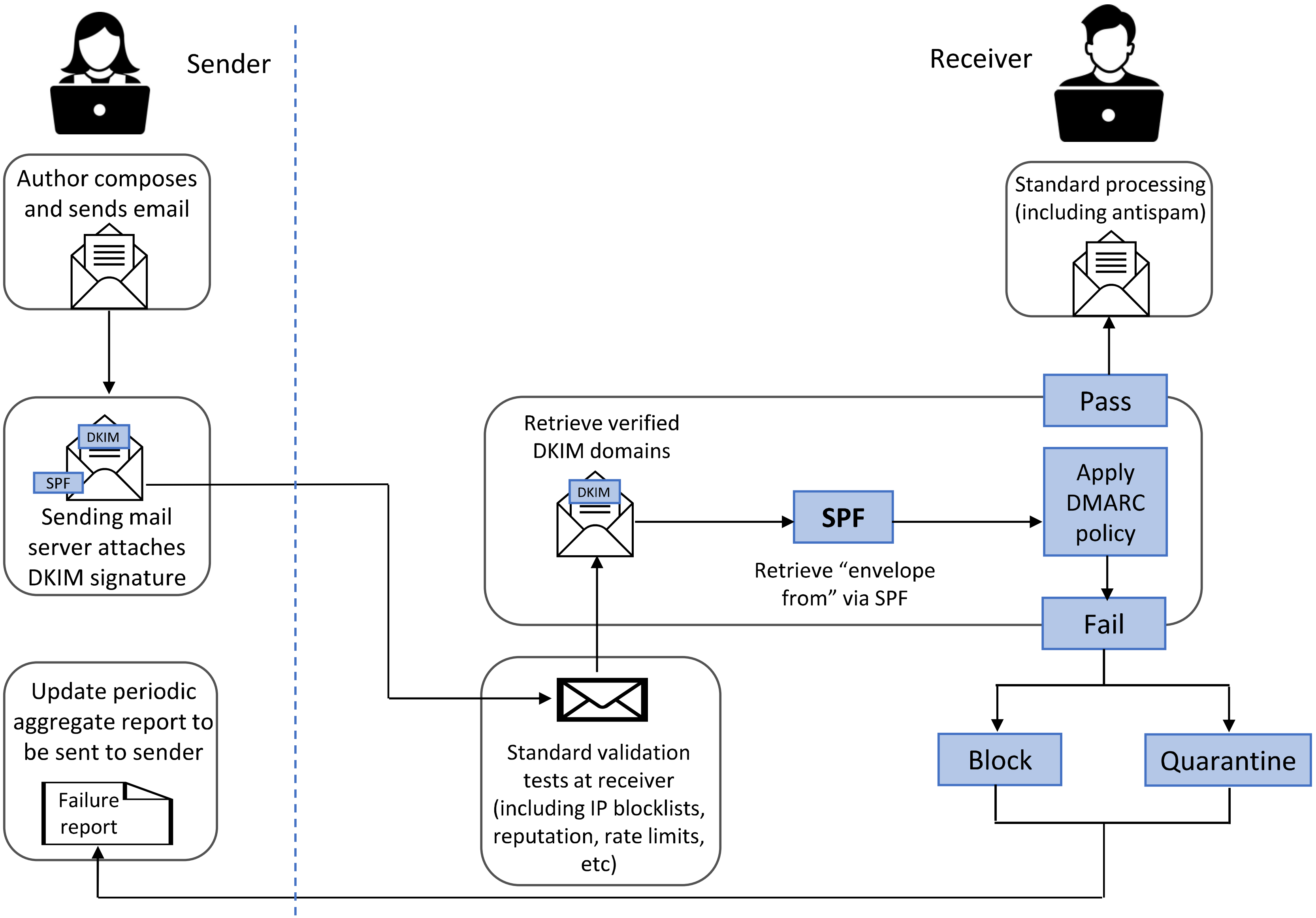
Read more: Ref 1: Pg. (648-653)

6.2.5. Domain-Based Message Authentication, Reporting, and Conformance

- It allows email senders to,
  - specify policy on how their mail should be handled,
  - the types of reports that receivers can send back,
  - the frequency those reports should be sent.

Read more: Ref 1: Pg. (654-658)

6.2.5. Domain-Based Message Authentication, Reporting, and Conformance...(2)


Sender
Receiver
Author composes and sends email
DKIM
SPF
Sending mail server attaches DKIM signature
Update periodic aggregate report to be sent to sender
Failure report
Standard validation tests at receiver (including IP blocklists, reputation, rate limits, etc)
Retrieve verified DKIM domains
DKIM
SPF
Retrieve “envelope from” via SPF
Apply DMARC policy
Pass
Fail
Standard processing (including antispam)
Block
Quarantine

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Read more: Ref 1: Pg. (654-658)

6.2.5. Domain-Based Message Authentication, Reporting, and Conformance…(3)

- DMARC reporting provides the sender’s feedback on their SPF, DKIM, Identifier Alignment, and message disposition policies.
- Reports includes,
  - The sender’s DMARC policy for that interval.
  - The message disposition by the receiver.
  - SPF result for a given SPF identifier.
  - DKIM result for a given DKIM identifier.
  - Results classified by sender subdomain.
  - The sending and receiving domain pair…etc

Read more: Ref 1: Pg. (654-658)

Reference

- Ref1: Cryptography and Network Security, Principles and Practice, 7th Edition, William Stallings. Online Chapter 23.2