Topic 4:Email Security

Topic 4– Lecture 1:

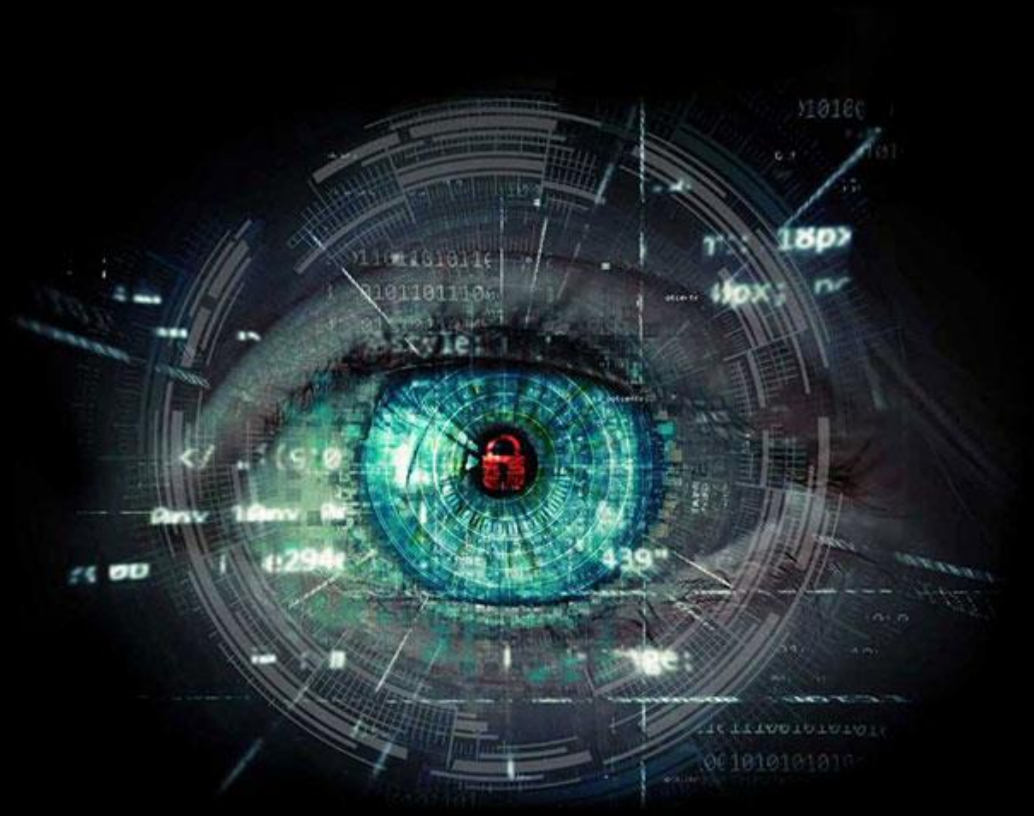
Email Security Threads

Network Security and Cryptography

Email Security Topic4 – 4.2

Scope and Coverage

This topic will cover:



01 Email security threats

02 Email security solutions

03 PGP

04 S/MIME

Email Security Topic4 – 4.3

Learning Outcomes

By the end of this topic students will be able to:

- Describe email security mechanisms
- Digitally sign an email

Importance of Email

- Business has come to rely on email as a means of communication:
  - fast
  - cost-effective
  - easy collaboration and information-sharing
- Email has become the primary method for corresponding with colleagues, customers, and business partners

Email Security Threats

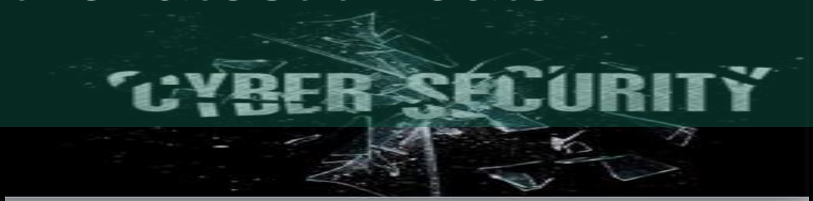
- Viruses can corrupt mission-critical documents and applications
- Hackers will try to obtain confidential information
- Spam can greatly deteriorate the performance of other components within the communications infrastructure
- Threats can stop business systems and mission- critical activities

Viruses

- Viruses are very sophisticated and often appear to be harmless correspondence:
  - personal communication
  - jokes
  - marketing promotions
- Most viruses require recipients to download attachments in order to spread
- Some are designed to launch automatically, with no user action required

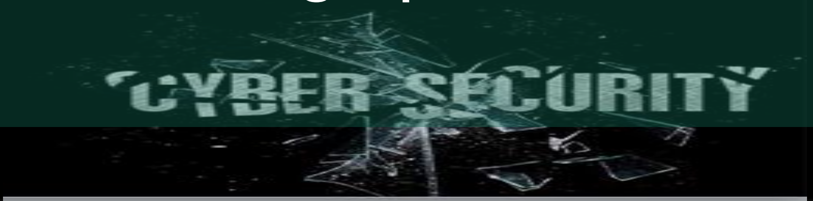
Protection from Viruses

- Email security solutions offer highly advanced virus protection:
  - automatically scan all ingoing and outgoing messages
  - automatically scan all attachments
  - automatic update capabilities
- New threats emerge all the time and updates offer protection from all the latest threats



Spam

- A large proportion of all corporate email is spam
- Spam costs US business billions of dollars in lost productivity and system slow-downs annually
- Most spam is annoying and slows down the network
- Hackers may sometimes disguise viruses, spyware, and malware as innocent-looking spam



Protection from Spam

- Email security packages usually contain spam filters that:
  - Identify non-relevant communications
  - Use key words and phrases
  - May also use format, size, or ratio of graphics to text
  - Spam is moved to a separate folder or deleted from email server
  - May also block email addresses that are known to have sent spam, preventing further disruptive emails

Phishing

- Used for identity theft and fraud
- Posing as authorised emails from trustworthy institutions
- Attempt to get recipients to surrender personal information such as bank account details
- Most are aimed at individuals
- Some have targeted smaller businesses

Protection from Phishing

- Email security packages provide anti-phishing protection
- Combination of methods:
  - Authentication
  - Detection
  - Prevention
  - Reporting
- Enables threat analysis, attack prioritisation and response to minimise risk and impact of phishing

Spyware

- Enables hackers to record activities and data from the infected computer
- Done via a program that dynamically gathers information and transmits it via an Internet connection
- Often bundled in with shareware and freeware programs
- Usually installs and runs without user knowledge

Protection from Spyware

- Firewalls alone are insufficient
- Email security packages will scan devices regularly for spyware programs
- Blocks known spyware programs before they can be downloaded and installed

Email Authentication

- Aims to provide enough information to the recipient so that they know the nature of the email
- A valid identity on an email is a vital step in stopping spam, forgery, fraud, and other serious crimes
- SMTP was not designed with security in mind and thus had no formal verification of the sender
- Signing emails identifies the origin of a message, but not if it should be trusted

Authenticating Source IP Address

- TCP allows an email recipient to automatically verify the message sender’s IP address
- This does not verify the identity of the sender
- Forged headers can be used to create a spam message that appears to be real
- The sending IP address may belong to a zombie machine under the control of a hacker

Blacklisting IP Addresses

- The IP addresses originating spam and phishing emails can be blacklisted so that future email from them is not received but either quarantined or deleted
- Many IP addresses are dynamic
  - Change frequently
  - An organization has a block of IP addresses
  - IP addresses are allocated when needed
  - May get a new address every time a connection is made
- Therefore, spammer will not have a permanent IP address

Controlling Traffic

- Some ISPs use techniques to prevent spamming by their customers:
  - Port 25 can be blocked so that port 587 is used and that requires authentication
  - Limiting the number of received headers in relayed mail
  - Infected computers can be cleaned and patched
  - Outgoing email can be monitored for any sudden increase in flow or in content (a typical spam signature)

Other Email Threats

- So far we have not even mentioned the following issues:
  - Sensitive information transmitted unencrypted between mail server and client may be intercepted
  - All popular email communication standards default to sending usernames, passwords, and email messages unencrypted
  - Information within email messages may be altered at some point between the sender and recipient

Securing Email Content

- The next lecture deals with securing the content of email
- It will include the techniques for:
  - Digitally signing an email
  - Encrypting the content of an email
  - Encrypting the header of an email

Break

Topic 4:Email Security

Topic 4– Lecture 2:

PGB & S/MIME

Network Security and Cryptography

Cryptography in Email Systems

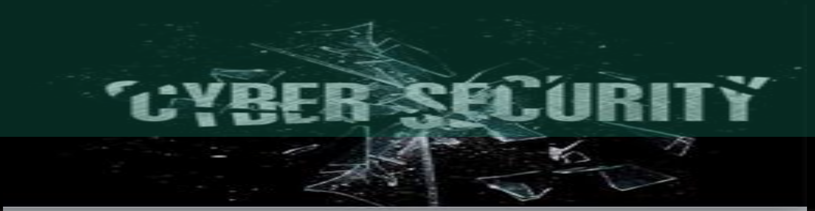
- Cryptography can be used in email to:
  - Sign an email message to ensure its integrity and confirm the identity of its sender
  - Encrypt the body of an email message to ensure its confidentiality
  - Encrypt the communications between mail servers to protect the confidentiality of both the message body and message header

Digitally Sign & Encrypt

- Signing a message and encrypting the body are often used together to provide authentication and privacy
- When a message needs to be encrypted to protect its confidentiality, it is usually digitally signed
  - so that the recipient can ensure the integrity of the message and also verify the identity of the signer
- Digitally signed messages are usually not encrypted if the confidentiality does not need to be protected

Encrypting Transmission

- Encrypting the transmissions between mail servers is used only when two organisations want to protect emails regularly sent between themselves
- The organisations could establish a virtual private network (VPN) to encrypt the communications between their mail servers over the Internet
- A VPN can be used encrypt entire messages including header information
  - E.g. senders, recipients, subject lines



Individual Emails

- Most email messages are protected individually rather than along a secure VPN
- Each message is protected by digitally signing and optionally encrypting it
- Widely used standards for signing and encrypting message bodies are:
  - Open Pretty Good Privacy (OpenPGP)
  - Secure/Multipurpose Internet Mail Extensions (S/MIME)

OpenPGP

- A protocol for encrypting and signing messages and creating certificates using public key cryptography
- Based on an earlier protocol, PGP
- First released in June 1991
- The original PGP protocol used some encryption algorithms with intellectual property restrictions
- OpenPGP was developed as a standard protocol based on PGP Version 5

OpenPGP Algorithms

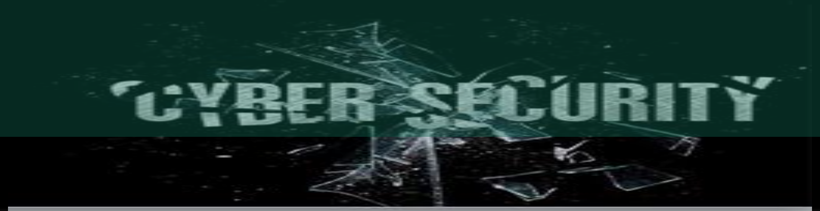
- A number of OpenPGP based products fully support cryptographic algorithms recommended by NIST including:
  - 3DES and AES for data encryption
  - Digital Signature Algorithm (DSA) and RSA for digital signatures
  - SHA for hashing
- Other implementations of OpenPGP support other encryption schemes

OpenPGP Cryptography

- OpenPGP use both public key cryptography and symmetric key cryptography
- Public key cryptography is used to create digitally signed message digests
- Encryption of the message body is performed using a symmetric key algorithm

OpenPGP – Signing & Encrypting - 1

- The plaintext is compressed
- A random session key is created
- A digital signature is generated for the message using the sender’s private key and then added to the message
- The message and signature are encrypted using the session key and a symmetric algorithm



OpenPGP – Signing & Encrypting - 2

- The session key is encrypted using the recipient’s public key and added to the encrypted message
- The encrypted message is sent to the recipient
- The recipient reverses these steps

Using OpenPGP

- Many popular mail clients require the installation of a plug-in in order to operate OpenPGP, e.g.:
  - Mozilla Thunderbird,
  - Apple Mail
  - Microsoft Outlook
- There are a number of OpenPGP distribution websites that contain instructions on how to use OpenPGP with various mail client applications

MIME

- Multipurpose Internet Mail Extensions - an Internet standard that extends the format of email to support:
  - Text that uses character sets other than ASCII
  - Attachments that are not text based
  - Message bodies with multiple parts
  - Header information in non-ASCII character sets

S/MIME

- Secure/MIME is a version of the MIME protocol
- It supports encryption of email messages and their contents via public-key encryption technology
- Created in 1995 by a group of software vendors to prevent interception and forgery of email
- Builds on the existing MIME protocol standard
- Is easily integrated into existing email products

S/MIME Functions

- Provides cryptographic security services for electronic messaging applications, including:
  - Authentication (via digital signatures)
  - Message integrity (via digital signatures)
  - Non-repudiation of origin (via digital signatures)
  - Privacy (using encryption)
  - Data security (using encryption)

S/MIME Interoperability

- Based on widely supported standards
  - likely to continue to be widely implemented across a variety of operating systems and email clients
- Is supported by many email clients and can be used to securely communicate between them
  - Not always simple
- For example, a Windows operating system user with the Outlook email client can send a secure, digitally signed email to a Unix operating system user without installing any additional software

S/MIME Certificates

- An individual key/certificate must be obtained from a Certificate Authority (CA)
- Accepted best practice is to use separate private keys for signature and encryption
  - permits escrow of the encryption key without compromise to the non-repudiation property of the signature key
- Encryption requires having the destination party's certificate stored

S/MIME Process

- S/MIME-enabled mail clients send messages in a similar way to OpenPGP
- S/MIME version 3.1 supports two recommended symmetric key encryption algorithms:
  - AES
  - 3DES
- AES is considered a stronger algorithm than 3DES

Key Management

- OpenPGP and S/MIME use digital certificates to manage keys
- A digital certificate identifies:
  - the entity that the certificate was issued to
  - the public key of the entity’s public key pair
  - other information, such as the date of expiration, signed by some trusted party
- There are differences in how the two protocols manage trust

Key Management in OpenPGP

- Uses the ***web of trust*** which has no central key issuing or approving authority:
  - The web of trust relies on the personal decisions of users for management and control
  - Suitable for individual users and very small organisations
  - Unworkable in most medium to large organisations
  - Some organisations deploy keyservers that users can access to get others’ keys and store their own keys

Key Management in S/MIME

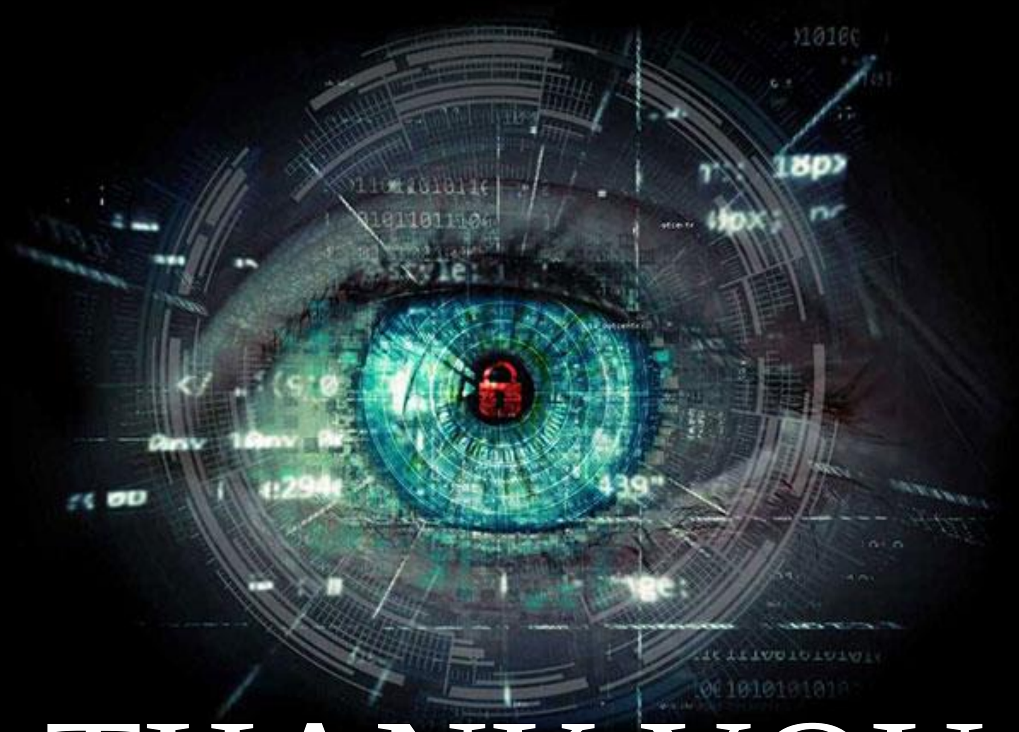
- Has a hierarchical structure:
  - Typically, there is a master registration and approving authority, the root Certificate Authority (CA), that issues a public key certificate for itself and any subordinate CAs
  - Subordinate CAs normally issue certificates to users and also to any other subordinate CAs
  - They in turn sanction to users and their subordinate CAs, forming a hierarchy
  - This public key infrastructure can be used to establish a chain of trust between two users holding valid certificates

Third Party Services

- Third-party services are available that allow organisations to exchange encrypted email
- Removes the need to establish trust relationships
- No worries about mail application compatibility
- But the use of such services means placing sensitive messages on third-party servers
  - This is also a security concern

References

- Stallings, W. (2010). *Cryptography and Network Security: Principles and Practice*. Pearson Education.
- NIST (2007). *Guidelines on Electronic Mail Security.* NIST.



THANK YOU

Any Question?

Topic4 – Email Security