Key Security Tools

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Firewalls

isolates organization's internal net from larger Internet
- some packets can pass through, others blocked

- Prevent DoS: SYN flooding, attacker establishes many fake TCP connections
- Prevent illegal access of internal data
- Allow only authorized access to inside network (authenticated users)

2 types of firewall: Application-level (also XML gateway)
Packet-filtering

Packet filtering

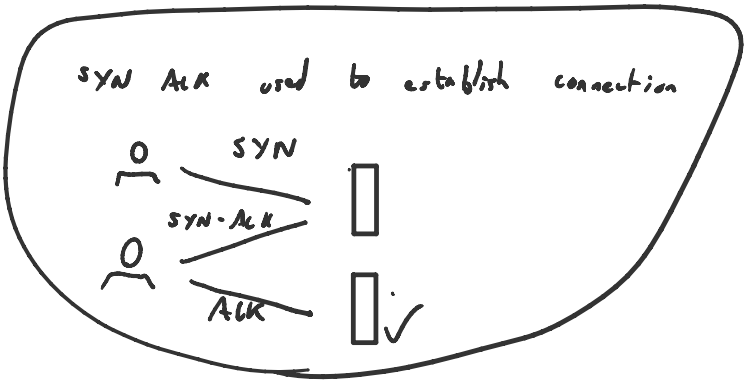
Decision to filter based on:
- source/destination IP
- TCP/UDP source + destination Port numbers
- ICMP message type
- TCP SYN and ACK bits

router firewall

should packet be allowed in/out?

ACK bit: acknowledge bit

Internet Control Message Protocol
- normally generated in response to errors in IP operations



Application Gateways

Filters packets on application data as well as IP/TCP/UDP

Example: only allow telephone network use to certain internal users
external

limitations of firewalls/gateways:
- IP spoofing, router can't really know claimed source
- each app needs own gateway
- filters often use all or nothing policy for UDP
- tradeoff = communication with outside world Vs security
- many highly protected sites still suffer from attacks

User Datagram Protocol
- can send messages to other IPs without prior communications to setup

XML Gateway

XML traffic passes through conventional firewall without inspection
- it passes through port 80 - generally left open

... traffic passes through conventional firewall without inspection
↳ it passes through port 80 - generally left open

Gateway examines XML payload, looking for:
- well formed payload
- no executable code
- source ID is known

Firewall State

Stateless - no concept of state
"packet filter" - less secure
- filters based on Layers 3 and 4 (IP, Port)

Stateful - have state tables to compare current packets with previous packets
- maybe slower than stateless
- Application firewalls can use Layer 7 information

Proxy firewalls - intermediary server
- terminate connections and initiate new ones
- two 3-way handshakes between 2 devices
↳ one with each device and firewall

Cryptography

Data in motion and data at rest - both need to be secure

Modern ciphers used modular math - XOR (exclusive or) is common

Stream cipher - bit by bit decryption/encryption

Block cipher - decrypt/encrypt many bits at a time i.e. 64-bit depends on algorithm

3 primary types

Symmetric - same key to encrypt and decrypt
- security depends on keeping key safe
- fast and key generally strong (bigger = stronger)
- Key needs to be shared using secure, out-of-band method
- examples: DES, Triples DES, AES

Asymmetric - 2 keys public and private
- one to encrypt one to decrypt
- uses "one way" algorithms to generate the two keys
↳ factoring prime numbers and discrete logarithm
- slower
- example: HTTPS uses asymetric encryption when first visiting site

Hash function - one way algorithm, no key
- variable-length "plaintext" $\xrightarrow{\text{hashed}}$ fixed length hash
- provides integrity verification

- variable-length "plaintext" → (hashed) fixed length hash
- provides integrity verification
- older algorithms prone to collisions - SHA-1, MD5
- SHA-2 is newer and recommended

Attacks

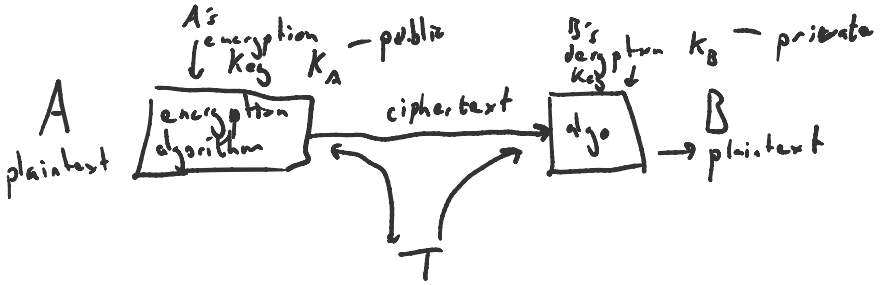
Brute force - trial and error

Rainbow tables - similar (faster) but using previously tried and known passes

Social engineering - non-technical methods to acquire from human

Known Plaintext - having plaintext and analysing to understand cipher

Known ciphertext - ↑ same but with only ciphertext



symmetric $K_A = K_B$

asymmetric $K_A \neq K_B$

A uses B's public key to encrypt and B uses their private key to decrypt

monoalphabetic cipher, replace one letter with another e.g. Caesar cipher

Foundational problem with symmetric cryptography is distribution of key

DES - Data encryption standard
- 56-bit symmetric key, 64 plaintext input
- how secure?
  - brute force decrypted in 4 months (could change every 3 months)
  - no known "backdoor" decryption approach
- make more secure?
  - use 3 DES sequentially
  - use cipher-block chaining

DES operation

16 identical permutations of applying function to different 48 bits of 64 bits

AES = Advanced encryption standard

replaced DES in 2011 - 64 → 128 bit blocks

256-bit key

brute force taking 1 sec for DES = 149 trillion years for DES

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Penetration Testing

White hat - ethical
- under contract and authorized

Gray hat - ethically motivated
- not authorized

Black hat - unethical
- money, politically, socially motivated

Threat actors (malicious actor)
- organization responsible for incident
- script kiddies (use available tools)
- hacktivists
- organized crime
- insiders (ex-employee)
- competitors
- Nation states - Fancy Bears aka APT28 (sophisticated highly funded)
  - Lazarus Group
  - Scarecrft aka Group 123
  - APT29

Methodologies:

OSSTMM
NIST - network security testing
FFIEC - financial
ISSAF
p-test - simple methodology

Vulnerability Assessment:

Vulnerability { Identify indicators
Exposure
Sensitivity
Adaptive capacity
Potential Impacts

automated process run on a regular basis

Digital Forensics:

Identification, recovery, investigation, validation of facts

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Identification, recovery, investigation, validation of facts

Digital evidence found on computers, phones, servers, hard drives

Locard's exchange principal
Criminal will take something but also leave something
↳ both = evidence

chain of custody: chronological documentation of custody of evidence
is required for evidence to be used legally in court

Tools: Faraday cage - blocks signals
Forensic laptops, cameras, power supply toolkit etc. } hardware

Volatility (opensource)
FTK
EnCase } paid
dd - bit by bit copier on Linux
Autopsy (the sleuth kit)
Bulk extractor
} software