IS 2150 / TEL 2810
Information Security & Privacy

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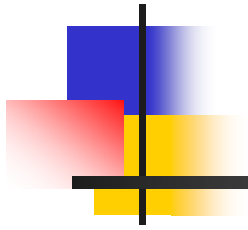
Lecture 8
March 16, 2016

Authentication, Identity

Objectives

- Understand/explain the issues related to, and utilize the techniques
  - Authentication and identification
  - Passwords

Authentication and Identity

What is Authentication?

- Authentication:
    - Binding identity and external entity to subject
- How do we do it?
    - Entity *knows* something (secret)
        - Passwords, id numbers
    - Entity *has* something
        - Badge, smart card
    - Entity *is* something
        - Biometrics: fingerprints or retinal characteristics
    - Entity is in *someplace*
        - Source IP, restricted area terminal

Authentication System: Definition

- *A*: Set of *authentication information*
  - used by entities to prove their identities (e.g., password)
- *C*: Set of *complementary information*
  - used by system to validate authentication information (e.g., hash of a password or the password itself)
- *F*: Set of *complementation functions* (to generate *C)*
  - *f* : *A* → *C*
  - Generate appropriate *c* ∈ *C* given *a* ∈ *A*
- *L*: set of *authentication functions*
  - *l*: *A* × *C* → { **true**, **false** }
  - verify identity
- *S*: set of *selection functions*
  - Generate/alter *A* and *C*
  - e.g., commands to change password

Authentication System: Passwords

- Example: plaintext passwords
  - $A = C =$ alphabet*
  - f returns argument: $f(a)$ returns a
  - l is string equivalence: $l(a, b)$ is true if $a = b$

- Complementation Function
  - Null (return the argument as above)
    - requires that c be protected; i.e. password file needs to be protected
  - One-way hash – function such that
    - *Complementary information $c = f(a)$ easy to compute*
    - $f^1(c)$ difficult to compute

Passwords

- Example: Original Unix
    - A password is up to eight characters
        - each character could be one of 127 possible characters;
    - *A* contains approx. 6.9×10^{16} passwords
    - Password is hashed using one of 4096 functions into a 11 character string
    - 2 characters pre-pended to indicate the hash function used
    - *C* contains passwords of size 13 characters, each character from an alphabet of 64 characters
        - Approximately 3.0×10^{23} strings
    - Stored in file */etc/passwd* (all can read)

Authentication System

- Goal: identify the entities correctly
- Approaches to protecting
  - Hide enough information so that one of a, c or f cannot be found
    - Make C readable only to root
    - Make F unknown
  - Prevent access to the authentication functions L
    - *root* cannot log in over the network

Attacks on Passwords

- Dictionary attack: Trial and error guessing
  - Type 1: attacker knows A, F, C
    - Guess g and compute $f(g)$ for each f in F
  - Type 2: attacker knows A, l
    - l returns **True** for guess g

- Counter: Difficulty based on $|A|$, Time
  - Probability P of breaking a password
  - G be the number of guesses that can be tested in one time unit
  - $|A| \geq TG/P$
  - Assumptions:
    - time constant; all passwords are equally likely

Password Selection

- Random
  - Depends on the quality of random number generator;
  - Size of legal passwords
    - 8 characters: humans can remember only one

- Pronounceable nonsense
  - Based on unit of sound (phoneme)
  - Easier to remember

- User selection (proactive selection)
  - Controls on allowable
    - At least 1 digit, 1 letter, 1 punctuation, 1 control character
    - Obscure poem verse

Password Selection

- Reusable Passwords susceptible to dictionary attack (type 1)
  - *Salting* can be used to increase effort needed
    - makes the choice of complementation function a function of randomly selected data
    - Random data is different for different user
    - Authentication function is chosen on the basis of the salt
    - Many Unix systems:
      - A salt is randomly chosen from 0..4095
      - Complementation function depends on the salt

Password Selection

- ## Password aging
  - Change password after some time: based on expected time to guess a password
  - Disallow change to previous n passwords
- ## Fundamental problem is *reusability*
  - Replay attack is easy
  - Solution:
    - Authenticate in such a way that the transmitted password changes each time

Authentication Systems: Challenge-Response

- Pass algorithm
  - authenticator sends message m
  - subject responds with $f(m)$
    - f is a secret encryption function
  - Example: ask for second input based on some algorithm

Authentication Systems: Challenge-Response

- One-time password: *invalidated after use*
  - *f* changes after use
- S/Key uses a hash function (MD4/MD5)
  - User chooses an initial seed k
  - Key generator calculates
    - $k_1 = h(k)$, $k_2 = h(k_1)$ ..., $k_n = h(k_{n-1})$
  - Passwords used in the order
    - $p_1 = k_n$, $p_2 = k_{n-1}$, ..., $p_n = k_1$
  - Suppose $p_1 = k_n$ is intercepted;
    - the next password is $p_2 = k_{n-1}$
    - Since $h(k_{n-1}) = k_n$, the attacker needs to invert h to determine the next password

Authentication Systems: Biometrics

- Used for human subject identification based on physical characteristics that are tough to copy
  - Fingerprint (optical scanning)
    - Camera's needed (bulky)
  - Voice
    - Speaker-verification (identity) or speaker-recognition (info content)
  - Iris/retina patterns (unique for each person)
    - Laser beaming is intrusive
  - Face recognition
    - Facial features can make this difficult
  - Keystroke interval/timing/pressure

Attacks on Biometrics

- Fake biometrics
  - fingerprint "mask"
  - copy keystroke pattern
- Fake the interaction between device and system
  - Replay attack
  - Requires careful design of entire authentication system