A6: Sensitive Data Exposure

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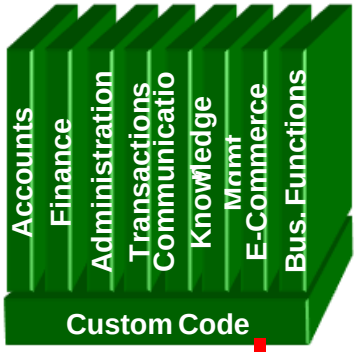
- Sensitive data stored or transmitted insecurely
  - Failure to protect all sensitive data
    - Usernames, passwords, password hashes, credit-card information, identity info
    - Session IDs, cookies
  - Failure to protect all places sensitive data gets stored
    - Databases, files, directories, log files, backups, etc.
  - Failure to protect all transmissions of sensitive data
    - Web, backend databases, business partners, internal communications

Example: Artifacts in source code

- Developers leaving secrets or tests in code
  - API keys inside git repositories
  - Comments by developers giving hints to hidden functionality (within HTML or code).

Example: Insecure Storage

1 Victim enters credit card number in form



2 Error handler logs CC details because merchant gateway is unavailable

3 Logs are accessible to all members of IT staff for debugging purposes

4 Malicious insider steals credit card numbers

Example: Insecure Transport

External Victim

Custom Code

Backend Systems

Business Partners

Employees

1

External attacker steals credentials and data off network

External Attacker

2

Internal attacker steals credentials and data from internal network

Internal Attacker

Target 2013 breach, $252 million

Example: Poor use of cryptography

- Weak algorithms (Base64, MD5, AES-ECB Mode, RC4/SSL 3.0)
- Poorly used algorithms
  - Pseudo-random number generators (PRNGs) with predictable seeds
  - Unsalted cryptographic hashes
- Examples
  - Guessable two-factor PIN codes
  - Guessable password resets (e.g. generated passwords, reset links)

A6 – Prevention

Verify architecture

- Ensure threat model accounts for possible attacks
- Encrypt everything
  - Encryption at rest
    - All sensitive data
    - All the places that data is stored
  - Encryption in flight
    - All times that data is communicated
  - Cloud providers
    - Default encryption at rest on most
    - Backend communication calls all encrypted
    - But, front-end is your responsibility (i.e. https)

Use algorithms appropriately

- Use standard strong algorithms
- Verify
  - All keys, certificates, and passwords are securely generated, distributed, stored, and protected
  - Effective plan for key change are in place
  - Audit code the utilizes encryption code for common flaws
    - (e.g. unsalted password hashes, uninitialized data)

Enable transport security

- Enable TLS for all connections
  - HSTS (HTTP Strict Transport Security)
  - HSTS Chrome preload list
    `http://src.chromium.org/viewvc/chrome/trunk/src/net/http/transport_security_state_static.json`
- Employ certificate and public key pinning
  - Key continuity to prevent rogue CA from redirecting your traffic
  - WoSign 8/2016
- Use the mechanisms correctly
  - Disable old SSL algorithms (Poodle)

http://www.owasp.org/index.php/Transport_Layer_Protection_Cheat_Sheet

Labs and homework

- Toy examples that don't require topics in CS 485/585 to perform
  - For more, take CS 485/585
  - Do the Matasano crypto challenges http://cryptopals.com

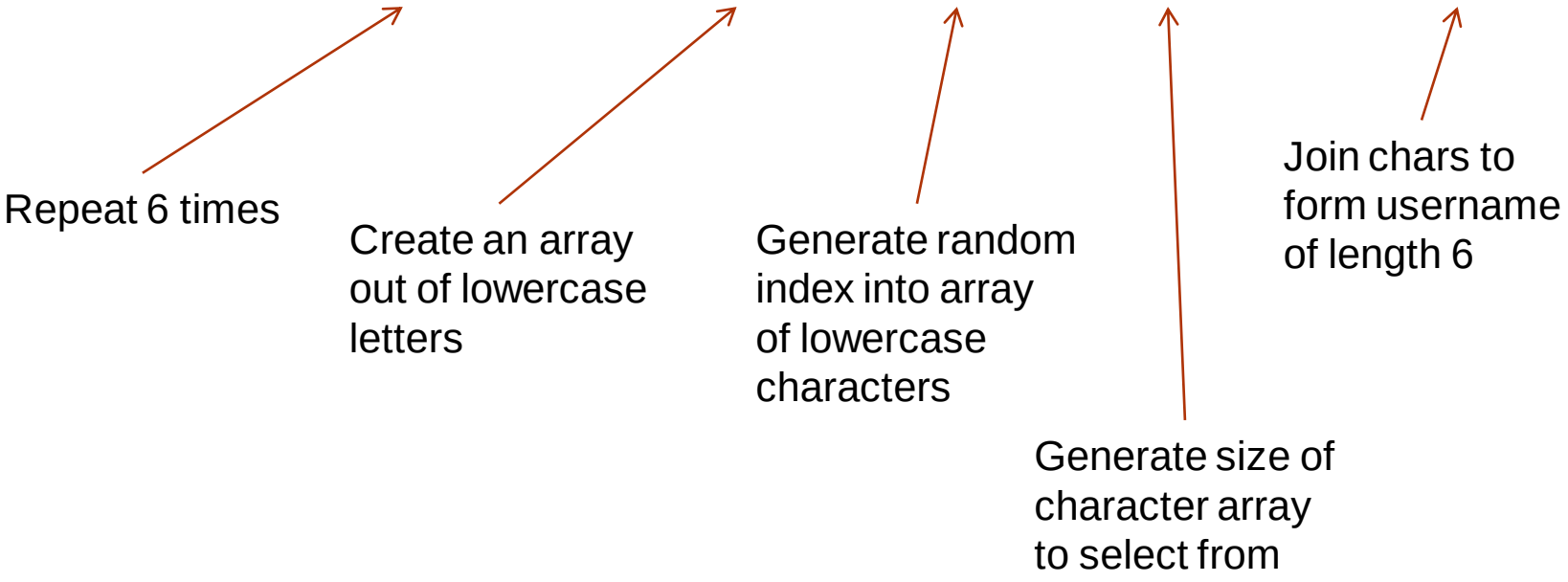
Lab Ruby walkthrough

- Break improper use of pseudo-random number generators to generate default passwords
  - Code uses Ruby to generate password
  - Seeds the random number generator with a constant
    - Random.new(seed)
  - Initial passwords are generated deterministically based on calls to the RNG
  - One generated password and the order in which it was generated is known
    - Attack
      - Brute-force all seeds until a generated password matches your known password
      - Reveals the seed
      - Use position of known passwords to deduce password of first (admin) user

Lab Ruby example

- Code to generate random usernames
- Find the seeds that produce "`vwywbw`" or "`jozfbe`" as random_name for the following code

```
s = Random.new(seed)
random_name = 6.times.map{('a'..'z').to_a[s.rand(('a'..'z').to_a.size)]}.join
```



Lab Ruby walkthrough

- Find the seeds that produce "`vwywbw`" or "`jozfbe`" as the first username
- Invoke program as

```
ruby InsecureCryptoStorage1.rb
```

```
s = Random.new(seed)

    # Use PRNG to generate username
    #   6.times -> Generate 6 random characters
    #   ('a'..'z').to_a -> Create array of lowercase letters
    #   [s.rand(('a'..'z').to_a.size] -> Index letter array with random number between 0,25
    random_name = 6.times.map{('a'..'z').to_a[s.rand(('a'..'z').to_a.size)]}.join
    print "Trying seed: ", seed, "\n"
    if (random_name == 'vwywbw') || (random_name == 'jozfbe')
        print "Found ",random_name," as first userid for seed: ",seed,"\n"
        print "MD5 hash of ",random_name," is ",Digest::MD5.hexdigest(random_name),"\n"
        seed=seed+1
    else
        seed=seed+1
    end
end
```

Other helpful Ruby constructs

- Bounded ‘do’ loops

```
10.times do |i|
    puts i
end
```

Before starting, do these two loops have the same output?

```
s = Random.new(0)
10.times do |i|
    print i," ",s.rand(100),"\n"
end
```

```
10.times do |i|
    s = Random.new(0)
    i.times{s.rand(100)}
    print i," ",s.rand(100),"\n"
end
```

Homework

- Insecure Cryptographic Storage Lesson
  - `echo -n Ym…GluZ0Zyb21Zb3U= | base64 -d`
- Insecure Cryptographic Storage Challenge #1
  - Reverse-engineer a simple rotation cipher
- Insecure Cryptographic Storage Challenge #2
  - Reverse-engineer a multi-alphabetic substitution cipher (Vigenere)
  - Use `nodejs` or Browser engine to execute JavaScript

Questions

- https://sayat.me/wu4f