CSE 484/M584: Computer Security (and Privacy)

Spring 2025

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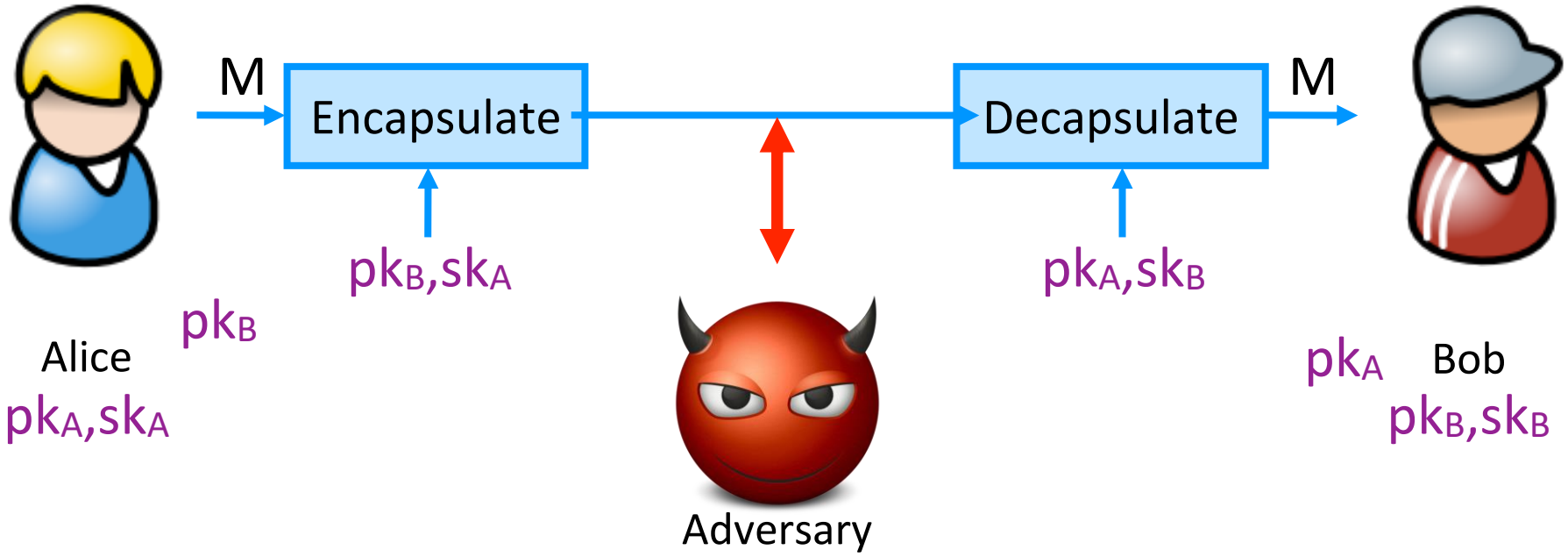
Admin

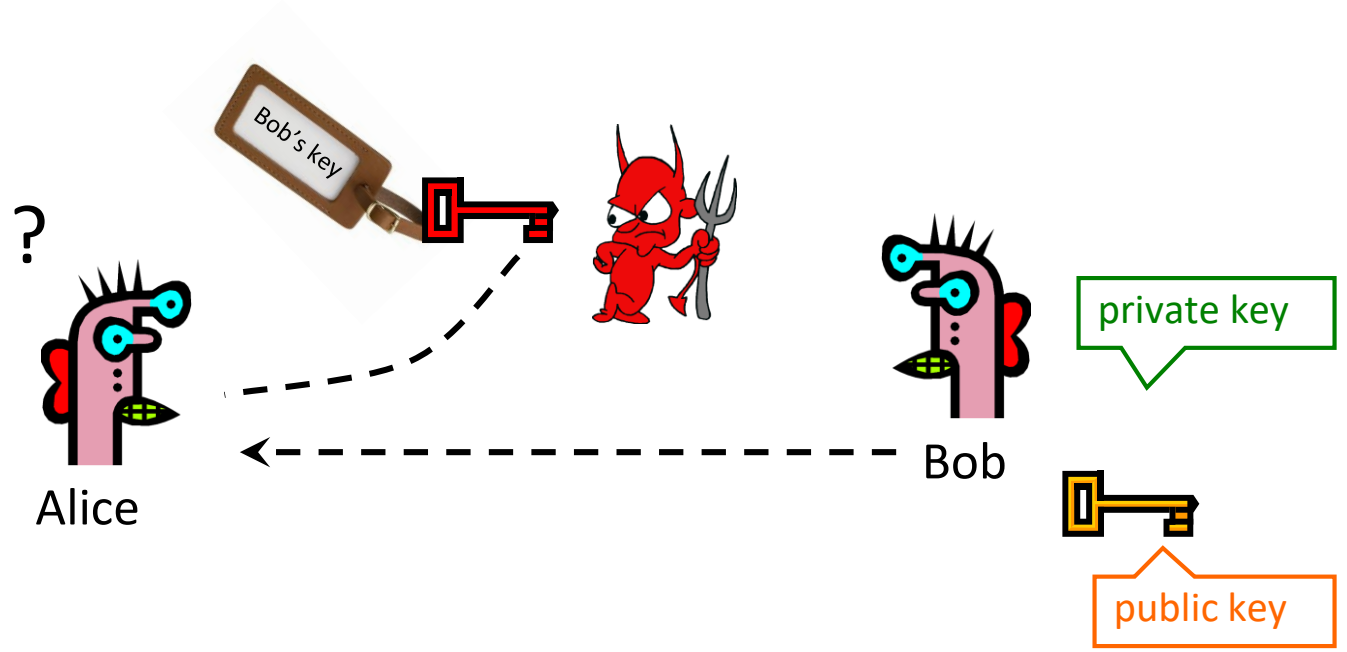
- Lab 2 (Cryptolab) this Wednesday

Asymmetric Setting

Each party creates a public key pk and a secret key sk.

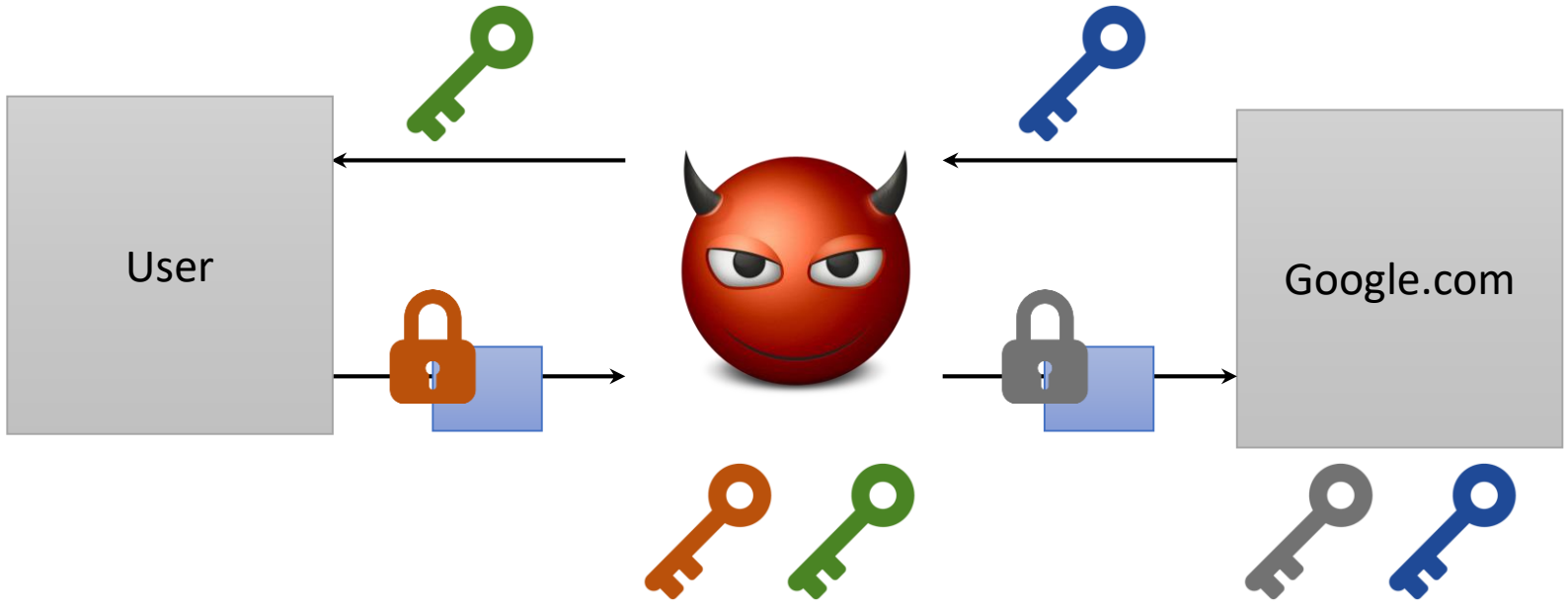


Authenticity of Public Keys



Problem: How does Alice know that the public key they received is really Bob's public key?

Person-in-the Middle/On-path-attacker



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  - Signed statement specifying the key and identity
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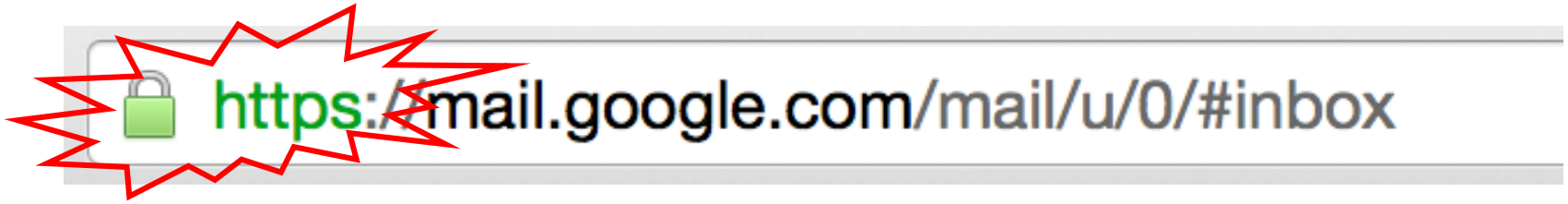
  - Additional information often signed as well (e.g., expiration date)

You encounter this every day…



SSL/TLS: Encryption & authentication for connections

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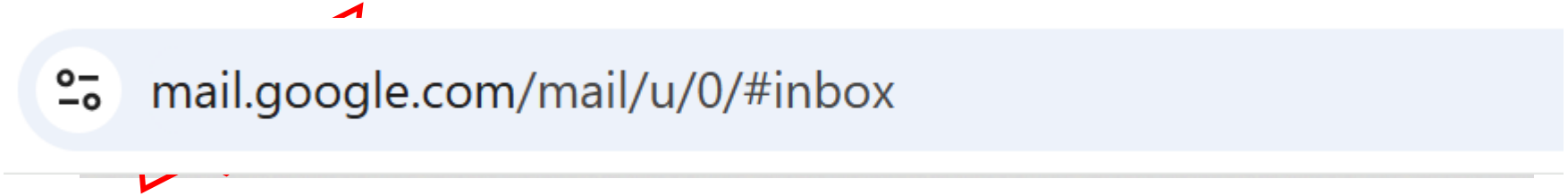

SSL/TLS: Encryption & authentication for connections

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David Koh

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Previously I was a pos
PhD with Hovav Shac

Google Scholar profile

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Office: CSE2 310

Research

My research interests
I put special focus on

Active projects include
Next generation micro
FPGA analog side-cha
The Keystone TEE fra

Teaching

Certificate Viewer: *.cs.washington.edu

General | Details

Issued To

Common Name (CN)	*.cs.washington.edu
Organization (O)	University of Washington
Organizational Unit (OU)	<Not Part Of Certificate>

Issued By

Common Name (CN)	InCommon RSA Server CA 2
Organization (O)	Internet2
Organizational Unit (OU)	<Not Part Of Certificate>

Validity Period

Issued On	Saturday, February 22, 2025 at 4:00:00 PM
Expires On	Monday, February 23, 2026 at 3:59:59 PM

SHA-256 Fingerprints

Certificate	41790008543f52c5f3b97bb5b62adeaa664525700d922b74e08f1e6463e9f511
Public Key	b6deb9fe86e5ce50840d964be61da32c8dcac5f0c1da00544790dcbf2582c3d9

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- **The approach: certificate authorities (CAs)**
  - Company/agency responsible for certifying public keys.
  - Provides certificates to anyone proving their identity.
  - $\text{Sign}(\text{“Bob”}||\text{PKB}, \text{SKCA})$
  - Certificate can then be handled *by the public key owner.*
  - Every computer is pre-configured with CA’s public key(s)

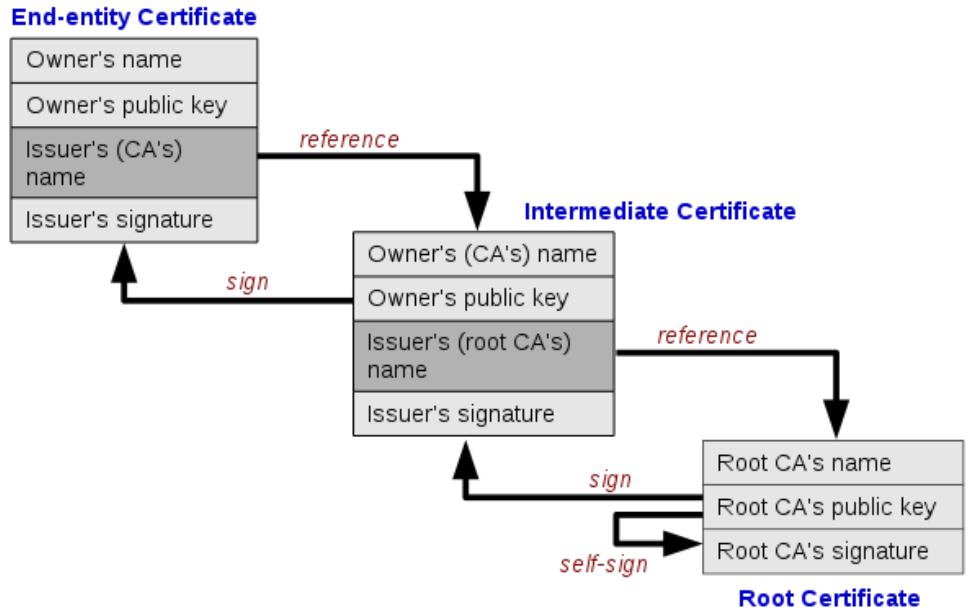
Certificate Authorities

- Many CAs
- Landscape has changed in the past decade
  - Old model: pay for certificates.
  - New model: certificates are free.

- How do they validate the owner of a domain?

Certificate Chains

- Single CA is impractical
- Instead, use *root* CAs who can delegate.
- Everybody must know the root's public key.
- Then use a certificate *chain*
  - sigVerisign("AnotherCA", PKAnotherCA), sigAnotherCA("Alice", PKA)
- Not shown in figure but important:
  - Each cert says "is this cert granting the ability to sign more certs?"



SSL/TLS High Level

- SSL/TLS consists of two protocols
  - Familiar pattern for key exchange protocols
- Handshake protocol
  - Use public-key cryptography to establish a shared secret key between the client and the server
- Record protocol
  - Use the secret symmetric key established in the handshake protocol to protect communication between the client and the server

Corporate CAs?

- Many corporations require that all company machines have an additional **Root Certificate** installed, owned and controlled by the company IT.
- This would allow the company to create a certificate for any website, service, etc. they want and have it trusted by any company machine. (But not by anyone else's).

- What does this let corporate IT do?
- Why might they want to do that?

Many Challenges…

- Weak security at CAs
  - Allows attackers to issue rogue certificates
- Users don’t notice when attacks happen
  - We’ll talk more about this later in the course
- How do you revoke certificates?

Rogue Certs

- In Jan 2013, a rogue *.google.com certificate was issued by an intermediate CA that gained its authority from the Turkish root CA TurkTrust
  - TurkTrust accidentally issued intermediate CA certs to customers who requested regular certificates
  - Ankara transit authority used its certificate to issue a fake *.google.com certificate in order to filter SSL traffic from its network
- This rogue *.google.com certificate was trusted by every browser in the world

Bad CAs

- DarkMatter (https://groups.google.com/g/mozilla.dev.security.policy/c/nnLVNfqgz7g/m/TseYqDzaDAAJ and https://bugzilla.mozilla.org/show_bug.cgi?id=1427262)
  - Security company wanted to get CA status
  - Questionable practices

- Symantec! (https://wiki.mozilla.org/CA:Symantec_Issues)
  - Major company, regular participant in standards
  - Poor practices, mismanagement 2013-2017
  - CA distrusted in Oct 2018

- Recall: How can we trust the CAs? What happens if we can't?

Certificate Revocation

- Revocation is very important

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- Many valid reasons to revoke a certificate
  - Private key corresponding to the certified public key has been compromised
  - User stopped paying their certification fee to this CA and CA no longer wishes to certify them
  - CA's private key has been compromised!

How do we revoke a certificate?

- Scenario:
  - Web browsers connect to website X, get certificate from X.
  - They validate that the certificate was signed by some CA C.
  - C wants to revoke the certificate, X is not necessarily responsive.
  - Consider both security and efficiency…

  Gradescope!

Certificate Revocation Mechanisms

- Certificate revocation list (CRL)
  - CA periodically issues a signed list of revoked certificates
    - Credit card companies used to issue thick books of canceled credit card numbers
  - Can issue a “delta CRL” containing only updates
- Online revocation service
  - When a certificate is presented, recipient goes to a special online service to verify whether it is still valid
    - Like a merchant dialing up the credit card processor

Modern revocation (for TLS certificates)

- Give up.

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- Give up.

- New CABForum rules, passed recently:

- Expand Section 4.2.1 to detail the allowed data reuse periods for validation data (both for domains/IPs and for everything else in Section 3.2)
  - Eventual reduction of non-SAN validation data reuse from **825 to 398 days**
  - Eventual reduction of SAN validation data reuse from **398 days to 10 days**
- Expand Section 6.3.2 to detail a schedule for reducing Public TLS certificate maximum validity periods in coming years
  - Eventual reduction of maximum validity period from **398 days to 47 days**
- These reductions are proposed to occur starting in March 2026 and concluding in March 2029

Attempt to Fix CA Problems:

Certificate Transparency

- **Problem:** browsers will think nothing is wrong with a rogue certificate until revoked
- **Goal:** make it impossible for a CA to issue a bad certificate for a domain *without the owner of that domain knowing*
- **Approach:** auditable certificate logs
  - Certificates published in public logs
  - Public logs checked for unexpected certificates

www.certificate-transparency.org

Next Major Topic!

Web+Browser Security