CSE 484 / CSE M 584

Computer Security: More Cryptography

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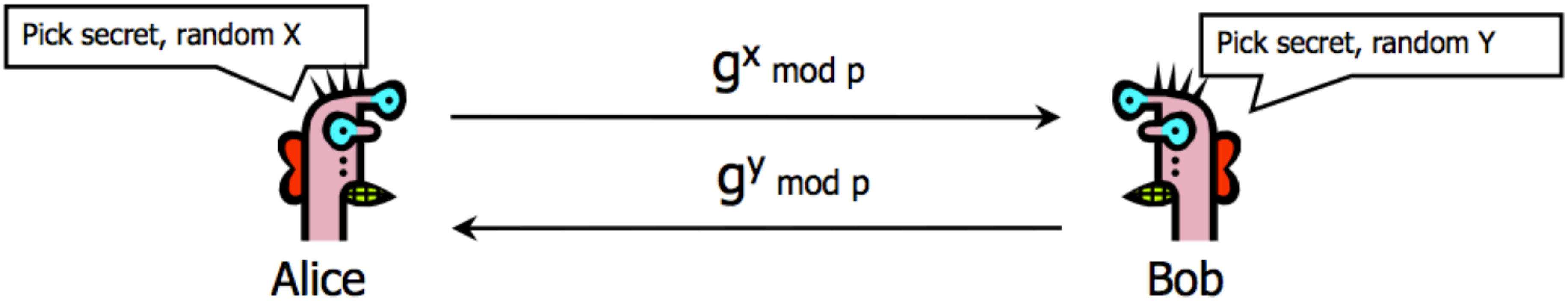
Logistics

- Lab 1 Final due TOMORROW (5pm).
- Office hours: tomorrow at 10:30am (Ian).
- For quickest response from TAs before 5pm tomorrow, email all of us:

  cse484-tas@cs.washington.edu
- Check forum for some tips.
- Homework #2 out now (crypto), due on Friday, 2/22, 5pm.

DH Summary



Compute $k=(g^y)^x=g^{xy}$ mod p

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- Public info: p (large prime) and
  g (generator of Z_p^*)

$Z_p^*=\{1, 2 \ldots p-1\}$; $\forall a \in Z_p^*$ $\exists i$ such that $a=g^i$ mod p

RSA Summary

- Key generation
  - Generate large primes p, q
    - Say, 1024 bits each (need primality testing, too)
  - Compute $n = pq$ and $\varphi(n) = (p-1)(q-1)$
  - Choose small e, relatively prime to $\varphi(n)$
  - Compute unique d such that $ed = 1 \bmod \varphi(n)$
  - Public key = (e,n); private key = (d,n)
- Encryption of m: $c = m^e \bmod n$
  - Modular exponentiation by repeated squaring
- Decryption of c: $c^d \bmod n = (m^e)^d \bmod n = m$

Sample RSA Decryption

- 26 2 15 13   7 14 13 13 1 28 14   15 13 14 20 9 6 31 25 26 14 16   23 15 26 2   6 13 1
- p=3, q=11, n=33, e=7, d=3

- A-1 B-2 C-3 D-4 E-5 F-6 G-7 H-8 I-9 J-10 K-11 L-12 M-13 N-14 O-15 P-16 Q-17 R-18 S-19 T-20 U-21 V-22 W-23 X-24 Y-25 Z-26

Sample RSA Decryption

- How to compute d?
  - Recall: $ed = 1 \bmod \varphi(n)$ (where $\varphi(n) = (p-1)(q-1)$)
  - So d is inverse of e mod φ(n).
  - How to compute modular inverse?
    - Use extended Euclidean algorithm
    - … or Wolfram Alpha ☺
    - Note that this is hard if you don't know φ(n) (i.e., can't factor n).

Public Key Crypto Summary

- Diffie-Hellman: Why is it secure?
  - Discrete log; computational DH problem; decisional DH problem are hard.
- RSA: Why is it secure?
  - Taking e^{th} root is hard; Factoring is hard.

Cryptography Summary

- Goal: Privacy
  - One-time pad
  - Block ciphers w/ symmetric keys (e.g., DES, AES)
    - Modes: EBC, CBC, CTR
  - Public key crypto (e.g., Diffie-Hellman, RSA)
- Goal: Integrity
  - MACs, often using hash functions (e.g, MD5, SHA-256)
- Goal: Privacy and Integrity
  - Encrypt-then-MAC (why?)
- Goal: Authenticity (and Integrity)
  - Digital signatures (e.g., RSA, DSS)

Certificate Authorities

- CAs sign certificates; root CAs can authorize intermediate CAs (certificate chains).
- Problems with this model?
- Ideas for alternate solutions?
  - Examples: Perspectives (http://perspectives-project.org/), Convergence (http://convergence.io/)
    - Both rely on notary servers (chosen by the user): browser checks certificates it sees against those seen over time by trusted notaries. How does this help?

SSL Strip Attack

[Figure omitted from online version of slides.]

[Figures thanks to Elie Bursztein. See also http://www.thoughtcrime.org/software/sslstrip/.]

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SSL User Interface Attacks

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