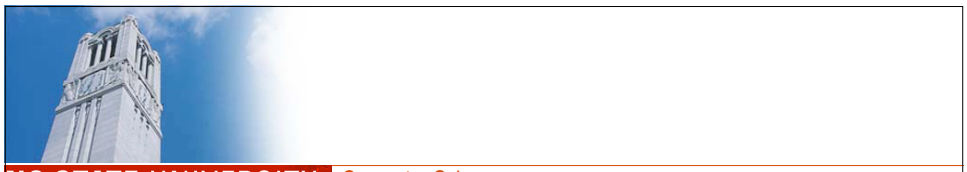


NC STATE UNIVERSITY Computer Science

CSC 774 -- Network Security

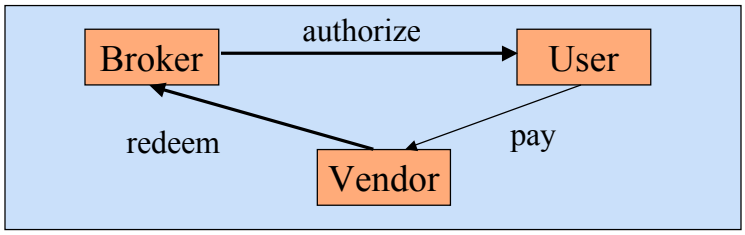
Topic 4.2: MicroPayments

Outline

- Micropayment systems
  - Make small purchase over the Internet
- Two simple micropayment schemes
  - PayWord
  - MicroMint

PayWord and MicroMint

- Mail goal
  - Minimize the number of public key operations
  - Use hash operations instead whenever possible
    - Hash functions are
      - 100 times faster than RSA signature verification
      - 10,000 times faster than RSA signature generation



PayWord

- Overview
  - Credit based scheme
  - Based on chains of paywords (hash values)
  - Broker gives a certificate to user to allow him/her to make paywords
  - User authenticates a complete chain to the vendor with a single public-key signature
  - User successively reveals each payword in the chain to make micropayment
  - Vendor gets money through broker.

PayWord (Cont'd)

- User-Broker relationship
  - User U establishes an account with broker B
    - Credit card number, expiration date, etc.
  - Broker B gives user U a certificate
    - Expiration date
    - Credit limit per vendor
    - Contact information of broker B
    - …
  - The certificate:
    - B will redeem authentic paywords produced by U turned in before the given expiration date.
    - Essentially allows U to produce paywords.

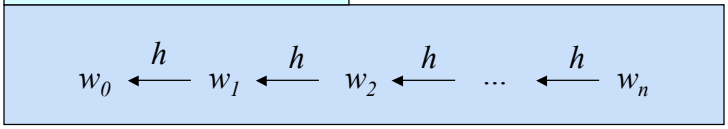
PayWord (Cont'd)

- User-Vendor relationships
  - Randomly choose w_n, and compute the paywords
  - User U sends Vender V her commitment

$$M=\{V, C_U, w_0, D, I_M\}_{SK_U}$$

  - Commitment is vendor-specific and user-specific

h: one-way hash function



PayWord (Cont'd)

- Payment
  - A payment P from U to V
  - P = (w_i, i)
  - U spends her paywords in order
  - Variable-size payment
    - Example: U has just paid (w_3, 3). What should U send to V if she wants to pay 3 more cents?
    - (_____, _____)

PayWord (Cont'd)

- Vendor-Broker relationship
  - For each User U, Vender V needs to send Broker B
    - The commitment C_U
    - The last payment P=(w_l, $_1$) received from U
  - Broker verifies C_U and each payment P=(w_l, $_1$)
  - Questions:
    - What's the cost of verifying P=(w_l, $_1$) ?
      - _____
    - What property(ies) of the hash function is used in PayWord?
      - _____

MicroMint

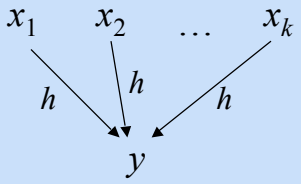
- Overview
  - No public key operations
  - For unrelated low-value payments
  - Broker produces MicroMint coins
    - A coin is a bit string whose validity can be checked by anyone
  - Users purchase the coins
  - Users give the coins to vendors as payments
  - Vendors return coins to broker in turn for payments by other means.

MicroMint (Cont'd)

- Coins
  - Each coin is represented by a k-way collision that has distinct x_i's.
  - The number of x-values that must be examined before one expects to see the first k-way collision is approximately
    - $2^{n(k-1)/k}$, where n is the number of bits in y.

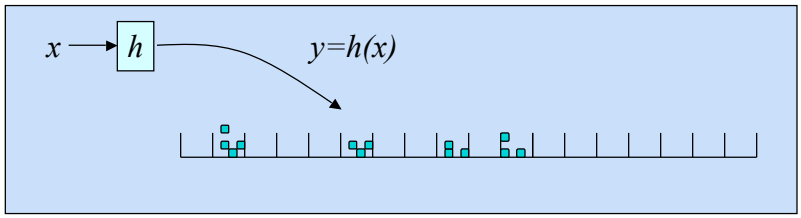
$(x_1, x_2, \ldots, x_k)$: k-way collision

$h(x_1)=h(x_2)=\ldots=h(x_k)=y$



MicroMint (Cont'd)

- Minting coins
  - Equivalent to throwing balls into 2^n bins
    - Randomly select x, and compute y=h(x).
  - Throw approximately $k*2^n$ balls
    - Roughly 1/2 of the bins have at least k balls.



MicroMint (Cont'd)

- Minting coins
  - Question: If there are more than k x's in the same bin, can we make more than one coin out of it?
    - _____
  - Balance computational and storage requirements
    - Good coins: a coin is good only when the high-order t bits are equal to a given value.
    - Reduce the storage requirements
    - Slow down the generation process
      - Tosses $k*2^n$ balls, but get $(1/2)*2^{(n-t)}$ coins.

MicroMint (Cont'd)

- Selling coins
  - Broker B remembers what coins User U gets
- Making payments
  - Vendor V can verify each coin
- Redemption
  - Vendor returns the coins to the broker
  - Broker checks coins and pays the vendor
    - Only pay for coins that have not been previously returned.

MicroMint (Cont'd)

- Double spending
  - Broker can detect doubly-spent coin
  - Broker can identify from which vendors he received such coins
  - Broker can link the doubly-spent coins with each user