L13: Identify and Anonymity on the Web

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Acknowledgement

- Many slides are from or are revised from the slides of the author of the textbook
  - Matt Bishop, Introduction to Computer Security, Addison-Wesley Professional, October, 2004, ISBN-13: 978-0-321-24774-5. Introduction to Computer Security @ VSU's Safari Book Online subscription
  - http://nob.cs.ucdavis.edu/book/book-intro/slides/

Outline

- Identity on the Web
  - hosts and domains
  - state and cookies
- Anonymity on the Web

Host Identity

- Host not connected to any networks
  - Pick any names; names are local
- Host connected to networking
  - Bound up to networking
  - One or more names depending on interfaces, network structure, and *context*

Example Context of Naming & Addressing

- ISO/OSI 7 model
  - A context for the issue of naming & addressing
- 7-layer model
  - Principals exist at each layer, and communicate with peers
  - A principal can have different names (or addresses) at a host
    - MAC layer
      - Ethernet address: 00:05:02:6B:A8:21
    - Network layer
      - IP address: 150.174.33.15
    - Transport layer
      - Host name: www.vsu.edu

Name and Address

- *Name* identifies principal
- *Address* identifies location of principal
  - May be virtual location (network segment) as opposed to physical location (room 222)
- In the context networking, a location often identifies a principal

Danger of Spoofing

- Attacker spoofs identity of another host
  - Protocols at and above the layer where the identity being spoofed will fail
  - Those protocols rely on spoofed, and hence faulty, information
- Example: spoof IP address, mapping between host names and IP addresses

Static and Dynamic Host Identifiers

- Static identifiers
  - Do not change over time
- Dynamic identifiers
  - Changes as a result of an event or the passing of time
- Databases contains mappings between different names

Example Name Mapping: Domain Name Server

- Maps transport identifiers (host names) to network identifiers (host addresses)
  - Forward records: host names → IP addresses
  - Reverse records: IP addresses → host names
- Weak authentication
  - Not cryptographically based
  - Various techniques used, such as reverse domain name lookup

Example Name Mapping: Reverse Domain Name Lookup

- Validate identity of peer (host) name
  - Get IP address of peer
  - Get associated host name via DNS
  - Get IP addresses associated with host name from DNS
  - If first IP address in this set, accept name as correct; otherwise, reject as spoofed
- If DNS corrupted, this will not work

Domain Names: Example

```
$ dig www.google.com

; <<>> DiG 9.9.5-3ubuntu0.5-Ubuntu <<>> www.google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 54988
;; flags: qr rd ra; QUERY: 1, ANSWER: 5, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; MBZ: 0005 , udp: 4000
;; QUESTION SECTION:
;www.google.com.                IN      A

;; ANSWER SECTION:
www.google.com.     5   IN   A    74.125.228.244
www.google.com.     5   IN   A    74.125.228.240
www.google.com.     5   IN   A    74.125.228.243
www.google.com.     5   IN   A    74.125.228.241
www.google.com.     5   IN   A    74.125.228.242

;; Query time: 5 msec
;; SERVER: 192.168.101.2#53(192.168.101.2)
;; WHEN: Mon Nov 16 09:22:12 EST 2015
;; MSG SIZE  rcvd: 123
```

```
$ dig -x 74.125.228.244

; <<>> DiG 9.9.5-3ubuntu0.5-Ubuntu <<>> -x 74.125.228.244
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 34185
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; MBZ: 0005 , udp: 4000
;; QUESTION SECTION:
;244.228.125.74.in-addr.arpa.   IN      PTR

;; ANSWER SECTION:
244.228.125.74.in-addr.arpa. 5  IN      PTR     iad23s24-in-f20.1e100.net.

;; Query time: 49 msec
;; SERVER: 192.168.101.2#53(192.168.101.2)
;; WHEN: Mon Nov 16 09:23:16 EST 2015
;; MSG SIZE  rcvd: 95
```

Dynamic Identifiers

- Assigned to principals for a limited time
  - Server maintains pool of identifiers
  - Client contacts server using *local identifier*
    - Only client, server need to know this identifier
  - Server sends client *global identifier*
    - Client uses global identifier in other contexts, for example to talk to other hosts
    - Server notifies intermediate hosts of new client, global identifier association

Example Dynamic Identifiers: DHCP

- DHCP: Dynamic Host Configuration Protocol
- DHCP server has pool of IP addresses
- Laptop sends DHCP server its MAC address, requests IP address
  - MAC address is local identifier
  - IP address is global identifier
- DHCP server sends unused IP address
  - Also notifies infrastructure systems of the association between laptop and IP address
- Laptop accepts IP address, uses that to communicate with hosts other than server

Example Dynamic Identifiers: Network Gateways

- Laptop wants to access host on another network
  - Laptop's address is 10.1.3.241
- Gateway assigns legitimate address to internal address
  - Say IP address is 101.43.21.241
  - Gateway rewrites all outgoing, incoming packets appropriately
  - Invisible to both laptop, remote peer
- Internet protocol NAT works this way

Weak Authentication

- Static: host/name binding fixed over time
- Dynamic: host/name binding varies over time
  - Must update reverse records in DNS
    - Otherwise, the reverse lookup technique fails
  - Cannot rely on binding remaining fixed unless you know the period of time over which the binding persists

DNS Security Issues

- Trust is that name/IP address binding is correct
- Goal of attacker: associate incorrectly an IP address with a host name
  - Assume attacker controls name server, or can intercept queries and send responses

Attacks on Domain Name Services

- Change records on server
- Add extra record to response, giving incorrect name/IP address association
  - Called “cache poisoning”
- Attacker sends victim request that must be resolved by asking attacker
  - Attacker responds with answer plus two records for address spoofing (1 forward, 1 reverse)
  - Called “ask me”

State and Cookies on the Web

- Client or server often needs to main state to simplify transaction process
- Cookie
  - Token containing information about state of transaction on network
- Usual use of Cookie
  - refers to *state* of interaction between web browser, client
  - Idea is to minimize storage requirements of servers, and put information on clients
  - Cookie consist of several *values*

Some Fields in Cookies

- *name*, *value*: name has given value
- *expires*: how long cookie valid
  - Expired cookies discarded, not sent to server
  - If omitted, cookie deleted at end of session
- *domain*: domain for which cookie intended
  - Consists of last *n* fields of domain name of server
  - *Must* have at least one "." in it
- *secure*: send only over secured (SSL, HTTPS) connection

Cookie: Example

- Caroline puts 2 books in shopping cartcart at books.com
  - Cookie: *name* bought, *value* BK=234&BK=8753, *domain* .books.com
- Caroline looks at other books, but decides to buy only those
  - She goes to the purchase page to order them
- Server requests cookie, gets above
  - From cookie, determines books in shopping cart

Who Can Get the Cookies?

- Web browser can send *any* cookie to a web server
  - Even if the cookie's domain does not match that of the web server
  - Usually controlled by browser settings
- Web server can *only* request cookies for its domain
  - Cookies need not have been sent by that browser

Where Did the Visitor Go?

- Server books.com sends Caroline 2 cookies
  - First described earlier
  - Second has *name* “id”, *value* “books.com”, *domain* “adv.com”
- Advertisements at books.com include some from site adv.com
  - When drawing page, Caroline’s browser requests content for ads from server “adv.com”
  - Server requests cookies from Caroline’s browser
  - By looking at *value*, server can tell Caroline visited “books.com”

Anonymity on the Web

- Recipients can determine origin of incoming packet
  - Sometimes not desirable
- Anonymizer: a site that hides origins of connections
  - Usually a proxy server
    - User connects to anonymizer, tells it destination
    - Anonymizer makes connection, sends traffic in both directions
  - Destination host sees only anonymizer

Example: *anon.penet.fi*

- Offered anonymous email service
  - Operated by Johan Helsingius in Finland 1993 – 1996
    - See https://w2.eff.org/Privacy/Anonymity/960830_penet_closure.announce and http://waste.informatik.hu-berlin.de/Grassmuck/Texts/remailer.html
  - Sender sends letter to it, naming another destination
  - Anonymizer strips headers, forwards message
    - Assigns an ID (say, 1234) to sender, records real sender and ID in database
    - Letter delivered as if from anon1234@anon.penet.fi
  - Recipient replies to that address
    - Anonymizer strips headers, forwards message as indicated by database entry

Problem

- Anonymizer knows who sender and recipient *really* are
- Called *pseudo-anonymous remailer* or *pseudonymous remailer*
  - Keeps mappings of anonymous identities and associated identities
- If you can get the mappings, you can figure out who sent what

More *anon.penet.fi*

- Material claimed to be copyrighted sent through site
- Finnish court directed owner to reveal mapping so plaintiffs could determine sender
- Owner appealed, subsequently shut down site

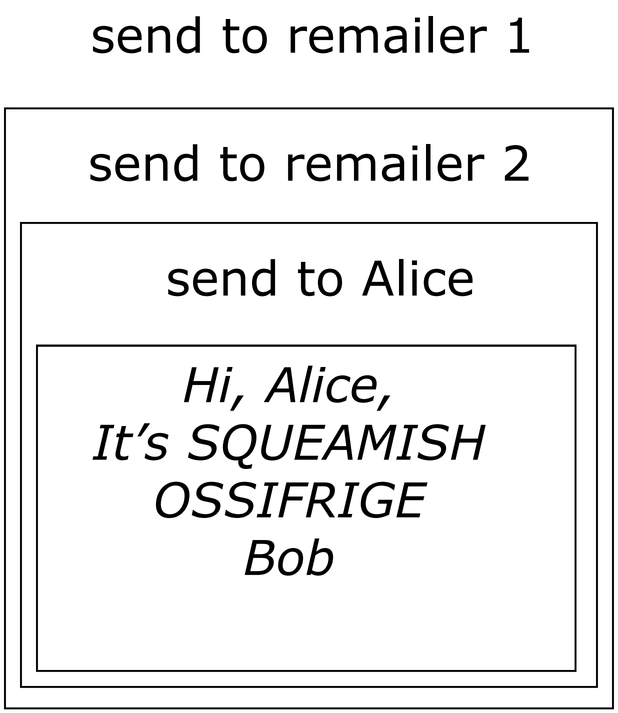
Cypherpunk Remailer

- See http://www.cypherpunks.to/remailers/
- Remailer that deletes header of incoming message, forwards body to destination
- Also called *Type I Remailer*
- No record kept of association between sender address, remailer's user name
  - Prevents tracing, as happened with *anon.penet.fi*
- Usually used in a chain, to obfuscate trail
  - For privacy, body of message may be enciphered

Cypherpunk Remailer Message

- Encipher message
- Add destination header
- Add header for remailer *n*

  …
- Add header for remailer 2


send to remailer 1

send to remailer 2

send to Alice

Hi, Alice,
It's SQUEAMISH
OSSIFRIGE
Bob

Weaknesses

- Attacker monitoring entire network
  - Observes in & out flows of remailers
  - Goal is to associate incoming & outgoing messages
- If messages are clear text, trivial
  - So assume all messages enciphered
- So use traffic analysis!
  - Used to determine information based simply on movement of messages (traffic) around the network

Attacks

- If remailer forwards message before next message arrives, attacker can match them up
  - Hold messages for some period of time, greater than the message interarrival time
  - Randomize order of sending messages, waiting until at least *n* messages are ready to be forwarded
    - Note: attacker can force this by sending *n*–1 messages into queue

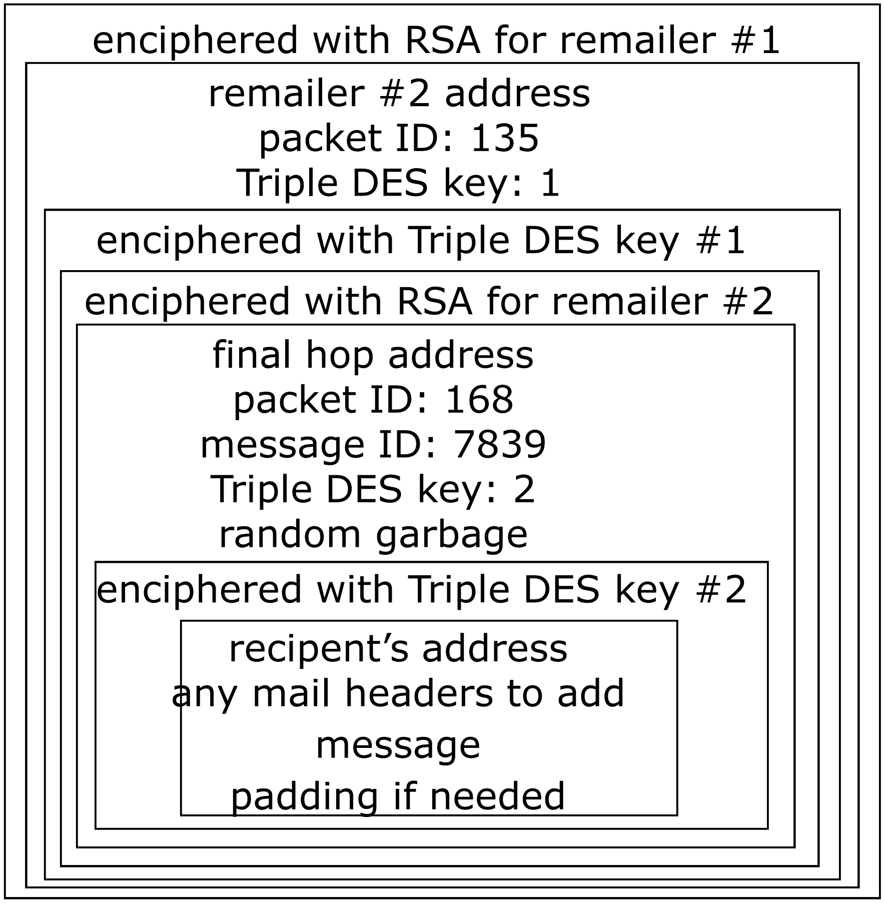
Attacks

- As messages forwarded, headers stripped so message size decreases
  - Pad message with garbage at each step, instructing next remailer to discard it
- Replay message, watch for spikes in outgoing traffic
  - Remailer can’t forward same message more than once

Mixmaster Remailer

- See http://mixmaster.sourceforge.net/
- Cypherpunk remailer that handles only enciphered mail and pads (or fragments) messages to fixed size before sending them
- Designed to hinder attacks on Cypherpunk remailers
  - Messages uniquely numbered
  - Fragments reassembled *only* at last remailer for sending to recipient
- Also called Type II Remailer

Cypherpunk Remailer Message



enciphered with RSA for remailer #1

remailer #2 address
packet ID: 135
Triple DES key: 1

enciphered with Triple DES key #1

enciphered with RSA for remailer #2

final hop address
packet ID: 168
message ID: 7839
Triple DES key: 2
random garbage

enciphered with Triple DES key #2

recipent’s address
any mail headers to add
message
padding if needed

HTTP over TLS

- Encrypt the traffic
- Hide the portion of the website you are visiting
- HTTP Everywhere project
  - The Electronics Frontier Foundation
  - https://www.eff.org/https-everywhere

Tor

- Hide identity in a *crowd*
- Connecting through a series of virtual tunnels via Onion routers
- https://www.torproject.org

Anonymity

- Some purposes for anonymity
  - Removes personalities from debate
  - With appropriate choice of pseudonym, shapes course of debate by implication
  - Prevents retaliation
- Are these benefits or drawbacks?
  - Depends on society, and who is involved

Privacy

- Anonymity protects privacy by obstructing amalgamation of individual records
- Important, because amalgamation poses 3 risks:
  - Incorrect conclusions from misinterpreted data
  - Harm from erroneous information
  - Not being let alone
- Also hinders monitoring to deter or prevent crime
- Conclusion: anonymity can be used for good or ill
  - Right to remain anonymous entails responsibility to use that right wisely

Summary

- Identity specifies a principal (unique entity)
  - Same principal may have many different identities
    - Function (role)
    - Associated principals (group)
    - Individual (user/host)
  - These may vary with view of principal
    - Different names at each network layer, for example
  - Anonymity possible; may or may not be desirable
    - Power to remain anonymous includes responsibility to use that power wisely