Security

CS499/579 :: Empirical Computer Security

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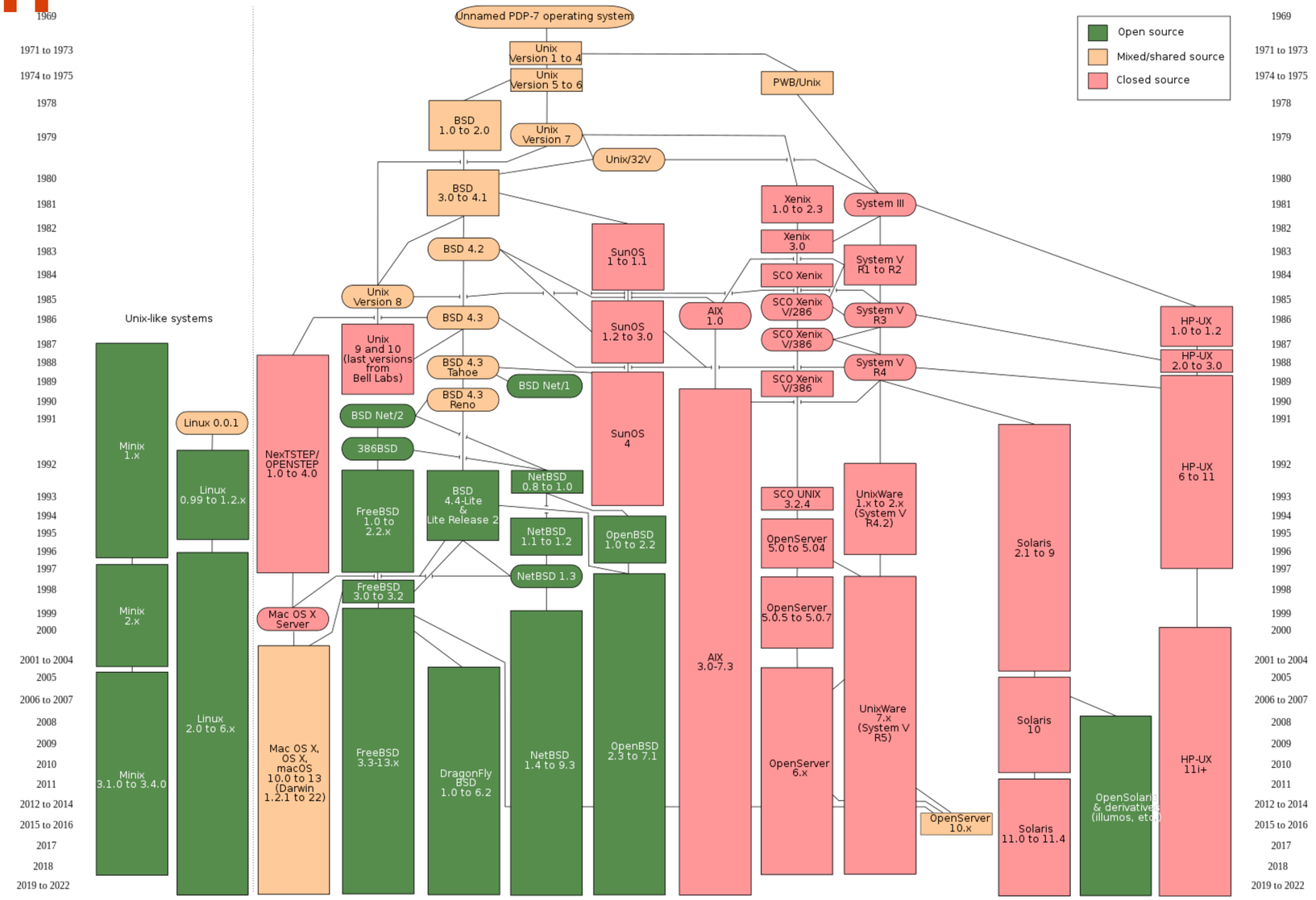
2023.10.09

Topics

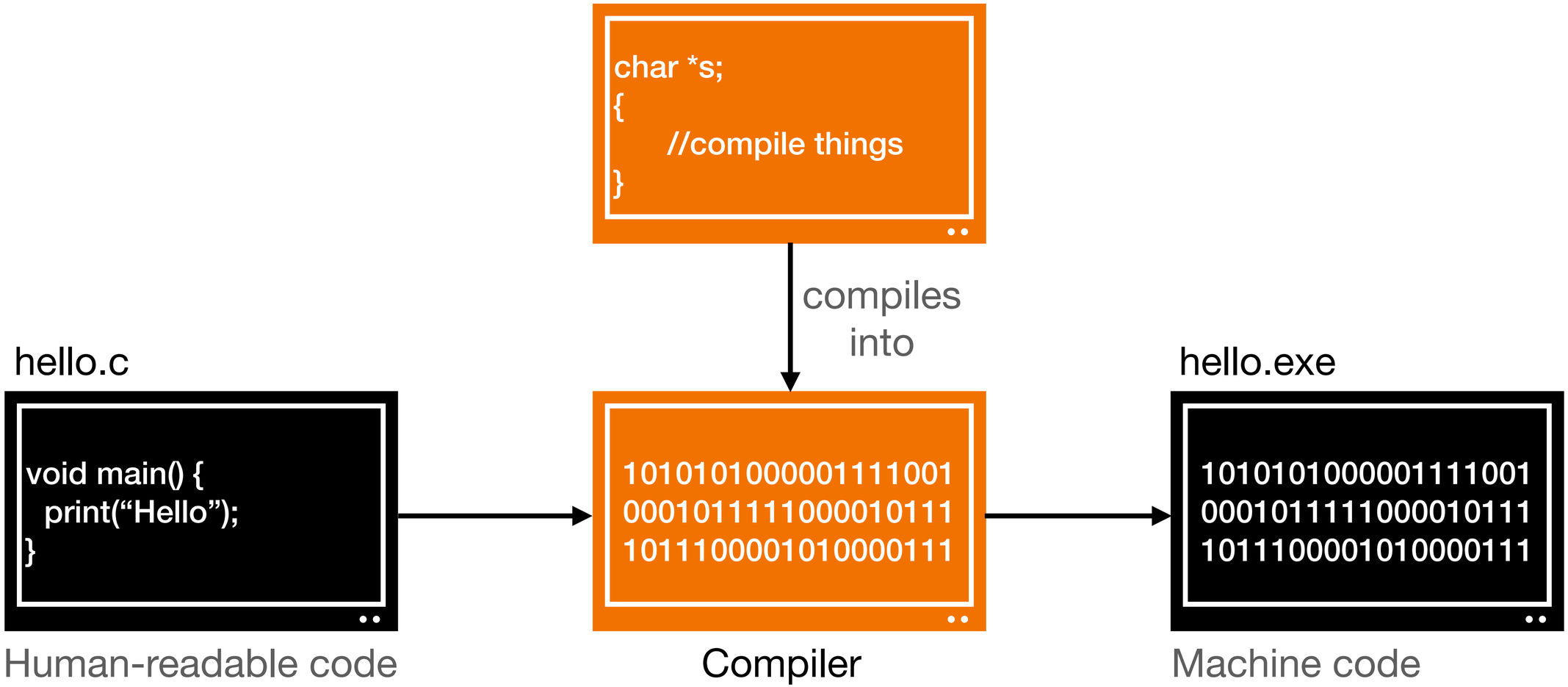
- Trusting Trust
- Authentication, Authorization, Auditing
- Threat Modeling
- Offensive / Defensive Security

Ken Thompson

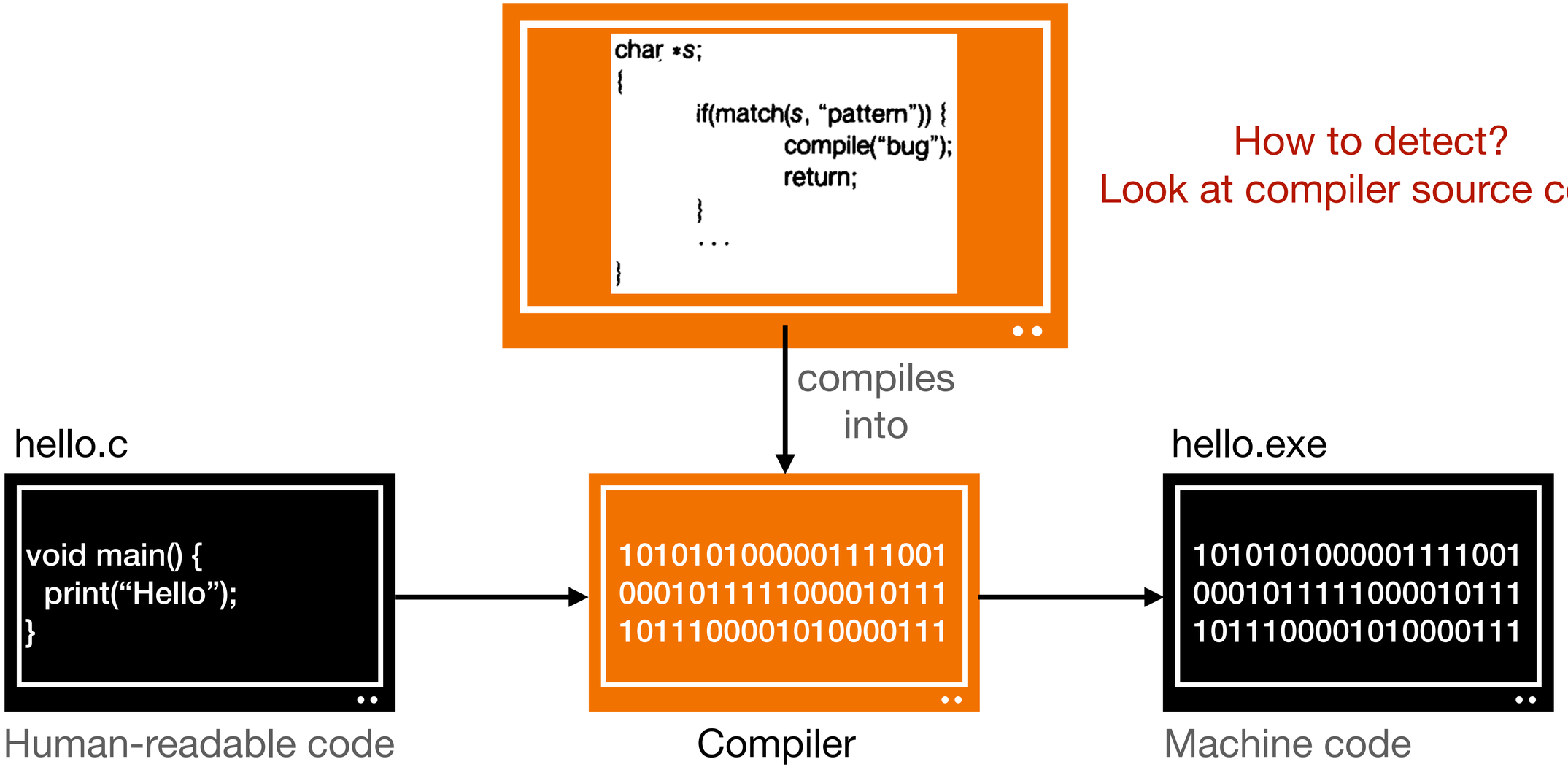
Co-creator of UNIX and Golang



Reflections on Trusting Trust

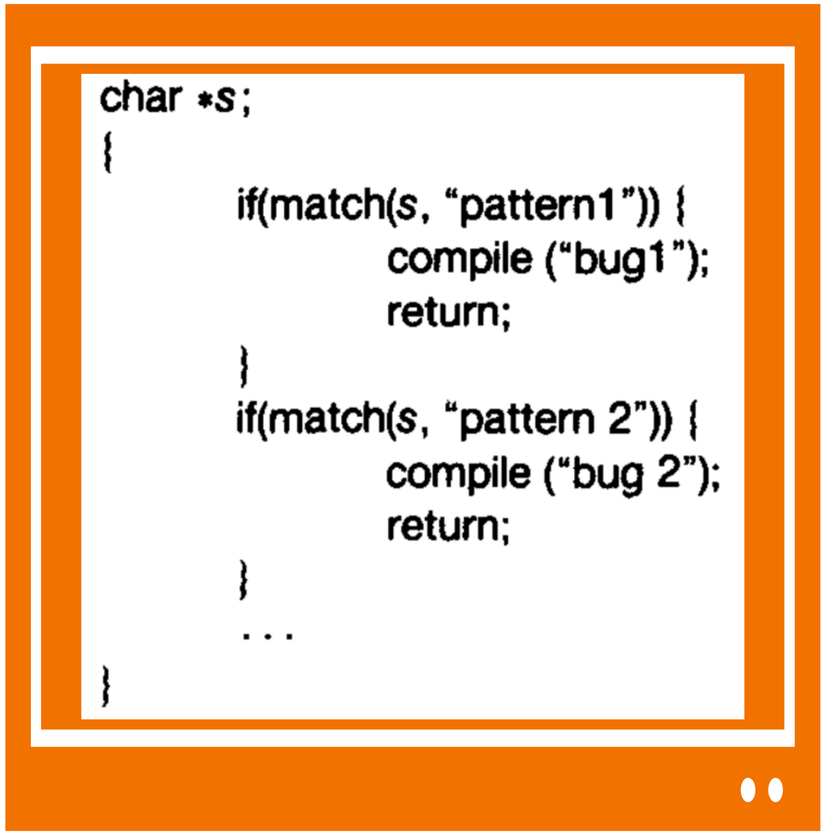


Reflections on Trusting Trust



How to detect?
Look at compiler source code!

Reflections on Trusting Trust



```
char *s;
{
        if(match(s, "pattern1")) {
                compile ("bug1");
                return;
        }
        if(match(s, "pattern 2")) {
                compile ("bug 2");
                return;
        }
        ...
}
```

- Pattern 1 = login operation that becomes insecure when compiled with bug
- Pattern 2 = compiler; anytime this compiler is compiling a future version of the compiler, it will inject the two matching patterns on the left
- Compiler binary contains both pattern 1 and pattern 2 bugs, in perpetuity, even if we remove them from the compiler source code!
- tl;dr - self-perpetuating vulnerability-injecting compiler that only exists in the machine code binary and cannot be seen from source

Reflections on Trusting Trust

MORAL
The moral is obvious. You can't trust code that you did not totally create yourself. (Especially code from companies that employ people like me.) No amount of source-level verification or scrutiny will protect you

- Can't trust compiler —> verify correctness of compiler beforehand or write your own from machine code
- Can't trust processor to execute code properly —> test hardware / drivers beforehand or create your own processor, and so on…
- Can't trust anyone implies…***do everything yourself, from scratch.***

Less daunting alternative?

- Accept the impossibility of perfect, guaranteed security - rely on trust!
- This is how modern society works
    - Trust government regulation - food from the store is safe to eat
    - Trust societal norms / laws - drivers won't act erratically
    - Trust friends, family - help you do things

Trust is imperfect - no guarantees, but it's more realistic than the alternative.

Trust enforcement

- Trust X to do A. If they don't, you can:

  1. Choose not to trust X in the future (e.g., don't purchase from brand X, which produces low quality items)

  2. And/or punish X (e.g., going to jail for breaking the law)

- Trust on the internet is difficult because:

  - Inadequate authentication - can't determine who to trust / distrust

  - Insufficient regulation / laws - few repercussions for trust-breakers

  - Implicit trust - cannot automatically act on violations of trust

Inadequate authentication

- Scenario: someone hacks your web server / phishes you / installs malware
    - IP-based network logs are insufficient to track down who did it
        - Tor network, bulletproof hosting clouds don’t track humans
    - Can’t avoid the same actor next time, too easy to spin up an infinite number of new “network identity” - website names, IPs, phishing sites
- Scenario: you get scammed and your Bitcoin wallet is drained.
    - Even though all bitcoin transactions are “authenticated” with a cryptographic key pair, any one can spin up any number of Bitcoin identities and mix / wash the stolen funds

Insufficient regulation

- For example, no laws against online abuse / harassment
    - The internet makes crime/abuse scalable, different enforcement considerations
- Even when there are laws, they are often just a “slap on the wrist”

- Thousands of customer’s raw DNA data exposed to the public —> $75K fine
- The European Union has been leading the way: e.g., General Data Protection Regulation

Implicit trust

- Even when authentication and legal consequences exist, we don’t explicitly track who we are trusting for what!
- Supply-chain security
    - Both hardware and software supply chain
- **Provenance**: a record of ownership, used as a guide to authenticity or quality
    - System provenance: trace which processes communicate with each other, and what resources they access
    - Network provenance: trace which network hosts communicate, and what data they transmit to each other

What about privacy?

- Crucial aspect; should be decided by society + legislation, not companies
- Privacy vs authentication is a nuanced spectrum
    - Potential starting point - digital equivalent of non-digital societal norms?

- Privacy vs accountability tradeoff: e.g., cash usage in the US; Tor darkweb
    - Challenge: privacy benefits individuals, privacy abuse can harm many

Research project: characterize + quantify this tradeoff

AAA: Authentication, Authorization, Auditing

- Butler Lampson (1992 Turing Award winner)

- Premise = some system with sensitive / valuable resources; for example, website with user health info, power generator, memory of a VM / process

- Authentication: who is trying to access the resource
- Authorization: what the authenticated entity is allowed to do (read, modify)
- Auditing: a log of “Who did what when?” - for retroactive detection / forensics

Why don’t we have “real” security?

- Systems are complicated, so they have bugs
- People don’t buy it
  - Danger is small, so it’s OK to buy features instead
  - Security is expensive
    - Configuring security is a lot of work
    - Secure systems do less because they’re older
  - Security is a pain
    - It stops you from doing things
    - Users have to authenticate themselves
  - Goals are unrealistic, ignoring technical feasibility and user behavior

Butler Lampson. “Perspectives on Security.” *SOSP,* 2015.

TODOs for you

First paper reading + questions will be due by 6PM **Tuesday, October 10th**.

Get the creative juices flowing! Project proposals (1-page max, at least 10pt font, single spaced) due **9PM Wednesday, October 18th**.

> If you feel stuck, please come discuss ideas at office hours, or schedule time to chat with me