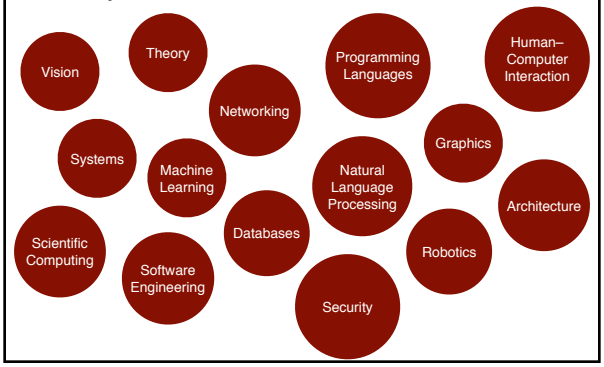
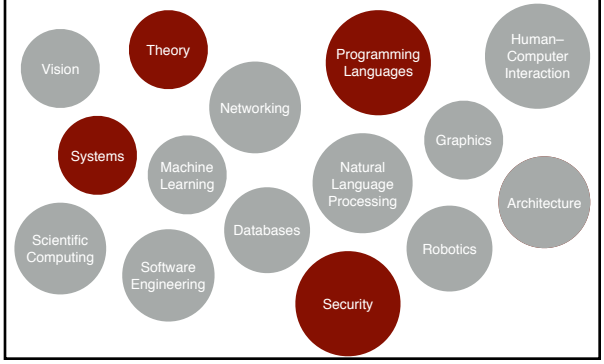
Computer Security

CS 2110 3 May, 2018

Computer Science



Computer Security



Computer Security

- Security is about making sure that computers behave correctly
- A secure system should:
  1) Do what it is supposed to do
  2) Not do anything else

What might go wrong

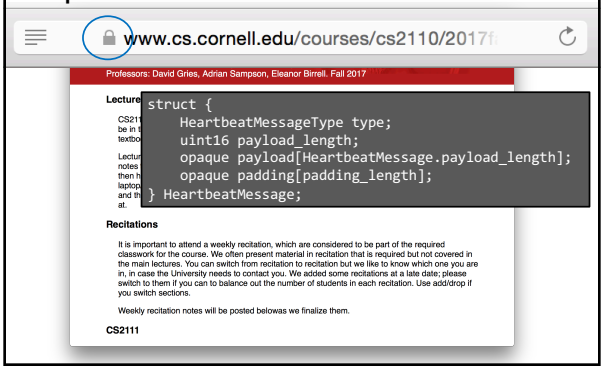
```
public class ObjectStore {
      private Object[] objects;

      public ObjectStore(int len){
            objects = new Object[len];
      }

      public Object read(int i){
            return objects[i];
      }

      public void store(int i, Object o){
            objects[i]= o;
      }
}
```


OpenSSL




```
struct {
    HeartbeatMessageType type;
    uint16 payload_length;
    opaque payload[HeartbeatMessage.payload_length];
    opaque padding[padding_length];
} HeartbeatMessage;
```

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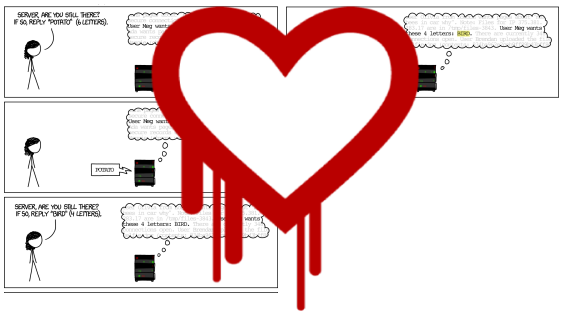
Heartbleed



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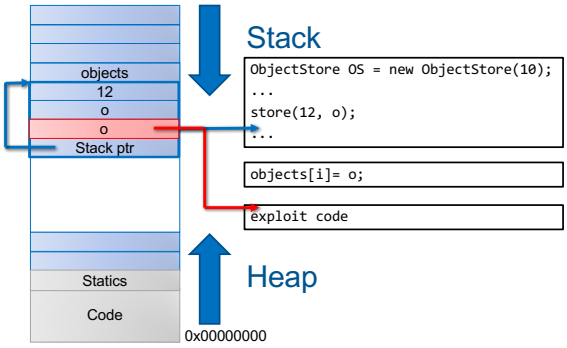
Memory



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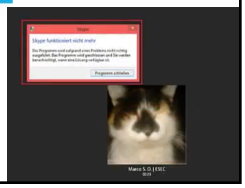
Skype Vulnerability



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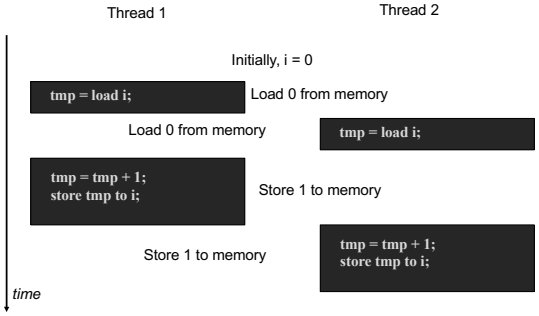
What might go wrong



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Copy-on-write (COW)

- Common resource optimization
- When someone copies a file, it doesn't really get copied
- If/when someone modifies the "copy" the original file gets copied and modified

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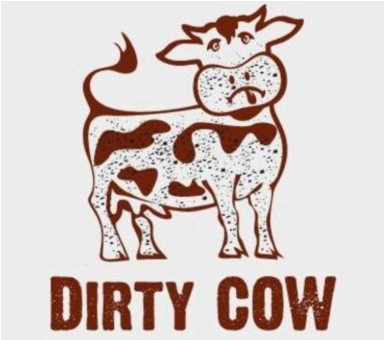
Privilege Escalation



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So how do we fix this?

- Testing
- Bug finding tools

FindBugs™

- White-hat hacking

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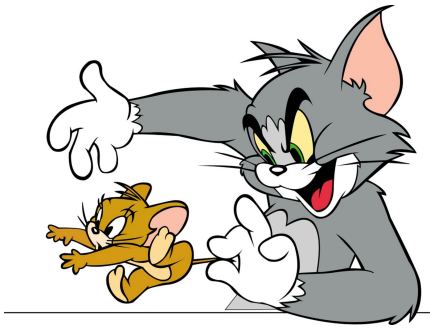

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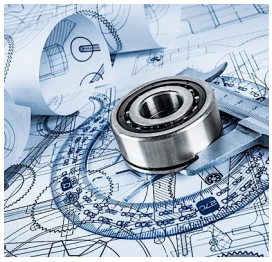
So how do we fix this?



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Security by Design

- Build secure, trustworthy computer systems/applications/etc.
- Define what the system is supposed to do
- Make sure it does that (and only that)

Engineering Security

Attacks
are perpetrated by
threats
that cause
incorrect behavior
by exploiting
vulnerabilities
which are controlled by
countermeasures.

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How do we specify what systems are and are not supposed to do?

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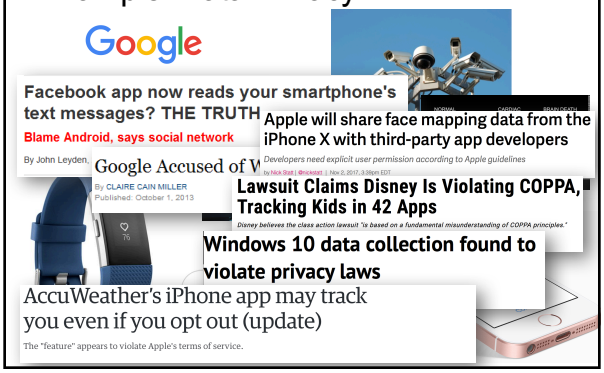
Example: Data Privacy



What is Privacy?

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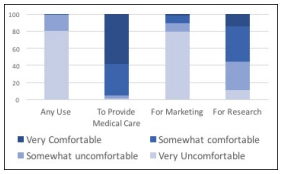
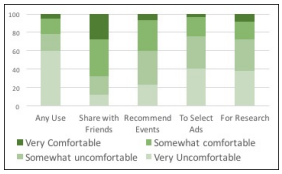
Use-Based Privacy

- Privacy viewed as **restrictions on uses** [Cate02]
- Captures modern privacy goals
  - express restrictions in presence of necessary sharing



Medical Data



Social Network Data

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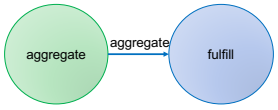
Policy Language




```
[{"curr":"1",
"states":{"1":{"name":"s1-1",
"permissions":{"aggregate":true},
"transitions":{"aggregate":"s2-1"},
"defaultPermission":false},
"2":{"name":"s2-1",
"permissions":{"fulfill":true},
"transitions":{},
"defaultPermission":true}}},
{"curr":"2",
"states":{"1":{"name":"s1-2",
"permissions":{"aggregate":true},
"transitions":{"aggregate":"s2-2"},
"defaultPermission":false},
"2":{"name":"s2-2",
"permissions":{"fulfill":true},
"transitions":{},
"defaultPermission":true}}}]
```

Engineering Security

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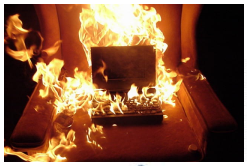
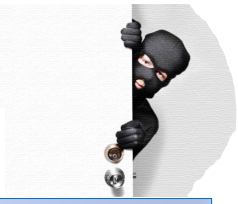
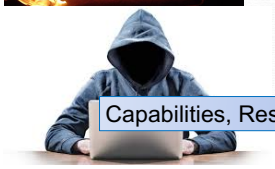
What are the threats?

Threat Models

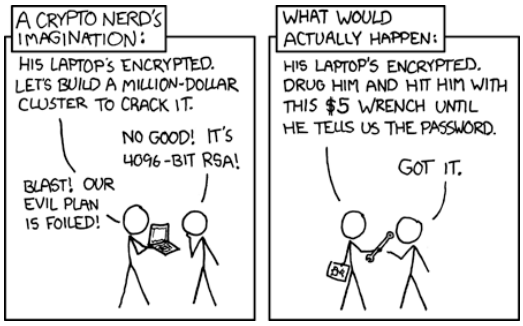






Capabilities, Resources, Motivation

Threat Models



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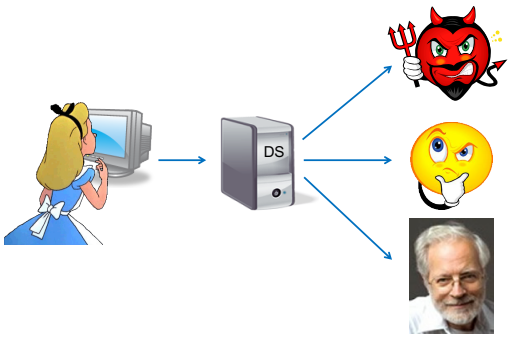
Example: Threat Model for Data Privacy



Engineering Security

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How do we design countermeasures

Classes of Countermeaures

79 Au Gold 196.967 thentication: mechanisms that bind principals to actions

79 Au Gold 196.967 thorization: mechanisms that govern whether actions are permitted

79 Au Gold 196.967 dit: mechanisms that record and review actions

Approaches to security

- Axiomatic security
  - You trust someone else to get it right

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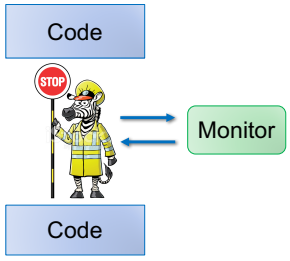
- Axiomatic security
  - You trust someone else to get it right
- Constructive security
  - E.g., compiler checks, automated proofs

```
35
36   String s=5;
37
```


Approaches to security

- Axiomatic security
  - You trust someone else to get it right
- Constructive security
  - E.g., compiler checks, automated proofs
- Synthetic security
  - Modify the code to add checks (e.g., monitoring)

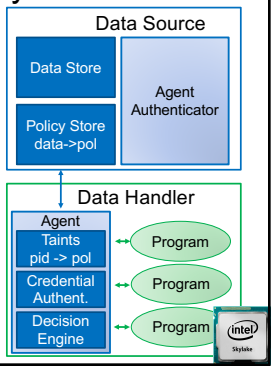


Approaches to security

- Axiomatic security
  - You trust someone else to get it right
- Constructive security
  - E.g., compiler checks, automated proofs
- Synthetic security
  - Modify the code to add checks (e.g., monitoring)
- Deterrence through accountability
  - Make sure you'll notice if something goes wrong

Example: Data Privacy from SGX

- Policy enforcement implemented by external monitor that runs on DHs
  - monitor can send/receive values from DS
  - monitor shares values with authorized programs co-located at DH
    - auth decisions based on credentials
  - unauthorized values are cryptographically sealed with associated policy to prevent authorized use
  - monitor maintains taint for each program, automatically derives policies for derived values

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Security
DIRTY COW
[{"curr":"1",
"states":{"1":{"name":"s1-1",
"permissions":{"aggregate":true},
"transitions":{"aggregate":"s2-1"}
"defaultPermission":false},
"2":{"name":"s2-1",
"permissions":{"fulfill":true},
"tr
"de
n":true}}}]
STOP
intel
Skylake