https://crypto.stanford.edu/cs155

CS155

Computer Security

Course overview

The computer security problem

- **Lots of buggy software**

- **Social engineering is very effective**

- **Money can be made from finding and exploiting vulns**.

  1. Marketplace for vulnerabilities

  2. Marketplace for owned machines (PPI)

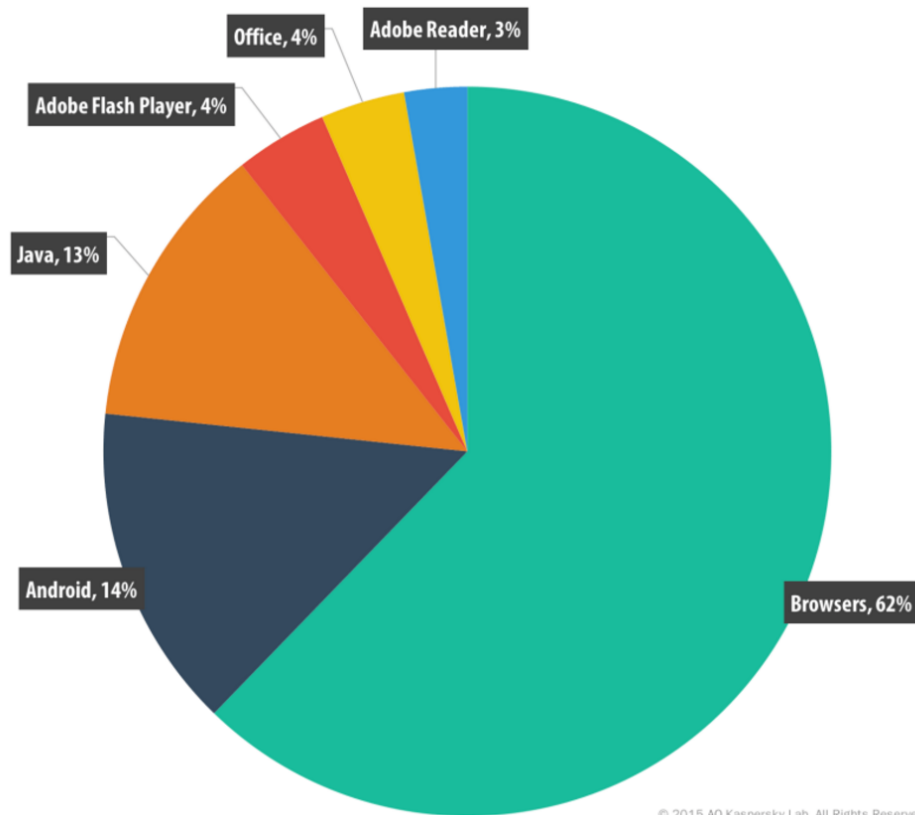 3. Many methods to profit from owned machines

current state of computer security

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Lots of vulnerability disclosures (2015)

	Product Name	Vendor Name	Product Type	Number of Vulnerabilities
1	Mac Os X	Apple	OS	385
2	Iphone Os	Apple	OS	376
3	Flash Player	Adobe	Application	313
4	Air Sdk	Adobe	Application	246
5	AIR	Adobe	Application	246
6	Air Sdk & Compiler	Adobe	Application	246
7	Internet Explorer	Microsoft	Application	231
8	Chrome	Google	Application	187
9	Firefox	Mozilla	Application	178
10	Windows Server 2012	Microsoft	OS	155
11	Ubuntu Linux	Canonical	OS	152
12	Windows 8.1	Microsoft	OS	151

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Vulnerable applications being exploited

Office, 4%
Adobe Reader, 3%
Adobe Flash Player, 4%
Java, 13%
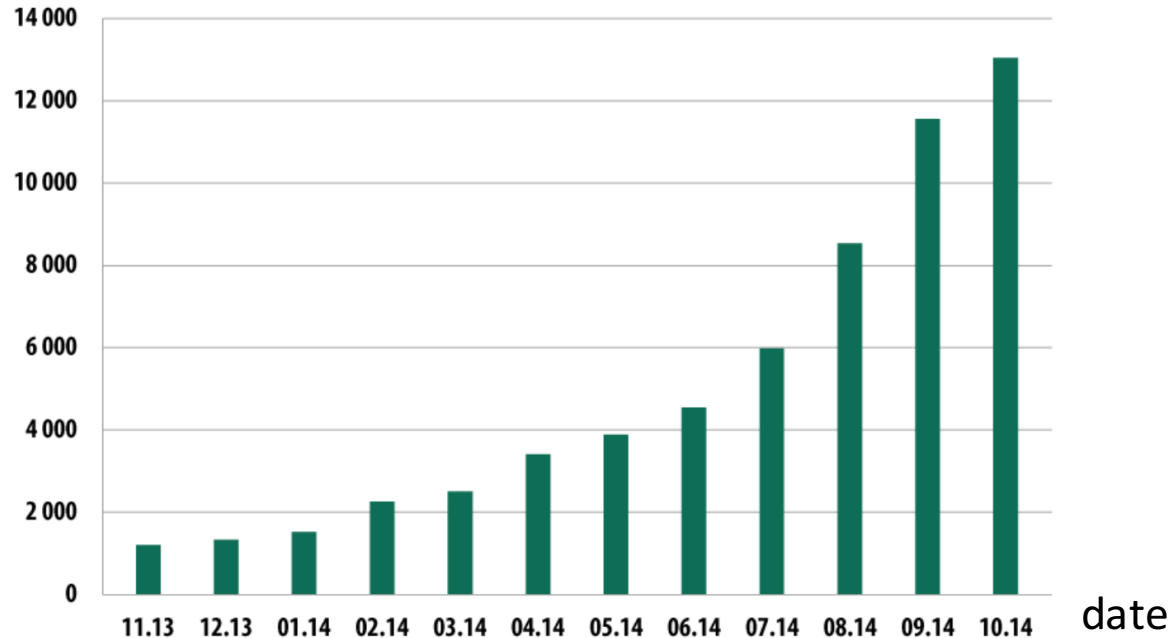Android, 14%
Browsers, 62%

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Source: Kaspersky Security Bulletin 2015

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Mobile malware (Nov. 2013 – Oct. 2014)

The rise of mobile banking Trojans (Kaspersky Security Bulletin 2014)

Introduction

Sample attacks

Why own machines:
1. IP address and bandwidth stealing

Attacker's goal: look like a random Internet user

Use the IP address of infected machine or phone for:

- **Spam**   (e.g. the storm botnet)

  Spamalytics: 1:12M pharma spams leads to purchase
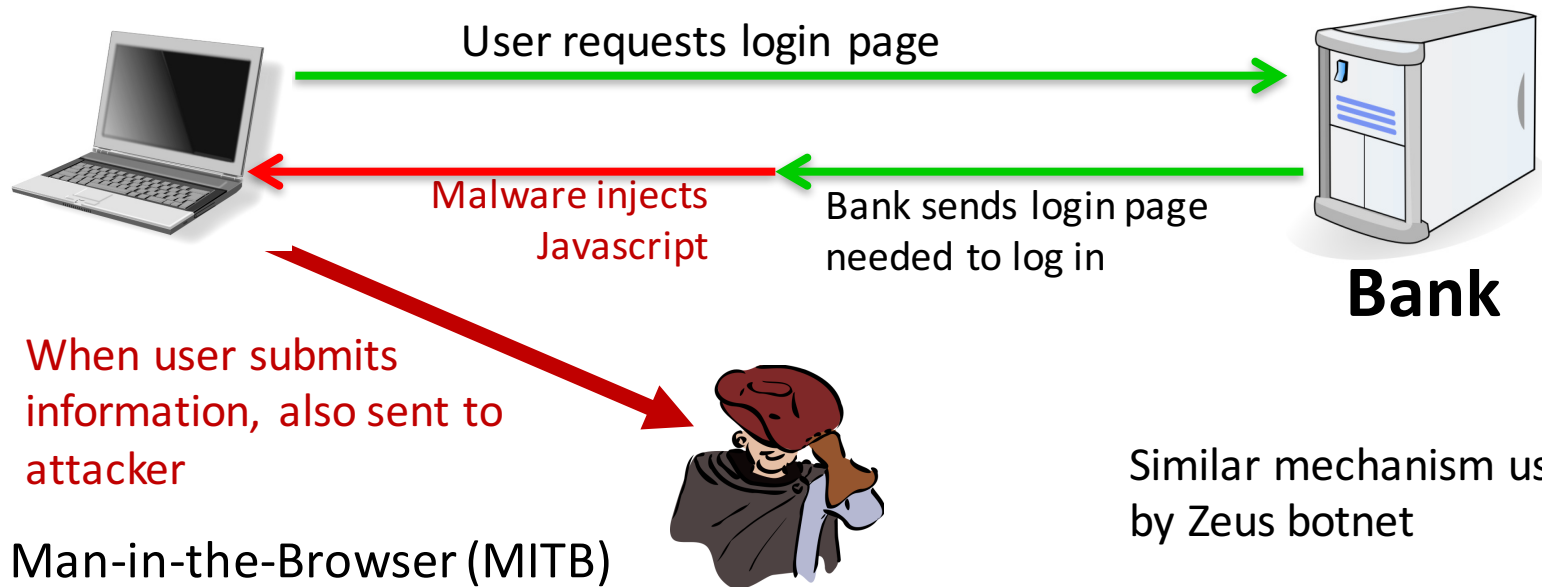
  1:260K greeting card spams leads to infection

- **Denial of Service:**   Services: 1 hour (20$),   24 hours (100$)

- **Click fraud** (e.g. Clickbot.a)

Why own machines:
2. Steal user credentials and inject ads

keylog for banking passwords, web passwords, gaming pwds.

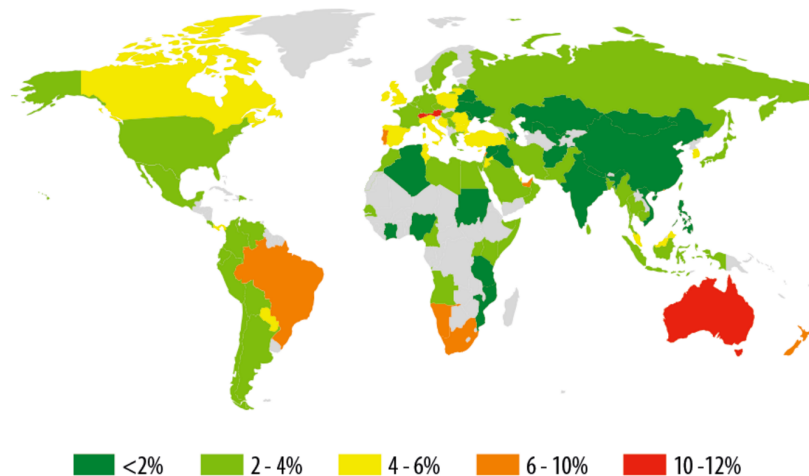Example: SilentBanker (and many like it)

User requests login page

Malware injects Javascript

Bank sends login page needed to log in

Bank

When user submits information, also sent to attacker

Man-in-the-Browser (MITB)

Similar mechanism used by Zeus botnet

Lots of financial malware

1	Trojan-Downloader.Win32.Upatre
2	Trojan-Spy.Win32.Zbot
3	Trojan-Banker.Win32.ChePro
4	Trojan-Banker.Win32.Shiotob
5	Trojan-Banker.Win32.Banbra
6	Trojan-Banker.Win32.Caphaw
7	Trojan-Banker.AndroidOS.Faketoken
8	Trojan-Banker.AndroidOS.Marcher
9	Trojan-Banker.Win32.Tinba
10	Trojan-Banker.JS.Agent

- size: 3.5 KB

- spread via email attachments

- also found on home routers

Source: Kaspersky Security Bulletin 2015

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Users attacked: stats
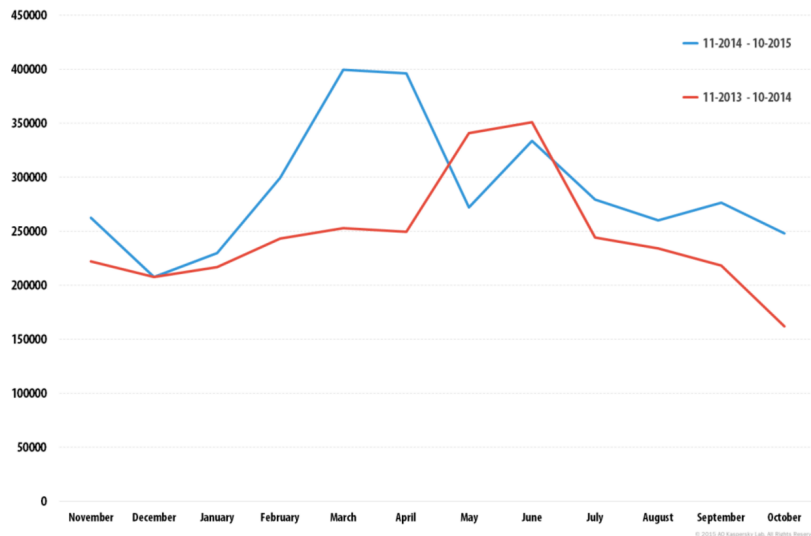
≈ 300,000 users worldwide

A worldwide problem

Source: Kaspersky Security Bulletin 2015

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Why own machines: 3. **Ransomware**

1	Trojan-Ransom.HTML.Agent
2	Trojan-Ransom.JS.Blocker
3	Trojan-Ransom.JS.InstallExtension
4	Trojan-Ransom.NSIS.Onion
5	Trojan-Ransom.Win32.Cryakl
6	Trojan-Ransom.Win32.Cryptodef
7	Trojan-Ransom.Win32.Snocry
8	Trojan-Ransom.BAT.Scatter
9	Trojan-Ransom.Win32.Crypmod
10	Trojan-Ransom.Win32.Shade

CryptoWall (2014-)
- targets Windows
- spread by spam emails

≈ 200,000 machines in 2015

A worldwide problem.

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Why own machines:
4. Spread to isolated systems

Example: **Stuxnet**

Windows infection $\Rightarrow$

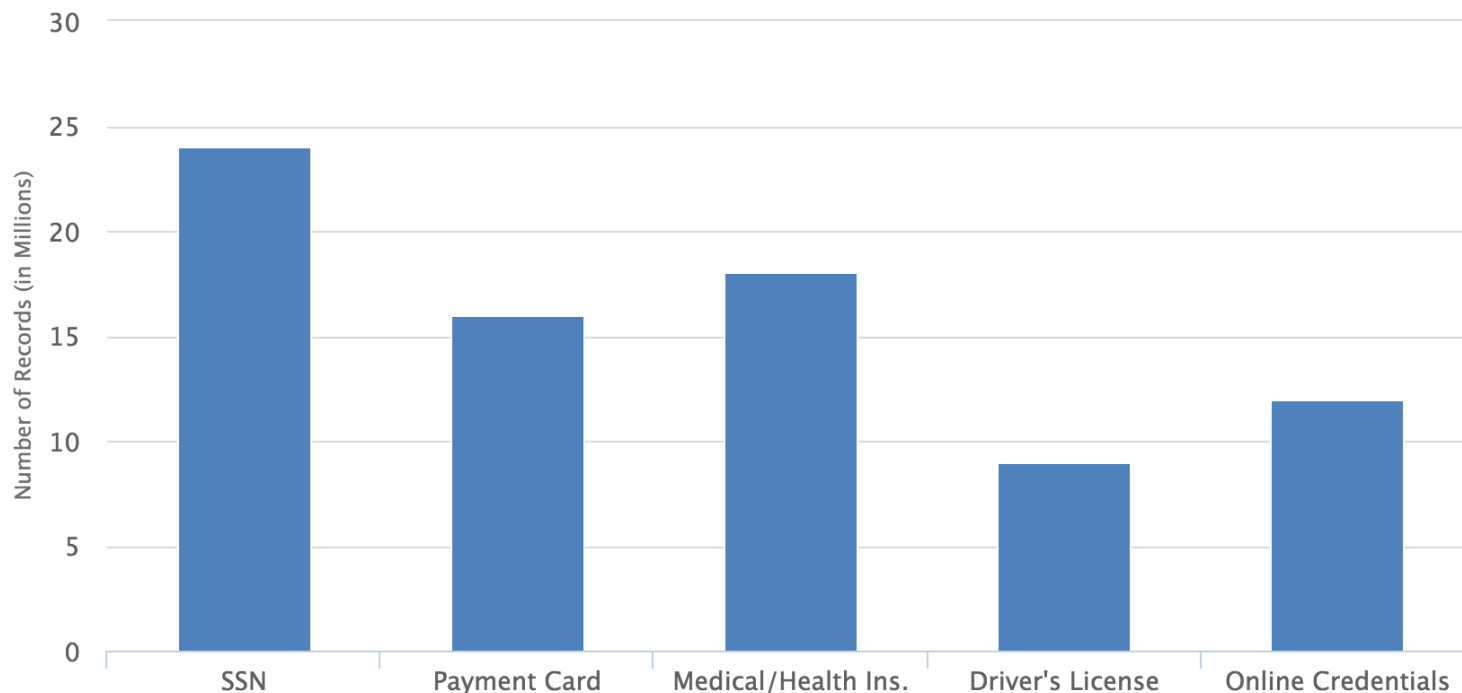 Siemens PCS 7 SCADA control software on Windows $\Rightarrow$

   Siemens device controller on isolated network

More on this later in course

Server-side attacks

- Financial data theft: often credit card numbers

  - Example: Target attack (2013),   ≈ 140M CC numbers stolen
  - Many similar (smaller) attacks since 2000

- Political motivation:

  - Aurora,   Tunisia Facebook (Feb. 2011),   GitHub (Mar. 2015)

- Infect visiting users

Types of data stolen (2012-2015)

Example: Mpack

- PHP-based tools installed on compromised web sites
  - Embedded as an iframe on infected page
  - Infects browsers that visit site

- Features
  - management console provides stats on infection rates
  - Sold for several 100$
  - Customer care can be purchased, one-year support contract

- Impact: 500,000 infected sites   (compromised via SQL injection)
  - Several defenses: e.g. Google safe browsing

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Insider attacks: example

Hidden trap door in Linux (nov 2003)

– Allows attacker to take over a computer

– Practically undetectable change   (uncovered via CVS logs)

Inserted line in wait4()

```
if ((options == (__WCLONE|__WALL)) && (current->uid = 0))
            retval = -EINVAL;
```

Looks like a standard error check, but …

See: http://lwn.net/Articles/57135/

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Many more examples

- Access to SIPRnet and a CD-RW: 260,000 cables $\Rightarrow$ Wikileaks

- SysAdmin for city of SF government.
        Changed passwords, locking out city from router access

- Inside logic bomb took down 2000 UBS servers
    ⋮

Can security technology help?

How companies lose data

Source: California breach notification report, 2015

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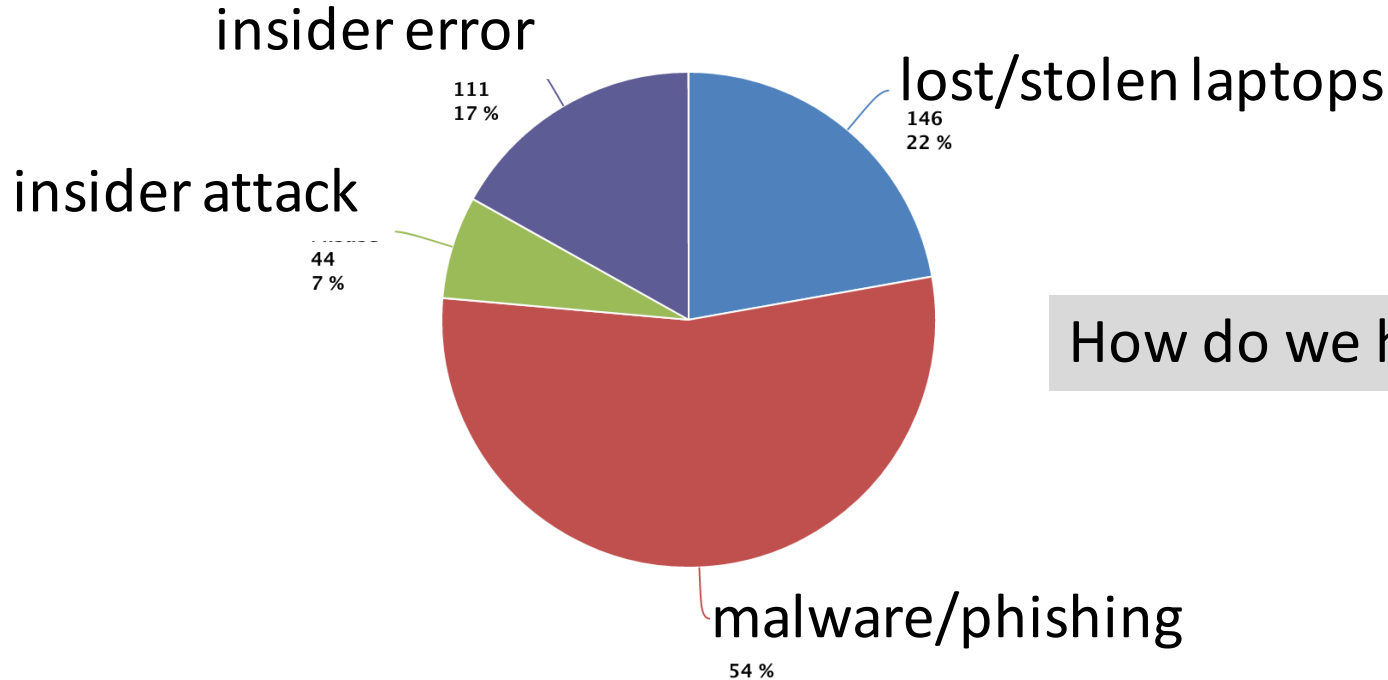
Introduction

The Marketplace for Vulnerabilities

Marketplace for Vulnerabilities

Option 1:   bug bounty programs (many)

- Google Vulnerability Reward Program: up to $20K
- Microsoft Bounty Program: up to $100K
- Mozilla Bug Bounty program: $7500
- Pwn2Own competition: $15K

Option 2:
- Zero day initiative (ZDI),   iDefense: $2K – $25K

Example: Mozilla

Novel vulnerability and exploit, new form of exploitation or an exceptional vulnerability	High quality bug report with clearly exploitable critical vulnerability$_1$	High quality bug report of a critical or high vulnerability$_2$	Minimum for a high or critical vulnerability$_3$	Medium vulnerability
$10,000+	$7,500	$5,000	$3,000	$500 - $2500

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Marketplace for Vulnerabilities

Option 3: black market

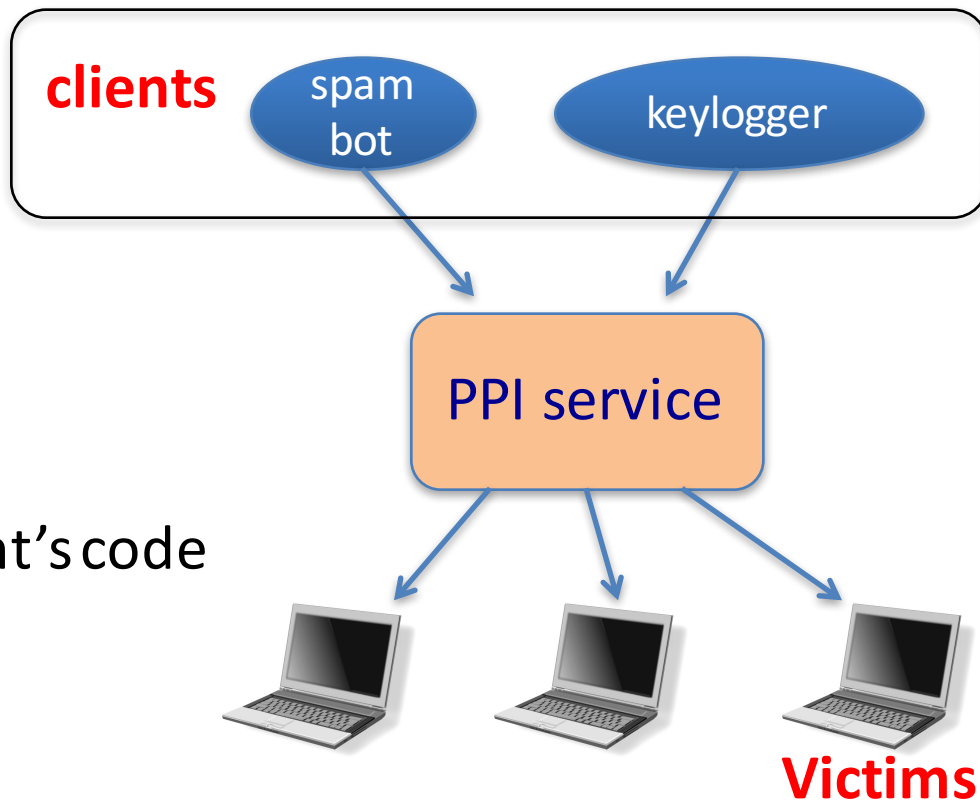|	
ADOBE READER	$5,000–$30,000
MAC OSX	$20,000–$50,000
ANDROID	$30,000–$60,000
FLASH OR JAVA BROWSER PLUG-INS	$40,000–$100,000
MICROSOFT WORD	$50,000–$100,000
WINDOWS	$60,000–$120,000
FIREFOX OR SAFARI	$60,000–$150,000
CHROME OR INTERNET EXPLORER	$80,000–$200,000
IOS	$100,000–$250,000

Source: Andy Greenberg   (Forbes, 3/23/2012)
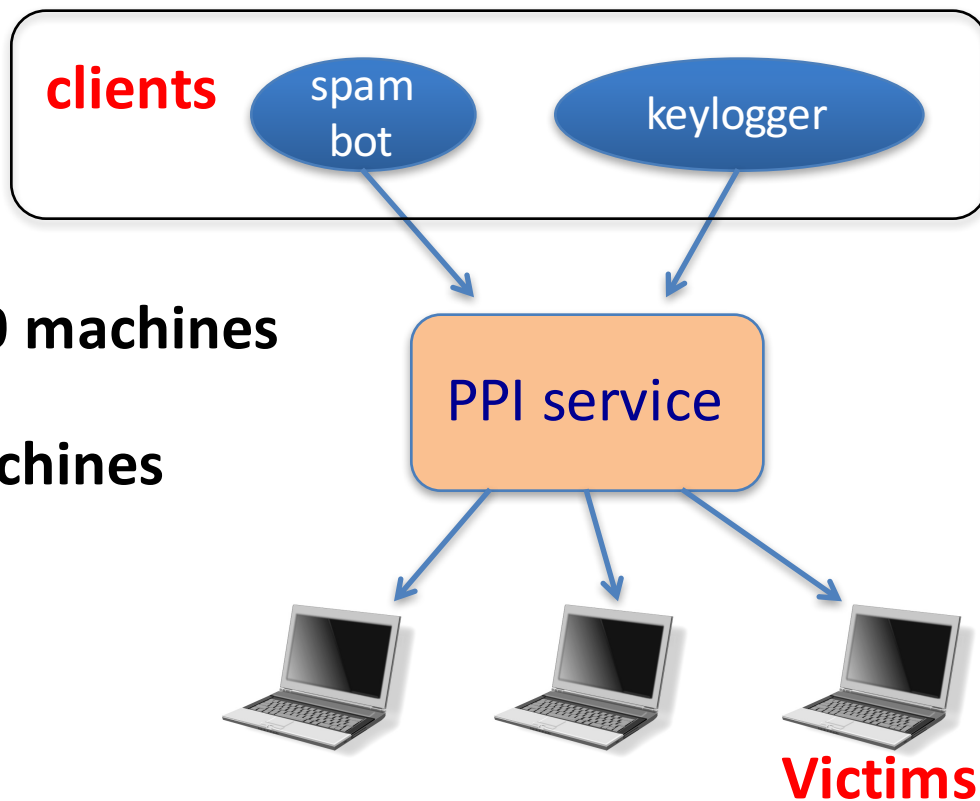
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Marketplace for owned machines

Pay-per-install (PPI) services

PPI operation:

1. Own victim's machine
2. Download and install client's code
3. Charge client

clients

spam bot

keylogger

PPI service

Victims

Source: Cabalerro et al. (www.icir.org/vern/papers/ppi-usesec11.pdf)

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Marketplace for owned machines

clients

spam bot

keylogger

Cost: **US   - 100-180\$ / 1000 machines**

  Asia -   7-8\$ / 1000 machines

PPI service

Victims

Source: Cabalerro et al.   (www.icir.org/vern/papers/ppi-usesec11.pdf)

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This course

Goals:

- Be aware of exploit techniques

- Learn to defend and avoid common exploits

- Learn to architect secure systems

This course

Part 1: **basics**   (architecting for security)

- Securing apps, OS, and legacy code
  Isolation, authentication, and access control

Part 2: **Web security**   (defending against a web attacker)

- Building robust web sites, understand the browser security model

Part 3: **network security**   (defending against a network attacker)

- Monitoring and architecting secure networks.

Part 4: **securing mobile applications**

Don't try this at home !

Ken Thompson's clever Trojan